G20
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TECHNICAL PAPERS

Environment and Climate Sustainability Working Group

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TECHNICAL PAPERS

The Technical Papers presented here were commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although these papers were subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Mobilising G20 Leadership to Support and Strengthen the Operationalisation of Subregional Technical and Scientific Cooperation Support Centres Established Under the CBD.

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This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

EXECUTIVE SUMMARY

As the world faces unprecedented biodiversity loss, effective implementation of the Kunming-Montreal Global Biodiversity Framework (KMGBF) adopted by the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) in Decision 15/4 has become essential. To ensure the full and effective implementation of the KMGBF, the CBD CoP, in its Decision 15/8, established the Global Mechanism for Technical and Scientific Cooperation aimed at facilitating access to science, technology, and innovation in support of the Convention and the KMGBF. This mechanism comprises a network of 18 regional and subregional technical and scientific cooperation support centres (TSCs) coordinated by a Global Coordination Entity hosted by the CBD Secretariat, 14 of which support developing countries and countries with economies in transition. Moreover, some of these 18 TSCs are hosted within the G20 countries, and by extension serve some of the G20 members. The primary function of each of these TSCs is to promote and facilitate technical and scientific cooperation, technology transfer, foster innovation, and offer capacity-building programmes, thus enabling the Parties to effectively utilize science, technology, and innovation to support the implementation of the KMGBF.

The paper calls on G20 member states to formally recognise the TSCs as critical institutional mechanisms for fostering international cooperation in biodiversity science, technology transfer and facilitating innovation for the successful implementation of the KMGBF. The centres serve as a pivotal vehicle for facilitating North-South and South-South collaboration, thereby enabling developing countries access to cutting-edge technologies and scientific expertise required for the implementation, monitoring and reporting of the KMGBF. The recognition and institutionalisation of these Centres under the ambit of the G20 framework further reinforces commitments under the KMGBF to ensure that all member states, regardless of their economic status, can leverage advanced scientific tools, innovative solutions and the necessary knowledge required to realise their 2030 Agenda. Recognising the TSCs under the G20 framework will enable mobilisation of resources, in accordance with Articles 16-20 of CBD, through strengthened international cooperation and promote equitable sharing of biodiversity-related technology and expertise, thereby accelerating the achievements of the KMGBF. Therefore, strategic recognition and support from the G20 member states are needed to enable these TSCs to fully deliver on their potential, leading to equitable access to knowledge, technology, and capacity-building opportunities across CBD Parties.

1 INTRODUCTION

The Fifth Edition of the Global Biodiversity Outlook (GBO-5) – *A report which provides global summary of progress made towards implementing the CBD's Strategic Plan for Biodiversity*

2011-2020 and the successes and challenges experienced in reaching the Aichi Biodiversity Targets - shows that none of the targets had been fully achieved by 2020 and that biodiversity continues to decline at an unprecedented rate[1].

A key message emanating from the GBO-5 was a need to give greater attention to the implementation and sustained and targeted support to countries, including through the promotion and facilitation of the technical and scientific cooperation among countries, *if we are to improve our capacity to halt and reverse biodiversity loss*[2].

Parties to the convention noted a high demand for opportunities to engage in technical and scientific cooperation initiatives undertaken by the Executive Secretary pursuant to CBD COP Decisions XI/29, XII/2 B, XIII/23 B and 14/24 (CBD/SBI/3/7). These initiatives played a key role in supporting the implementation of NBSAPs II, enabling South-South and triangular cooperation, and providing direct technical assistance to national governments.

This is despite the fact that these technical and scientific cooperation initiatives have been small and mainly short-term, not tailored to individual Party needs and gaps. This compromised their potential to leverage additional resources and deliver impactful and sustainable results through multi-stakeholder partnerships (CBD/SBI/3/7).

The primary lesson from these past technical and scientific cooperation initiatives is the need for the convention to strengthen this mechanism by ensuring that it is targeted and has dedicated resources, including human, technical and financial, for the effective implementation of any future global biodiversity framework (CBD/SBI/3/7).

Following the adoption of the Kunming-Montreal Global Biodiversity Framework (KMGBF) in December 2022, the CBD COP 15 and subsequent COP 16 adopted a comprehensive package of decisions, including the establishment of the Technical and Scientific Cooperation (TSC) mechanism to guide and support the implementation of the Convention, its Protocols and the KMGBF[3].

This TSC mechanism comprises a network of 18 Subregional TSC Support Centres coordinated by a Global Coordination Entity hosted by the CBD Secretariat. Several of the 18 TSCs are located in G20 countries and by extension also serve the G20 Member States, including the South African National Biodiversity Institute, Nanjing Institute of Environmental Sciences in China, and those within the European Union (Joint Research Centre, IUCN Centre for Mediterranean Cooperation, and the Royal Belgian Institute for Natural Science) (See Figure 1[4]). Fourteen of the 18 TSCs support developing countries and countries with economies in transition, including the CBD Parties in Africa, Asia, the Americas and Oceania.

This TSC mechanism has been designed to support Parties, particularly developing countries that lack the necessary resources to research, monitor, and manage biodiversity sustainably

[1] https://www.cbd.int/gbo5
[2] (https://www.cbd.int/gbo5)
[3] (https://www.cbd.int/decisions/cop/15/8)
[4] https://www.cbd.int/decisions/cop/15/8

by bridging gaps in knowledge, capacity, and access to technology, thereby enabling the conservation, sustainable use and equitable and fair benefit sharing arising from biodiversity while fostering sustainable development[5].

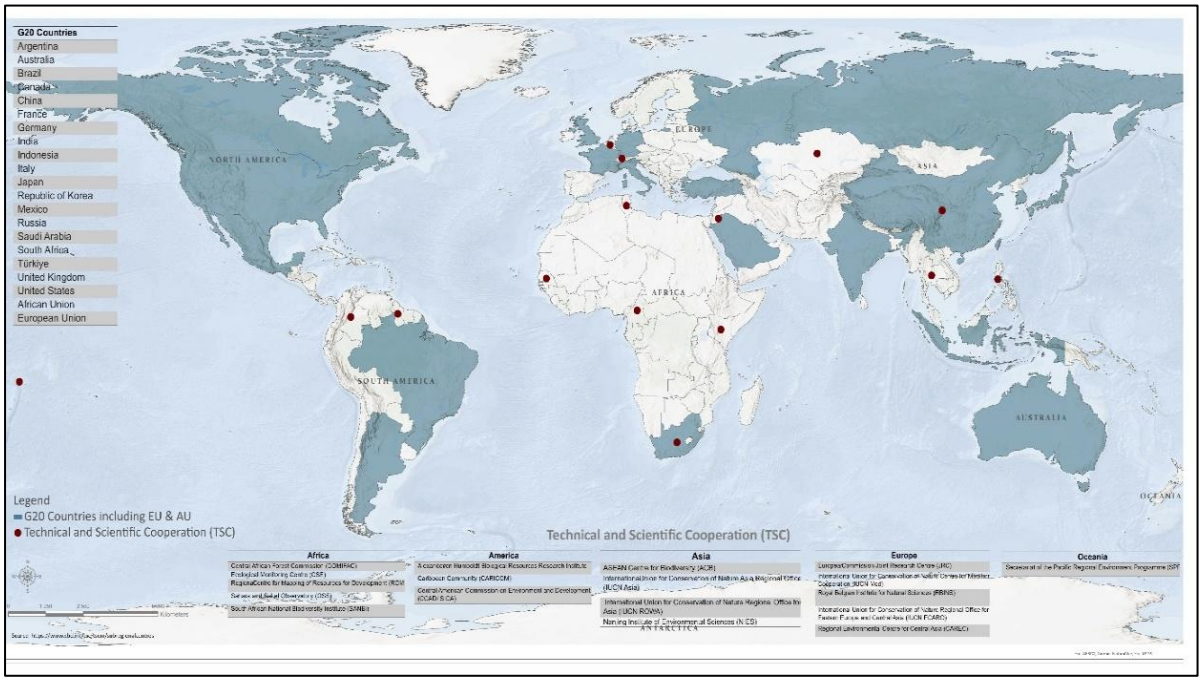


Figure 1: *Location of the 18 Technical and Scientific Cooperation Support Centres*

The primary function of each of these TSCs is to promote and facilitate technical and scientific cooperation, technology transfer, foster innovation, and offer capacity-building programmes, for the effective implementation of the KMGBF[6]. These 'one-stop service centres' which are accessible to all the KMGBF stakeholders (Member States, Indigenous Peoples, local communities, women, and youth organisations) will also promote inclusive and sustainable development[7].

This builds on the CBD Preamble, which recognizes that biodiversity conservation requires international collaboration and also acknowledges the special needs of developing countries[8]. The TSC mechanism also puts into practice Article 16 and Article 18 of the CBD, which emphasize the importance of equitable access to technology and knowledge-sharing to achieve global biodiversity targets and goals[9].

The TSC mechanism, through South-South, North-South and triangular cooperation models, creates an opportunity for mutual learning and coordinated action among Parties within the same region or with similar ecosystems and environmental characteristics[10]. Moreover, the

[5] (https://www.cbd.int/decisions/cop/15/8)
[6] (https://www.cbd.int/tsc/tscm/subregionalcentres/functions)
[7] (https://www.cbd.int/tsc/tscm/subregionalcentres/functions)
[8] https://www.cbd.int/doc/legal/cbd-en.pdf
[9] (https://www.cbd.int/doc/legal/cbd-en.pdf)
[10] https://www.cbd.int/tsc/tscm/subregionalcentres/functions

scope of work under the CBD technical and scientific cooperation and technology transfer aligns well with G20 priorities on innovation, trade, and sustainable development, and offers a platform to scale up impact through partnerships and coordinated action.

Despite their mandate, functions and ultimate goals, the TSCs (particularly those serving developing countries, including small island developing states and countries with economies in transition), are currently operating without long-term institutional financing, adequate infrastructure and outreach, and dedicated human resource capacity, forcing them to rely on ad hoc resources and partnerships (CBD/COP/DEC/15/8). As independent entities, TSCs, through their host institutions, are expected to mobilise the required resources from a diverse pool of funding sources and through partnerships to provide timely and targeted support for projects and activities that address the technical and scientific needs of the Parties that each TSC serve (CBD/SBI/3/7; CBD/COP/DEC/15/8;)[11]. This includes mobilising the financial and in-kind contributions from partners.

This approaches places TSCs in developing countries and countries with economies in transition in a compromised position of competing with TSCs located in developed countries for existing multilateral resources, which are already insufficient[12]. The Kunming Biodiversity Fund (KBF), which is the only fund dedicated to providing support for the operationalisation and activities of the TSCs in least developed countries, requires these TSCs to have the requisite capacity to access available funding. However, it is more likely such resources are not readily available resulting in significant delays, which in turn may compromise their sustainability. This imbalance has the potential to increase the risk of unequal access by Parties in some CBD regions and subregions to technical and scientific cooperation and transfer (CBD/SBI/3/7) compromising the quality and sustainability of the programmes delivered to the Parties[13].

These outcomes represent a missed opportunity and create a risk for global biodiversity governance, as these countries lack the means and capacity to independently access the science, tools, and data necessary to implement biodiversity commitments[14]. Strengthening the capacity and effectiveness of the TSCs within developing countries will increase the likelihood that all nations, regardless of their economic status, are able to contribute positively to the 2050 Vision of Living in Harmony with Nature[15]. This can be achieved in accordance with Articles 16-20 of CBD, which outline the obligations of developed countries on matters pertaining to technology transfer, information sharing, cooperation and financial resources[16]. CBD Decision 16/3 also emphasises the need for developed nations to support the operationalisation and activities of the TSCs located in developing countries and countries with economies in transition.

[11] https://www.cbd.int/doc/decisions/cop-16/cop-16-dec-03-en.pdf
[12] https://www.cbd.int/doc/decisions/cop-16/cop-16-dec-03-en.pdf
[13] https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf
[14] https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-08-en.pdf
[15] https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-08-en.pdf
[16] https://www.cbd.int/doc/legal/cbd-en.pdf

An alternative option is for all the TSCs to collaborate with one another and with Parties, relevant organisations, the Consortium of Scientific Partners on Biodiversity and development cooperation agencies to leverage the expertise and resources required to achieve the technical and scientific cooperation, as envisaged in the CBD Decision 16/3.

The effective operationalisation of the TSC mechanism to meet the needs of participants requires the provision of adequate, predictable, and easily accessible resources and expertise on a needs basis. Building the necessary capacity to implement the Framework requires cooperation and collaboration[17].

To overcome the abovementioned challenges this paper make a case on how the recognition and strategic investment, by the G20 nations in accordance with articles 16-20 of the CBD, in the CBD's technical and scientific cooperation mechanism could yield high-impact and cost-effective returns. This is proposed to be done through scalable, replicable approaches to build national competence and reduce external expert dependency.

2 CURRENT MULTILATERAL DELIBERATIONS

The CBD has long recognised the need for technical and scientific cooperation between Parties to achieve the global biodiversity agenda. The Preamble of the CBD underscores that biodiversity conservation requires international cooperation and special attention to the needs of developing countries. Furthermore, Articles 16 and 18 of the same convention highlight the need for equitable access to technology and knowledge-sharing[18].

Article 18(1) of the CBD requires Parties to promote international technical and scientific cooperation in the conservation and sustainable use of biological diversity through appropriate international and national channels. It further encourages, in accordance with national legislation and policies, the development and use of technologies—including indigenous and traditional technologies—and promotes joint research programmes and ventures aimed at informing the decision-making process. Other related provisions supporting this agenda include Articles 7, 12, 14, 16, 17, and 19 of the CBD.

The observed increased gaps in expertise, technology, data, and knowledge between Parties to effectively utilise science, technology, and innovation to support the implementation of the convention and its protocols further warranted the CBD to adopt and implement several decisions around capacity-building, improved access to and transfer of technology, and enhancing technical and scientific cooperation amongst Parties[19], as noted in Target 20 of the KMGBF (COP 15)[20].

However, this is constrained by limited and ad hoc funding, insufficient human resource capacity, and a lack of dedicated institutional support. CBD Decision 15/8, encourages the

[17] CBD/COP/DEC/15/4; https://www.cbd.int/doc/legal/cbd-en.pdf
[18] https://www.cbd.int/doc/legal/cbd-en.pdf
[19] (https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-08-en.pdf
[20] https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf

Global Coordination Entity and the TSCs to mobilise necessary funding from diverse sources, including international and domestic, public and private, as well as financial and in-kind contributions from host organisations to support their operationalisation and long-term sustainability. Moreover, CBD COP 16, in paragraph 18 of Decision 16/3, even requested all the TSCs to collaborate with one another, as well as with Parties, relevant organizations, the consortium of scientific partners on biodiversity, and development cooperation agencies for the effective implementation of the TSC mechanism. This collaboration aims to deliver support to Parties in their respective regions and subregions, address gaps in geographical and thematic coverage, and foster programmatic coordination, complementarity, and synergy, including through the establishment of memoranda of understanding, as appropriate[21].

2.1 The G20 on the Development and Implementation of the KMGBF

There is a recognition amongst the G20 Leaders of the importance of healthy biodiversity and ecosystems in addressing the pressing climate change, biodiversity loss, land degradation, and water scarcity. The past G20 Summits, through their declarations' statements, have always recognised the CBD and other related Multilateral Environmental Agreements as important platforms for addressing global environmental issues through the conservation and sustainable utilisation of biodiversity. Important contributions of the past G20 presidencies include early support for biodiversity commitments under the CBD, with growing recognition of biodiversity loss as a systemic risk[22].

Japan's Presidency (2019) emphasised ecosystem protection and the role of science-based targets. Saudi Arabia's Presidency (2020) promoted nature-based solutions and mainstreaming biodiversity across sectors. The 16th G20 Summit, hosted by Italy in 2021, committed to strengthening actions to halt and reverse biodiversity loss by 2030 through CBD and other processes and also called on CBD Parties to adopt an ambitious, balanced, practical, effective, robust and transformative post-2020 Global Biodiversity Framework at COP15 in Kunming[23]. Italy's Presidency also endorsed the post-2020 GBF and its integration into economic planning. The G20 in Indonesia (2022) stressed the need for clear and measurable goals and targets for biodiversity within the post-2020 GBF and effective means of implementation and accountability. The Indonesian presidency further emphasised the increasing need to mobilise resources from all sources to help, enable and support developing countries to effectively implement the GBF.

More recently, India's Presidency (2023) placed a strong emphasis on biodiversity finance, capacity-building, and technology transfer, highlighting the importance of inclusive implementation of the GBF and support for National Biodiversity Strategies and Action Plans (NBSAPs). Finally, the G20 Summit held in Brazil (2024) reaffirmed the G20 commitment to

[21] https://www.cbd.int/doc/decisions/cop-16/cop-16-dec-03-en.pdf
[22] https://g20.org/about-g20/previous-summits-and-logos-2/
[23] https://g20.org/about-g20/previous-summits-and-logos-2/

the full and effective implementation of the KMGBF 2030 targets. It also underscored the need for Parties to the CBD to update or revise their NBSAPs in alignment with the KMGBF and for enhanced financial resources from all sources to support its implementation [24].

2.2 Technical and Scientific Cooperation under other Biodiversity-Related MEAs

Various provisions of other biodiversity-related conventions also require Parties to promote and facilitate technical and scientific cooperation. For example:

- Preamble of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) also recognizes the importance of international cooperation for the protection of certain species of wild fauna and flora[25].
- Article 2 of the Convention on Migratory Species of Wild Animals requires Parties to promote, cooperate in and support research relating to migratory species[26].
- The International Treaty on Plant Genetic Resources for Food and Agriculture also stresses the importance of international cooperation[27].
- Article 4 of the World Heritage Convention requires each State Party to do all it can, including with international assistance and cooperation, to ensure the identification, protection and conservation of its cultural and natural heritage[28].
- The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment Report (2019) underscores that achieving transformative change to halt biodiversity loss requires significantly enhanced access to appropriate technologies, capacity support, and inclusive innovation. It highlights the deep disparities in technological infrastructure and capacity between countries and regions, noting that many biodiversity-rich but resource-limited nations, including those that are home to IPLCs, lack the tools and knowledge systems needed to monitor, manage, and restore ecosystems effectively. The report stresses the urgency of equitable technology transfer and capacity development tailored to local contexts, to empower all stakeholders to contribute meaningfully to global biodiversity goals. Furthermore, the Assessment emphasises that innovation, both technological and institutional, is a critical enabler of transformative change. The report makes clear that without investing in and scaling up capacity, access, and innovation, particularly in the Global South, the objectives of the KMGBF cannot be achieved (IPBES, 2019).
- The United Nations Framework Convention on Climate Change (UNFCCC) has a technology mechanism which seeks to promote, facilitate and finance, as appropriate,

[24] https://g20.org/about-g20/previous-summits-and-logos-2/
[25] https://cites.org/sites/default/files/eng/disc/CITES-Convention-EN.pdf
[26] https://www.cms.int/sites/default/files/instrument/CMS-text.en_.PDF
[27] https://www.fao.org/plant-treaty/overview/texts-treaty/en/
[28] https://whc.unesco.org/archive/convention-en.pdf

the transfer of, or access to, environmentally sound technologies and know-how to enable Parties to implement its provisions[29].

- The United Nations Stockholm Convention on Persistent Organic Pollutants has 16 autonomous Regional and Subregional Centres (SCRCs) operating under the authority of the Conference of the Parties to render timely and appropriate technical assistance in response to requests from developing country Parties and Parties with economies in transition to implement the provisions of the Stockholm Convention[30].
- The technical and scientific cooperation (Article 16 and 17) of the United Nations Convention to Combat Desertification (UNCCD) is facilitated through the Committee on Science and Technology (CST), Science-Policy Interface (SPI), and Knowledge Hub[31]. The CST, as a subsidiary body of the COP, provides the CoP with information and advice on scientific and technological matters. The Knowledge Hub supports knowledge management by organizing scientific and technical information and providing access to best practices through:
    - Knowledge Sharing Systems: an interactive search tool that provides resources and websites reported by Parties; and
    - Roster of Independent Experts: to facilitate access to information and expertise in relevant fields.

The institutional arrangements, mandates, focus areas, and modus operandi of these technical and scientific cooperation mechanisms vary considerably per MEA. Some of these networks are operated at the global level by the secretariats of the MEA concerned (e.g. Technology Mechanism of the UNFCCC; Committee on Science and Technology of the UNCCD), while others are autonomous institutions operating under the authority of the COPs operating at either global, regional and/or subregional levels. Of note is that most of these TSC mechanisms have struggled to provide meaningful impact and sustained technical assistance to the Parties, mainly due to a lack of adequate resources.

The current institutional arrangements of the TSC mechanism under the CBD have been informed by the lessons learned in the facilitation of the technical and scientific cooperation initiatives by the other biodiversity-related MEAs. The past technical and scientific cooperation and technology transfer initiatives undertaken by the CBD Executive Secretary, in collaboration with partners in pursuant of decisions XI/29, XII/2 B, XIII/23 B and 14/24 of the COP also contributed immensely to the format of the current CBD TSC mechanism.

It is our view that this TSC mechanism, comprising a network of 18 TSCs coordinated by a Global Coordination Entity hosted by the CBD Secretariat, is the best model for promoting and facilitating technical and scientific cooperation and technology transfer amongst the

[29] https://unfccc.int/resources
[30] https://www.pops.int/Portals/0/download.aspx?e=UNEP-POPS-COP-CONVTEXT-2023.English.pdf
[31] https://www.unccd.int/sites/default/files/2022-02/UNCCD_Convention_ENG_0.pdf

CBD Parties. However, resourcing has always been a challenge, and it remains a challenge in the TSC mechanism under the CBD.

3 CURRENT INITIATIVES AND DEBATES

The current global challenges that have emerged with new technologies and innovation highlight the need for international cooperation and collaboration to enable inclusive innovation, research networks, strengthen STI capabilities and leverage research networks to ensure inclusive participation. This is emphasized by SDG 17, which calls for stakeholder partnerships to achieve the 2030 goals[32]. Similarly, the KMGBF calls for a whole-of-society and a whole of-government approach to ensure equity and inclusion[33]. There is global recognition that access to scientific knowledge, innovative technologies and capacity-building resources remains uneven globally, particularly between developed and developing countries.

Developing countries and countries with economies in transition with a rich biodiversity, such as many countries in Africa and South America, lack access to cutting-edge science, technology and innovation due to various challenges, including poor infrastructure for biodiversity assessments, monitoring and reporting, economic challenges and intellectual property constraints. These disparities often lead to a lack of meaningful transformative change, as was evident with the failure to achieve the Aichi targets[34].

The global community has entered a decade for transformative change, and the current debates to realise the change include an increasing acknowledgement of the importance of indigenous and local knowledge systems, as highlighted in the KMGBF[35]. At a global level, the KMGBF also highlights the need for equitable technology transfer mechanisms that will enable developing countries to participate meaningfully towards the implementation and achievement of the biodiversity targets. The international community is increasingly calling for scientific and technical cooperation among member states and the strengthening of South-North collaboration to bridge the current gaps and barriers to sustainable development.

As SDG 17 underscores the importance of multi-stakeholder partnerships across the local communities, research institutions, traditional leaders, NGOs, and various spheres of government to achieve sustainable development goals, this technical paper positions the TSCs as a pivotal vehicle for enabling such cooperation on biodiversity-related matters among the G20 member states and beyond.

[32] https://sdgs.un.org/goals
[33] https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf
[34] IPBES, 2019; https://g20.org/about-g20/previous-summits-and-logos-2/
[35] https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

There is an urgent need to scale up capacity to halt and reverse biodiversity loss, particularly through the operationalisation of TSCs located in developing countries and countries with economies in transition. This G20 Technical Paper echoes the CBD COP 15 decision, which encourages the Global Coordination Entity and the regional and subregional support centres to mobilise necessary funding from diverse sources, including international and domestic, public and private, as well as financial and in-kind contributions from host organisations to support the operationalisation and long-term sustainability of the TSC mechanism. By so doing, this G20 Technical Paper

- Urges the G20 Member States to formally recognise the TSCs as critical institutional mechanisms for fostering international cooperation in biodiversity science, technology transfer and facilitating innovation for the successful and cost-effective implementation of the KMGBF. These TSCs serve as a pivotal vehicle for facilitating North-South and South-South collaboration, thereby enabling developing countries access to cutting-edge technologies and scientific expertise required for the implementation, monitoring and reporting of the KMGBF. It will also enable joint mobilisation of resources through strengthened international cooperation and promote equitable sharing of biodiversity-related technology and expertise, thereby accelerating the achievements of the KMGBF. G20 recognition of the TSCs under the CBD aligns with other G20 priorities like innovation, resilience, and framing biodiversity as an economic opportunity.
- Calls for a strong commitment from G20 members, in accordance with Articles 16-20 of CBD, to sustainably provide financial, technical (expertise, technology) and policy support to the full operationalisation of the TSCs. The G20 nations, particularly the developed country Member States, are encouraged to support the TSCs hosted and serving developing nations Parties to the CBD.
- Encourages the G20 countries to engage constructively with the TSCs in their respective regions/subregions to identify opportunities to leverage capacity-building, technical and scientific cooperation and technology transfer, in accordance with the provisions of CBD, and address the challenges of developing countries

The G20 can draw from successful case studies to date in promoting and facilitating technical and scientific cooperation initiatives and projects in developing countries and countries with economies in transition. These include the European Union-supported Regional Centres of Excellence (RCoEs), which foster the use of science, technology, innovation, and knowledge to inform decision-making in responding to megatrends such as climate change and environmental degradation in developing nations. Similarly, the Bio-Bridge Initiative (BBI) established under the Convention on Biological Diversity (CBD) supports biodiversity-related projects by matching developing countries' needs with expertise and resources from donor agencies, research institutions, and the private sector. The NBSAP Accelerator Partnership is another key mechanism, providing technical and

financial support to accelerate the updating, alignment, and implementation of NBSAPs, thereby enhancing national capacities to meet the KMGBF targets. In parallel, the High Ambition Coalition for Nature and People (HAC) has mobilised political will and fostered knowledge exchange to champion the global 30x30 target, further demonstrating how collective commitments can drive technical cooperation and capacity-building. Together, these demand-driven and collaborative approaches illustrate how targeted investments in technical and scientific cooperation and technology transfer can enhance capacity-building, foster international collaboration, and accelerate progress towards biodiversity conservation goals. Furthermore, the Group on Earth Observations Biodiversity Observation Network (GEO BON) facilitates collaboration among scientific institutions, governments, and civil society to improve biodiversity data collection, monitoring, and use in decision-making. These complementary initiatives provide valuable models for how the G20 could structure and scale up support for technical and scientific cooperation in biodiversity conservation.

Investing in the TSCs enables the G20 (and its Member States) to:

- Position itself as a global leader in biodiversity governance and implementation of the NBSAPs and the KMGBF.
- Signal strong political will, unlock transformative partnerships, and enable all countries to fulfil their commitments under the KMGBF.
- Contribute towards a better alignment of the NBSAPs and Nationally Determined Contribution processes at the national level.
- Lead by example in integrating biodiversity into economic and policy frameworks.
- Offer an opportunity to translate biodiversity commitments into action and unlock investment opportunities that benefit both people and the planet.
- Enhance efforts on policy coherence and innovation at the science-policy-society/implementation interface.
- Drive sustainable economic growth through the sharing of best practices and regional peer learning through the TSC mechanism.
- Unlock investments, strengthen partnerships, and drive sustainable growth.
- Foster local, national, regional and global cooperation and peer learning on the conservation and sustainable use of biodiversity.
- Catalyse biodiversity-based economic growth and attain sustainable development goals across sectors, including agriculture, health, tourism, and infrastructure.
- Reinforces the commitments to sustainable development.
- Promote the existing regional and subregional platforms and/or Community of Practice that consolidate biodiversity-related data, foster South-South cooperation, and provide technical support for monitoring, reporting, and planning processes.

As G20 Chair, South Africa proposes a strategic framework for resource mobilisation of the G20 leadership to:

- **Strengthen Technical and Scientific Cooperation** to enhance the capacity and sustainability of existing TSC support centres in support of the NBSAP development.
- **Explore financial and human resources to operationalise the TSCs,** including innovative financial mechanisms, public-private partnerships, blended finance models, and access to multilateral funds to ensure predictable and sustained support for TSCs.
- **Foster Joint Research and Innovation Partnerships**: Promote North-South, South-South, and triangular cooperation in science, technology, and innovation through joint research programmes, digital platforms, and regional knowledge hubs focused on ecosystem restoration, sustainable use, and nature-based solutions.
- **Enhancing Biodiversity Action with G20 Priorities**: Consider mainstreaming biodiversity across G20 initiatives.
- **Leveraging Existing Successes**: Build on existing models of excellence to enhance regional cooperation, technical capacity-building, and policy integration across all regions. These models offer scalable and replicable pathways to advance global biodiversity goals and KMGBF implementation.
- **Promote Synergies Across Biodiversity Related MEAs at a national level**: Facilitate structured collaboration between the biodiversity-related MEAs, including CBD, UNFCCC, UNCCD, CITES, CMS, IPBES, etc, to align scientific agendas, knowledge-sharing platforms, and capacity-building efforts, enabling a coherent response to interconnected environmental challenges.
- **Support IPLC Engagement in Scientific Cooperation**: Ensure that TSCs are inclusive of IPLC-led knowledge systems and innovations and provide mechanisms for meaningful participation and capacity development.
- **Ensure the TSCs serve as enablers for the effective development and implementation of NBSAPs and Regional Biodiversity Strategies and Action Plans**.

In conclusion, the Presidency urges **G20 Members to collaborate in support of the revision and implementation of the NBSAPs.**

5 ACKNOWLEDGMENTS

1. CBD secretariat
2. African Union Commission
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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Wildlife Economy Investment Index (WEII)

A Tool for Measuring Progress and Reducing Sovereign Debt

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This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

EXECUTIVE SUMMARY

Given human reliance on biodiversity for survival, it is essential that the current decline in biodiversity is halted and ideally reversed. We cannot continue with a business-as-usual approach to conservation or to the insufficient funding of conservation, which, in Africa and other developing countries, largely relies on donor-funding. Globally, conservation is currently estimated to be underfunded by USD 700 billion and in Africa alone, it is estimated to be more than USD 100 billion annually. This biodiversity finance gap requires innovative, sustainable finance mechanisms which include a suite of options to build resilience and ensure sustainability. A regulated biodiversity economy is one of these options which encompasses a number of different activities which, if sustainably managed, can diversify finance streams and build greater resilience for economies, people, and nature.

One potential tool to support resource mobilisation as well monitoring of the sustainability of the wildlife economy is the African Leadership University's School of Wildlife Conservation Wildlife Economy Investment Index (WEII) which was developed over a two-year period, with the first results launched in October 2023. The aim of the WEII is that through the overall indicator scores and rankings, governments would see wildlife as a key strategic asset and critical growth opportunity for their economies and begin to create better enabling environments, through improving and streamlining policy, amongst other things. Another key overall ambition of the WEII is to encourage increased public and private investments in natural landscapes to improve conservation outcomes and support economic development.

In this context, the G20 countries may look at developing, implementing and monitoring global policies, respecting the particularities of each state, to promote more sustainable, inclusive and equitable wildlife economies and sustainable investments in these. To support the growth and development of sustainable wildlife economies through the WEII, two key actions are proposed: (1) G20 member support in providing guidance on the revision to the WEII, through engagement on the indicators to be included in version two as well as on the sovereign debt instrument in order to ensure a robust Index, with the potential for it to be expanded globally; (2) Potential investment partnerships by G20 members supportive of sustainable, inclusive and equitable growth of wildlife economies.

This technical paper highlights the benefits of implementing the proposed actions while also addressing the current challenges related to definitions of the wildlife economy and misconceptions of what is and what is not included in it, as well as a lack of data to measure the wildlife asset base of countries and their management of this. This technical paper identifies the development of a robust tool to promote effective and sustainable wildlife economies at global, regional, national and local levels.

1 INTRODUCTION

Despite an ever-growing number of protected areas being declared each year (UNEP-WCMC and IUCN, 2024) biodiversity continues to decline year on year (WWF, 2024). Given human reliance on biodiversity for survival, it is essential that this decline is halted and ideally reversed. We cannot continue with a business-as-usual approach to conservation or to the insufficient funding of conservation, which, in Africa and other developing countries, largely relies on donor-funding. Given recent (2025) changes in terms of funding for conservation and development, an over-reliance on donor funding has clearly demonstrated a lack of resilience and sustainability.

Globally, conservation is currently estimated to be underfunded by USD 700 billion (UNEP, 2025) and in Africa alone, it is estimated to be more than USD 100 billion annually (FSD Africa, 2022). This biodiversity finance gap underscores the urgent need for developed countries to assume greater responsibility in providing financial resources or investing in relevant financial instruments, as developing countries are disproportionately affected by biodiversity loss but lack the necessary funds to implement effective conservation and restoration measures. Innovative, sustainable finance mechanisms include a suite of options to build resilience and ensure sustainability that could help to bridge this gap. The biodiversity economy is one of these options which encompasses a number of different regulated activities which, if sustainably managed, can diversify finance streams and build greater resilience for economies, people, and nature.

Several countries in Africa are leading in the development and unlocking of the biodiversity economy, specifically South Africa through its White Paper on Conservation and Sustainable Use of South Africa's Biodiversity and the related 2016 National Biodiversity Economy Strategy (NBES). The NBES defines the biodiversity economy as one which encompasses the businesses and economic activities that either directly depend on biodiversity for their core business or that contribute to conservation of biodiversity through their activities. The scope of the biodiversity economy (BE) includes sectors such as bioprospecting and the related biotrade, wildlife ranching and ecotourism, and includes activities such as regulated harvesting, hunting, breeding, game drive/viewing, and product development and manufacturing, targeting marine, freshwater and terrestrial resources and, therefore, complementing nature-related elements of the blue economy.

Numerous of these activities are already being undertaken globally (e.g. through extractive and non- extractive use of wild species) but not necessarily formally referred to as part of the biodiversity economy. They are, however, important in terms of national, regional and global conservation and development. For example, the use of indigenous plants in medicine, cosmetics and food products across the globe, forms part of the biodiversity economy, as defined above. It is, therefore, important that not only developing countries focus on sustainably developing, managing and monitoring the biodiversity economy, but that there is consensus in terms of what is and isn't part of this economy and how it can be better

valued and incorporated into countries reporting on and potentially achieving the Kunming-Montreal Global Biodiversity Framework (KMGBF) targets.

A working definition used in this paper for the biodiversity economy includes the following:

- regulated biodiversity-based products, activities, and services that enhance biodiversity.
- the sustainable use of biodiversity in in situ, uncontrolled environments.
- regulated activities which are inclusive, equitable and contribute to economic growth, while at the same time aligning with conservation objectives.

And excludes:

- the intensive commodification of wildlife (e.g. any intensified farming activities), and any cruel, morally, culturally, or ethically indefensible practices.
- any local or internationally illegal or unsustainable businesses and economic activities.

The biodiversity economy, therefore, is the element of the broader economy that focuses on sustainable development, as the concept of a biodiversity economy is an articulation of the conservation of nature through its sustainable use for human benefit (Snyman et al., 2021). The term wildlife economy will be used in this paper going forward but, in this context, can be interchanged with the term biodiversity or wildlife-based economy as defined above in terms of focusing on the regulated sustainable utilisation of fauna and flora to achieve and/or support conservation and development objectives, while at the same time ensuring that all related activities are sustainable, circular and nature positive. The wildlife economy is one sector within the broader bioeconomy and, therefore, aligns with the G20 high-level principles on the bioeconomy.

With the recent Southern African Development Community (SADC) Ministers-approved Wildlife-Based Economy Strategy Framework (WBESF), it is important to develop monitoring and evaluation tools for the growth and development of wildlife economies, as well as to develop tools for resource mobilisation to fund the development and growth of the wildlife economy. It is important to note the multi-sectoral, multi-dimensional nature of the wildlife economy and the importance, therefore, of multi-sectoral, multi-country collaboration, partnerships, policy/legislation, and institutional alignment. This can be supported by an appropriate tool which highlights best practice and supports collaboration through focusing on national-level strengths and addressing areas of weakness.

The African Leadership University's School of Wildlife Conservation (ALU SOWC) developed the Wildlife Economy Investment Index (WEII) over a two-year period, launching the first results in October 2023. The development of the WEII was based on the research, stakeholder engagement and findings in the State of the Wildlife Economy in Africa (Snyman et al., 2021b) and the Roadmap for Africa's Wildlife Economy reports (Snyman et al., 2021a) and the need for a tool to support and encourage investment in the wildlife economy so that

conservation is seen as a key growth industry, increasing investments in wildlife resources and the related businesses. The aim was also that, through the WEII and the results of individual indicators, governments would see wildlife as a key strategic asset and critical growth opportunity for their economies and begin to create better enabling environments, through improving and streamlining policy, amongst other things. Another key overall ambition of the WEII is to encourage more public and private investments in natural landscapes to improve conservation outcomes and support economic development.

The WEII is a measure of investment potential in Africa's wildlife economy, with the 'big five' investment opportunities focused on being: ecotourism, the carbon market, hunting (including some aspects of fishing), wildlife ranching, and forest products (which largely include non-timber forest products and some elements of sustainable indigenous timber). Taken together, they constitute a market share of over USD 250 billion a year in Africa (see Snyman et al., 2021a, 2021b for more details on Africa's wildlife economy).

The ALU SOWC defines the wildlife economy as one which uses wildlife, both plants and animals (marine, freshwater and terrestrial) as an economic asset to create value that aligns with conservation objectives and delivers sustainable growth and economic development (wildlife includes indigenous, undomesticated terrestrial and marine animals, plants and other life forms) (Snyman et al., 2021b). This definition includes and excludes the same elements as described above for the biodiversity economy.

The WEII, therefore, serves as a comprehensive framework, sustainably utilising indigenous wildlife as an economic asset, aligning with conservation objectives, and fostering sustainable growth and development. With two main Sub-Indices, the Wildlife Status Sub-Index looks at a country's wildlife diversity and the management effectiveness of this diversity, evaluating indicators related to assets, species richness, ecological habitats, and wildlife management effectiveness. And the Investment-enabling Environment Sub-index assesses conditions facilitating investments, considering indicators such as ease of doing business, corruption, infrastructure, and security. The WEII provides a multidimensional analysis, drawing from 280 indicators across 34 datasets. Please find an Executive Summary of the WEII v1 results here.

Following on from the first iteration of the WEII which was published in October 2023 and included the development of a full results report, an interactive dashboard and 54 national reports covering all African countries, ALU SOWC is currently working on the second iteration. Based on feedback on WEII v1 which has been received through various stakeholder engagements where the WEII has been presented, including to SADC Member States, WildCRU at the University of Oxford, the Cambridge Conservation Initiative (CCI), numerous African NGOs, the G20 Bioeconomy Initiative (GIB), the G20 Environment and Climate Sustainability Working Group (ECSWG) and private sector partners, the WEII is being refined to further increase the robustness and usefulness of the Index. The aim being to ensure that the WEII captures all relevant indicators to measure the potential of a country's

wildlife economy, is robust and trusted as an Index by governments, the private sector, and other relevant stakeholders.

Such a tool will serve as a measurement of country's progress in terms of the two sub-indices: Wildlife Status and Investment-enabling Environment, highlighting for government where they are doing well, where improvements are needed and illustrating to private and public investors where the most suitable potential investment options are.

With the development of a robust Index measuring the potential for the wildlife economy at a national level (while also highlighting regional and Regional Economic Community (REC) trends) and the alignment of this with a sovereign debt instrument, there is the also potential to encourage countries to improve their Index rankings (and related sustainable conservation and development) and in so doing receive lower/preferential sovereign debt interest rates through a flexible interest rate system, resulting in lower debt interest payments and in turn these savings can be used to invest in conservation, education, health and other development initiatives. Given their experience and expertise, G20 countries have an important role to play in the refinement of the WEII as a tool, as well as in the development and potential investment in related sovereign debt instruments.

2 CURRENT MULTILATERAL DELIBERATIONS

2.1 The G20

A G20 Brazil 2024 technical paper titled "Payment for ecosystem services (PES): Scaling up PES to meet global environmental and climate crises" highlighted that PES promotes sustainable use at the local, regional and global levels and that Indigenous Peoples and local communities (IPLC) rights and access to benefits are essential for long-term sustainability. This aligns with the key areas of the wildlife economy highlighted by Snyman et al (2021b) which states that Africa's wild resources – both its wildlife (fauna and flora) and its natural landscapes – should be recognised for their economic, livelihood, and health contributions, including ecosystem services that benefit industries, such as agriculture and commercial forestry which are, therefore, directly linked to wild resources. Additionally, the PES technical paper emphasises that "national integrated conservation policies and instruments are critical for scaling PES and that it is, therefore, necessary to strengthen institutional capacities at the national and sub-national levels to manage broad PES programs." This is consistent with the recommendations of this technical paper in terms of the wildlife economy and the required institutional and policy strengthening to support the unlocking and growth of the wildlife economy, which is emphasised in the Investment-enabling Environment Sub-index.

Principle 1 in a broader G20 discussion paper titled 'Principles for an inclusive and sustainable global economy: A discussion paper for the G20' (Mazzucato, 2025) states the need to "Shape the Economy: Place climate and development goals at the heart of industrial policy to direct growth" with recommendations to:

- Embed directionality in public investment to shape markets to be inclusive and sustainable.
- Align policy tools and institutions with climate and development goals, stimulating cross-sectoral outcome-oriented innovation
- Restore policy space for green industrialisation and development.

While Principle 2 titled "Finance for Impact: Align macroeconomic policy with public purpose" recommends to:

- Make effective use of existing public wealth and long-term resources for industrial transformation.
- Harness tax policy for public investment, structural transformation, and global equity.
- Steer private finance through purpose-driven blended instruments.

Overall, the discussion paper (Mazzucato, 2025) calls for the global economy to be reshaped to deliver not just more growth, but better growth—growth that is green, inclusive, and resilient, which is a key focus area of the wildlife economy. The use of the WEII to promote public and private investment in and, therefore, growth of the wildlife economy for conservation and development directly aligns with the recommendations of Principle 1 and Principle 2 for developing an inclusive and sustainable economy.

2.2 Other Multilateral Forums

The KMGBF adopted during the fifteenth meeting of the Conference of the Parties (COP 15) supports the achievement of the Sustainable Development Goals (SDGs) and includes four goals and 23 targets for 2030. The achievement of a number of these targets can be supported by the development and growth of the wildlife economy. According to the KMGBF (pp. 13-14), its successful implementation requires responsibility and transparency, which needs to be supported by effective mechanisms for planning, monitoring, reporting and review, forming an agreed, synchronised and cyclical system, which includes the following elements:

- National biodiversity strategies and action plans, revised or updated in alignment with the Framework and its goals and targets as the main vehicle for implementation of the Framework, including national targets communicated in a standardised format;
- National reports, including the headline and, as appropriate, other indicators in the monitoring framework of the KMGBF;
- Global analysis of information in national biodiversity strategies and action plans, including national targets to assess the contribution towards the Framework;
- Global review of collective progress in the implementation of the Framework, including the means of implementation, based on national reports and, as appropriate, other sources;
- Voluntary peer reviews;

- Further development and testing of an open-ended forum for voluntary country reviews;
- Information on non-state actor commitments towards the Framework, as applicable.

In terms of the KMGBF, targets 3, 5, 8, 9, 10, 11, 13, 14, 19 and 20 may have an association to the wildlife economy, with Targets 5, 9, 10, 13 and 14 being particularly relevant. Through the development and growth of a regulated sustainable wildlife economy, countries could be supported in meeting these targets sustainably, equitably, and inclusively. The WEII described here provides a potential tool which can be used to support countries in terms of reporting on their implementation of the KMGBF. Through the monitoring and evaluating of their progress on the WEII countries can be supported in meeting their sustainable-use, beneficiation and other related KMGBF targets. They can also use information from the WEII scores in developing their national biodiversity strategies and action plans and in writing their national reports to the CBD.

It is important to note synergies with Priority Two of the G20 Research and Innovation Working Group: "Biodiversity Information for Sustainable Development". This Priority and its implementation is key in terms of understanding the natural resource asset base of the wildlife economy. This Priority provides important baseline information for the implementation of Priority 1: Biodiversity and Conservation of the ESCWG and in terms of providing data for the indicators of the Wildlife Status Sub-Index of the WEII. This Sub-Index is the one for which the least indicators were found consistently across Africa, and for which collaboration and partnerships across the G20 are welcomed to develop and agree on indicators for inclusion, in order to accurately capture the wildlife asset base of countries and their effectiveness in terms of managing it.

The SADC Wildlife-Based Strategy Framework approved by Ministers and currently being implemented requires an effective monitoring and reporting tool. It has been proposed that the WEII could support with this: highlighting the importance of G20 inputs into ensuring a robust and accurate Index for measurement, which could be piloted at SADC level and then rolled out at a broader global level.

3 CURRENT INITIATIVES AND DEBATES

The first iteration of the WEII was published in October 2023, following extensive stakeholder engagement and inputs, including with the South African National Biodiversity Institute (SANBI), the World Bank, WWF, Oppenheimer Generations Research and Conservation, African Wildlife Foundation, IUCN, African Wildlife Economy Institute, Rwanda Development Board, Conservation Capital, Uganda Wildlife Authority, ZimParks, Institute for Tropical Ecology (IRET), United Nations Environment Programme (UNEP), Wildlife Producers Association of Zambia, The Malilangwe Trust, amongst other stakeholders. The Index results have since been presented in numerous national (South African Biodiversity Economy Investment Indaba), regional (including two SADC Member State meetings related to the SADC Wildlife- Based Economy Strategy Framework) and international forums (G20

Bioeconomy Initiative, G20 ECSWG meeting) and have received a positive response, as well as requests to extend it beyond Africa to become a global index.

The Index is currently (2025) being reviewed in preparation for the second iteration with the aim to improve areas where needed and align more specifically with KMGBF reporting requirements, as well as ensure robustness of the Index to support the development of a linked sovereign debt instrument. This process has already included several engagements with relevant stakeholders and further, broader stakeholder engagement will continue throughout 2025 and into 2026. The WEII has the potential to serve as a valuable tool in terms of monitoring and evaluating the wildlife economy over time, as well as supporting countries with sovereign debt, which is currently one of the biggest impediments to economic growth and development in many countries (UNCTAD, 2023).

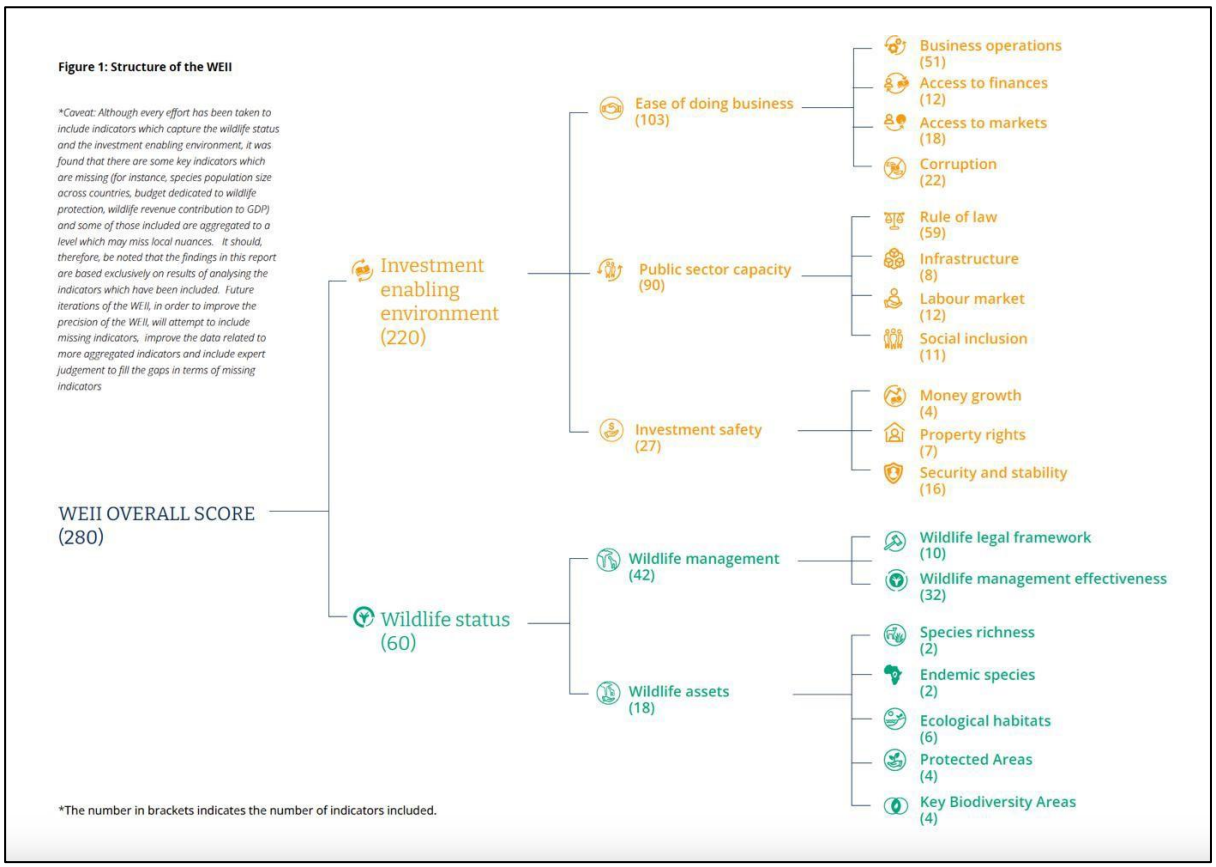


***Figure 1**: Structure of the WEII v1 (Source: Habumuremyi & Snyman, 2023)*

The WEII has two main Sub-Indices, firstly the Wildlife Status Sub-Index scrutinises a country's wildlife diversity and management of this diversity, evaluating indicators related to assets, species richness, ecological habitats, and wildlife management effectiveness. Secondly, the Investment-enabling Environment Sub-index assesses conditions facilitating investments, considering indicators such as ease of doing business, corruption, infrastructure, and security. The WEII provides a multidimensional analysis, drawing from 280 indicators across 34 datasets. These indicators are organised into 2 sub-indices, 5

categories, and 18 subcategories. Each country's performance on the overall WEII, as well as its individual components, is expressed as a score on a scale of 0 to 100, where 100 represents the highest possible score. The indicators included in the WEII spanned from 2017 to 2023, with a predominant 60.56% published in 2022 and 2023. Figure 1 shows the structure of the WEII v1, including the number of indicators per Sub-Index, Category and Sub-category (Habumuremyi & Snyman, 2023).

In terms of the overall Index, South Africa emerges as the frontrunner, boasting an overall score of 63.12 out of 100, closely followed by the Seychelles (62.84) and Mauritius (58.66). Somalia, on the other hand, ranks the lowest with an overall score of 22.19, indicating challenges in both protecting the wildlife asset base and establishing a conducive environment for investment and starting and operating businesses (Habumuremyi & Snyman, 2023). Libya and Eritrea face obstacles in achieving satisfactory scores in wildlife asset base, rule of law, access to markets and social inclusion, resulting in the overall second and third lowest scores of 24.07 and 31.33, respectively (Habumuremyi & Snyman, 2023).

In terms of the Sub-Indices, in the Wildlife Status Sub-Index South Africa leads with a score of 55.11 out of 100, highlighting its consistently high score in terms of both wildlife assets and management. Madagascar, Tanzania, and Seychelles follow with scores above 49, showcasing their biodiversity richness. As mentioned above, this Sub-Index requires further indicators to capture greater detail on management effectiveness, as there are currently limited, consistent indicators related to this, which results in potentially skewed results in this Sub-Index. Libya, Somalia, Djibouti, and Eritrea have scores below 30, indicating the need for improved conservation and conservation management efforts. In the Investment Enabling Environment Sub-Index Mauritius tops the list with a score of 78.27 out of 100, highlighting its favourable investment and business environment. Somalia is in last position with a score of 22.09, reflecting challenges in attracting investments most likely due to political and civil unrest. Countries such as South Sudan, Libya, Eritrea, Central African Republic, and Equatorial Guinea also have low scores, illustrating difficulties in attracting and enabling business.

Within the framework of Regional Economic Communities (RECs), the SADC emerges as a regional leader, demonstrating a heightened attractiveness for wildlife economy investments, which is supported by the recent launch of the SADC Wildlife-Based Economy Strategy Framework (WBESF). In contrast, the Economic Community of Central African States (ECCAS) faces several challenges, particularly in the ease of doing business and public sector capacity, warranting focused efforts to ensure progress (Habumuremyi & Snyman, 2023).

On a continental scale, Africa demonstrates a higher mean score (53.49) in the Investment-enabling Environment Sub-index compared to the Wildlife Status Sub-index (40.88) (Habumuremyi & Snyman, 2023). This emphasises the continent’s relatively stronger focus on creating favourable conditions for businesses compared to conserving and expanding

wildlife and ecosystems. It underscores the imperative for Africa to accord Wildlife Status the same level of attention as it does for the Investment-enabling Environment and to enhance efforts in wildlife data collection (related to the wildlife asset base, as well as the management of it) and updates, linking to Priority 2 of the G20 Research and Innovation Working Group.

A notable finding is the positive correlation between the Wildlife Status and the Investment-enabling Environment Sub-indices, suggesting that wildlife conservation and economic development are not mutually exclusive. The cluster of countries, including South Africa, Namibia, Seychelles, Cabo Verde, The Gambia, Botswana, Mauritius, Ghana, Rwanda, Morocco, Kenya, Senegal, Benin, and Tunisia, exemplifies this positive correlation. These countries stand out as models of success, demonstrating that robust wildlife conservation can coexist with economic development (Habumuremyi & Snyman, 2023).

A common thread among lower-ranking countries is their experience of conflict and war, which has taken a significant toll on both their wildlife and business enabling environments (Habumuremyi & Snyman, 2023). This is evident in the negative correlation between WEII and the Fragile States Index (Habumuremyi & Snyman, 2023). As such, global efforts aimed at achieving and maintaining peace deserve focus for their potential positive impact on both conservation and development.

Depending on the specific focus of investors interested in multinational investments, the WEII proposes different clusters of countries based on WEII scores, Wildlife Status Sub-index, the Investment-enabling Environment Sub-index, wildlife assets, wildlife management, ease of doing business, public sector capacity, and investment safety and countries are provided with model countries that share similar contextual factors, offering important benchmarks for progress (Habumuremyi & Snyman, 2023).

Overall, the WEII full results and 54 country reports provide invaluable insights into the attractiveness of investment in the African wildlife economy, with the WEII aiming to measure specifically regulated, sustainable wildlife economy activities, which support long-term conservation and development. Through an in-depth analysis of African countries, regions, and the continent as a whole, a nuanced narrative was found that not only underscores the opportunities and strengths but also highlights the challenges and areas for improvement (Habumuremyi & Snyman, 2023).

The WEII and its 280 indicators can be used as a potential tool in terms of monitoring and evaluating the wildlife economy over time (for the KMGBF and the SADC Wildlife-Based Economy Strategy Framework (WBESF) and the South African NBES), as well as the possibility of linking them to national Biodiversity Accounts or relevant satellite accounts. Stakeholder input, including G20 members, into the indicators and ensuring the robustness of the WEII and its accuracy in measuring investment potential in the wildlife economy will be critical in ensuring consistency and comparability over time. Discussions should include decisions related to which indicators could be included in the CBD related to NBSAPs reporting and achieving the relevant sustainable use targets of the KMGBF. It is thus

important to raise awareness about the WEII and its potential role in measurement and reporting so as to ensure the WEII v2 serves as a useful tool for governments and investors in the wildlife economy.

In addition, it is important to link the WEII to relevant investment opportunities or portals, such as South Africa's National Biodiversity Sector Investment Portal which was launched in 2022 to support bankable/investable biodiversity economy projects and to promote bankable Investment Opportunities (Investees). The portal serves as a catalyst to introduce and match investment opportunities to the appropriate investors and intermediaries. Given the aim of the Portal, the WEII could serve as a useful tool for investors to assess investment opportunities. This could potentially be expanded to other countries in Africa and globally.

3.1 Linking the WEII to a sovereign debt instrument

To ensure long-term sustainable conservation of biodiversity, there needs to be greater recognition from governments of the importance of biodiversity in terms of health, wellbeing, livelihoods, climate change mitigation, employment, and sustainable economies. To support this going forward, conversations about conservation will need to be held at the highest levels of government, including in the Finance Ministry and the Presidency. As part of Phase 2 of the WEII, therefore, ALU SOWC is looking at a policy- and practice-relevant application of the WEII linked to a sovereign debt instrument.

African public debt reached approximately USD 1.8 trillion in 2022 (having increased by 183% since 2010) (UNCTAD, 2023). In general, Africa faces challenges in debt management and restructuring due to the lack of coordination among diverse creditors, which complicates timely interventions during debt distress situations (UNCTAD, 2023). Additionally, there are high borrowing costs in Africa - average cost of financing is 11.6% (8.5% points higher than the risk-free rate of the US benchmark) (UNCTAD, 2023).

Twenty-seven (of 54) African countries have a debt-to-GDP ratio above the 60% threshold considered sustainable by the World Bank and the rising costs of servicing debt divert resources from essential services such as health and education, further impacting development and conservation goals across the continent (UNCTAD, 2023). More than half of Africa's population (+- 751 million people) live in countries that spend more on interest than on education or health (UNCTAD, 2023).

What is being proposed is that the WEII be linked to an innovative financing mechanism that integrates environmental sustainability into debt management. By assessing a country's sustainable wildlife economy potential, the WEII can inform the issuance of 'green bonds' or 'sustainability- or index-linked bonds' which are aimed at financing conservation efforts but also reducing a country's debt burden by reducing the interest rates on sovereign debt based on performance on the Index. This can lead to increased investment and enhancing a country's credit worthiness by showing that it is committed to sustainable practices: while

at the same time growing the wildlife economy and promoting socio-economic development.

An Index-linked bond could, as a country's WEII ranking improves, provide flexible interest rates which would go up or down depending on performance against the WEII indicators. The development of such a financial instrument is timely given the establishment of the African Credit Rating Agency (AfCRA) (African Union, undated) which is due to launch in September 2025. Although still to be assessed in the feasibility studies (see below) to determine if it will be the best financial instrument, the focus on the bond market is due to it being a familiar market for investors and one which is globally estimated to be over USD 133 trillion at the end of 2023 (Aviva Investors, 2025) and it being the largest capital market.

For the WEII to be linked to a sovereign debt instrument it will be essential that the indicators in the WEII v2 capture all relevant elements being measured, that the WEII is robust and trusted by governments and private investors, and that governments have an enabling environment for the sovereign debt instrument to be trusted by private investors. Given that one of the aims of the debt instrument is to impact government policy towards greater sustainability, recognition of wildlife as a key strategic asset in which to invest and to unlock the wildlife economy over time, there will need to be discussions in terms of how policy prescriptive it should be, given ongoing changes in government over time and over bond periods.

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

Over the next six months (July to December 2025) ALU SOWC will be conducting feasibility exercises to determine what revisions are needed to WEII v1, what policy, governance and legislative requirements are needed to support a sovereign debt instrument of this nature and also to determine the overall viability of a sovereign sustainability-linked bond (SLB) or an index-linked note in a bond. This will include specifically looking at what indicators and other measures are needed to ensure that the WEII is robust and seen as a trusted measure of wildlife economy potential with positive linkages to sustainability and ongoing biodiversity conservation, what terms and conditions would need to be applied to the sovereign debt instrument to ensure direct linkages between sustainability and debt management, as well as other areas related to viability, sustainability and acceptability in the market. Also, through extensive stakeholder engagement, interest in the idea from investors (private and public) and governments will be assessed.

Through ensuring that the WEII v2 is robust and captures the necessary nuances of the regulated wildlife economy and potential investment in it, it can be used as a tool for resource mobilisation for the wildlife economy. Investors can use the WEII to guide their investment in the wildlife economy and countries can use it as a tool to highlight a positive, enabling environment for investment. Increased investment in the wildlife economy can support the development of further wildlife economy businesses, along with further value chain development; potentially increasing employment and revenues, both for businesses

but also potentially for reinvestment into conservation. The sovereign debt instrument linkages could also result in further resource mobilisation for conservation and development through the potential savings on interest payments depending on performance in the WEII rankings.

The recommendations and considerations included here are potential actions identified as relevant to advancing the wildlife economy through stimulating resource mobilisation for investment in the wildlife economy and in so doing promoting the alignment of conservation and development and ensuring long-term sustainability.

4.1 Key proposed initiatives for the G20:

- G20 members, based on their extensive expertise and experience, may provide support, feedback and advice during the feasibility study and stakeholder engagements to enhance the robustness of the WEII v2. The Wildlife Status Sub-Index is the one for which the least indicators were found consistently across Africa (and globally), and for which collaboration and partnerships across the G20 are welcomed in order to accurately capture the wildlife asset base of countries and their effectiveness in terms of managing it. This could serve to support countries with reporting on the KMGBF targets going forward.
- The G20 could encourage international partnerships and investments that expand the wildlife economy, including through public-private cooperation, capacity building, and alignment of biodiversity strategies with national development plans and biodiversity goals.
- Inputs from G20 members on the indicators and refining the WEII are welcomed to ensure the development of a robust, trusted Index which can be used as monitoring and evaluation tool, nationally, regionally as well as potentially globally. Although this Index is focused on the wildlife economy, there is the potential to develop one or expand the existing one globally and also to the broader bioeconomy.
- Potential investment partnerships by G20 members supportive of sustainable, inclusive and equitable growth of the wildlife economies.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

The Biodiversity Economy

A Critical Tool for Sustainable, Inclusive, and Equitable Economic Growth, Conservation, and Development at National and Regional Level

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This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

EXECUTIVE SUMMARY

The G20 High-level Principles on Bioeconomy agreed upon during Brazil's G20 Presidency (2024), are very much aligned with the biodiversity economy. The biodiversity economy offers a new narrative for nature conservation: one where nature conservation and development are aligned and where people and nature are not separated but co-exist in a mutually beneficial, inclusive and sustainable way. The biodiversity economy is one sector within the wider bioeconomy, however, there is no global consensus on what defines the bioeconomy or the biodiversity economy, even though there is some form of it in every country in the world, e.g. through extractive and non-extractive use of wild species.

The biodiversity economy, therefore, is the element of the broader economy that focuses on sustainable development, as the concept of a biodiversity economy is an articulation of the conservation of nature through its sustainable and eco-efficient use for the benefit of humans and nature while at the same time ensuring that all related activities are sustainable, circular and nature positive. In southern Africa, the value of the biodiversity economy has been found to be extensive, with the potential to sustainably grow it further. The Kunming-Montreal Global Biodiversity Framework (KMGBF) targets and goals provide a means to encourage sustainable use of wild species which is important to achieving a functioning bioeconomy.

In this context, the G20 countries are encouraged to implement global policies, respecting the particularities of each state, to promote more sustainable, and eco-efficient, inclusive and equitable biodiversity economies including to promote good practices related to biodiversity-derived products and services that contribute to the promotion of the bioeconomy. To support sustainable and eco-efficient biodiversity economies, this technical paper proposes three key actions also in support of the bioeconomy: (1) Promoting regulated, sustainable socio-economic biodiversity-based developments and nature-based solutions that contribute to the conservation of biodiversity, nature/ecosystem restoration, and sustainable use of its components; (2) also in line with the sustainable and circular bioeconomy principles, recognition and involvement of Indigenous Peoples and local communities to achieve fair and equitable sharing of benefits; and (3) supporting the development of a glossary of terms related to the various types of biodiversity-based economies in order to promote a common understanding and true assessment of its value and role in conservation in relevant global platforms.

This technical paper highlights the benefits of implementing the proposed actions while also addressing the current challenges related to definitions of the bioeconomy or biodiversity economy and misconceptions of what is and what is

not included in it. In summary, this technical paper identifies the development of key actions as robust tools to promote effective, sustainable and eco-efficient biodiversity economies at global, regional, national and local levels.

1 INTRODUCTION

Traditionally, biodiversity conservation and development have been seen as mutually exclusive, with many countries following a conservation model that is protectionist and exclusionary, separating people and nature. The biodiversity economy (BE), however, offers a new narrative for conservation: one where nature conservation and development are aligned and where people and nature are not always separated but co-exist in a mutually beneficial and sustainable way. It is also about providing sustainable industries that would not usually be protected or conserved. This does not discount the need, however, to still have 'pure' protected areas, but it broadens the scope and scale for conservation to other areas, which are currently largely captured under Other Effective Area-Based Conservation Measures (OECMs) (Jonas et al., 2024), in which a number of biodiversity economy activities already take place with long-term biodiversity conservation as the main objective. Within all these there is a need to measure and monitor the natural resources that are to be used, to ensure the maintenance of ecological infrastructure and the provision of ecosystem services.

The G20 High-level Principles on Bioeconomy Initiative agreed upon during Brazil's G20 Presidency (2024), are very much aligned with the biodiversity economy in terms of integrating and promoting sustainable development (Principle 1), being inclusive and equitable (Principle 2), mitigating and adapting against climate change (Principle 3), contributing to the conservation of biodiversity (Principle 4), advancing sustainable consumption and production patterns that promote restoration and regeneration of degraded areas and ecosystems (Principle 5), integrating traditional knowledge and innovation, science and technology (Principle 6), benefitting from robust and coherent policy frameworks which foster trade (Principle 7), utilising clear, comparable criteria and methodologies (Principle 8), fostering international collaboration and cooperation (Principle 9) and being based on country-specific approaches implemented in line with national priorities and regional and local circumstances (Principle 10). The biodiversity economy is one sector within the wider bioeconomy.

The 2016 South African National Biodiversity Economy Strategy (NBES) defines the biodiversity economy as one which encompasses the businesses and economic activities that either directly depend on biodiversity for their core business or that contribute to conservation of biodiversity through their activities. The scope of the BE includes sectors such as bioprospecting and the related biotrade; wildlife ranching and ecotourism, which includes activities such as regulated harvesting, hunting, breeding, game drive/viewing;

product development/manufacturing, targeting marine, freshwater and terrestrial resources, and, therefore, complement nature-related elements of the blue economy. Many of these activities are undertaken globally (e.g. through extractive and non-extractive use of wild species) but are not necessarily formally referred to as the biodiversity economy. They are, however, still important in terms of national, regional and global conservation and development.

It is important to note that the BE is not a new or different type of economy, but is rather an element/sector within the broader national economy, where an economy is defined as a "complex system of consumers, businesses, and governments that produce, consume, and distribute goods and services, combining to fulfil the needs of those living and operating within it", and where "…an economy can encompass a nation, a region, a single industry, or even just one family, no two economies are identical and each evolves according to the choices and actions of the participants" (Kenton 2025).

The IPBES Nexus Assessment (2024) explores the interconnectedness of biodiversity, water, food, health, and climate change. It emphasises that these are not isolated issues but rather deeply intertwined challenges that require an integrated, "nexus" approach for effective solutions. It highlights how actions in one area can have significant consequences in others, and that addressing them together is crucial for sustainable development and achieving global goals like the Sustainable Development Goals (SDGs) and the Paris Agreement. The BE provides one option of an integrated "nexus" approach through its integration of conservation and development.

Within the definition of a biodiversity economy, it is important to also unpack sustainable utilisation and what it means. Sustainable utilisation is a core objective of the Convention on Biological Diversity (CBD) (CBD, 2006), encompassing "the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations." Sustainable use is also central to the UN SDGs, with SDG 14 calling on all humanity to "Conserve and sustainably use the oceans, seas and marine resources for sustainable development", and SDG 15 calling on us to "Protect, restore and promote sustainable use of terrestrial ecosystems…" (United Nations, n.d.). The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) Thematic Assessment Report on the Sustainable Use of Wild Species (IPBES, 2022) includes seven policy options to strengthen sustainable use. These align with the principles of the biodiversity economy and include to:

- Strengthen inclusive and participatory decision-making;
- Recognise and support multiple forms of knowledge;
- Ensure fair and equitable distribution of costs and benefits;

- Tailor policies to specific context;
- Monitor wild species and practices;
- Align policies at international, national, regional, and local levels; and
- Support strong institutions, including customary institutions.

The South African White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (DFFE, 2023b) similarly defines sustainable use as the use of any component of biodiversity in a manner that:

- Is ecologically, economically, and socially sustainable;
- Does not contribute to its long-term decline in the wild or disrupt the genetic integrity of the population;
- Does not disrupt the ecological integrity of the ecosystem in which it occurs;
- Ensures continued benefits to people in a manner that is fair, equitable, and meet the needs and aspirations of present and future generations; and
- Ensures a duty of care towards all components of biodiversity for thriving people and nature.

As can be seen above, it is important to note that sustainable use does not equate to commodification. There may be elements of commodification within some forms of sustainable use, but on its own it does not equate to commodification but is rather the use of natural resources for human benefit in a way that still conserves such resources for future generations.

In summary, a working definition used in this paper for the biodiversity economy includes the following:

- Regulated biodiversity-based products, activities, and services that enhance biodiversity;
- The sustainable use of biodiversity in in situ, uncontrolled environments; and
- Regulated activities which are inclusive, equitable and contribute to economic growth, while at the same time aligning with conservation objectives.

And excludes:

- The intensive commodification of wildlife (e.g. any intensified farming activities), and any cruel, morally, culturally, or ethically indefensible practices; and
- Any local or internationally illegal or unsustainable businesses and economic activities.

The biodiversity economy, therefore, is the element of the broader economy that focuses on sustainable development, as the concept of a biodiversity economy is an articulation of the conservation of nature through its sustainable use for the benefit of humans and nature

(Snyman et al., 2021). The term biodiversity economy will be used in this paper but can be interchanged with the term wildlife or wildlife-based economy as defined above in terms of focusing on the sustainable utilisation of fauna and flora to achieve and/or support conservation and development objectives, along with wider bioeconomy impacts on the sustainable innovation and development of rural, marginal and degraded areas.

Many of the activities described as elements of the biodiversity economy could also be described as nature-based solutions (NbS), which are defined as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits" (UNEP 2022b). They could also be categorised as "Biodiversity-based products, activities, and services that enhance biodiversity", which is a key element of Target 9 of the KMGBF focused on the benefits to people from sustainable use of biodiversity (Roe et al., undated). Additionally, they can form part of an Ecosystems-based Approach as outlined in the South African White Paper on the Conservation and Sustainable Use of South Africa's biodiversity (DFFE, 2023b), especially implementing ecosystem-based responses to climate change such as ecosystem-based adaption, mitigation and disaster risk reduction (DEA & SANBI 2016). Goal 12 of the SDGs to ensure sustainable consumption and production patterns should also be considered when looking at the biodiversity economy.

Both nature-based solutions and the ecosystem-based approach are highlighted in Target 8 of KMGBF which aims to "Minimise the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation, and disaster risk reduction actions, including through nature-based solution and/or ecosystem-based approaches, while minimising negative and fostering positive impacts of climate action on biodiversity." The Just Transition Framework to a low-carbon climate-resilient economy and society in South Africa, acknowledges biodiversity economy as one of the key policy areas to give effect to the transition. This includes investing in ecological infrastructures to deliver healthy and functioning ecosystems that provide essential services for the thriving biodiversity economy such as freshwater, food, nutrient recycling, climate regulation, soil moisture retention and fertility, and disaster risk reduction (SANBI, 2016). This also involves promoting sustainable land-use practices and fostering biodiversity stewardship and integration of traditional knowledge of Indigenous Peoples and local communities (IPLC), as part of the Nationally Determined Contribution (NDC).

In line with the ECSWG issue note/work programme Priority Area 1: Biodiversity and Conservation, the biodiversity economy is an important part of a holistic approach to managing sustainable legal trade in the biodiversity sector, by addressing both the demand and supply side and it also serves to better engage IPLCs and to recognise their need for adequate income and livelihoods. By creating value for biological resources through BE

activities there is an incentive to conserve these resources (managing the demand side) and by expanding activities such as regulated wildlife ranching or harvesting , a country can improve the legal, sustainable global supply of natural ingredients or products (supply side) while at the same time increasing employment and revenues in the local and national economy. Through the development of local value chains, the BE and the related inclusive policies and legislation (including land and use rights) can serve to devolve rights to IPLCs to manage and benefit from conservation and sustainable use. As noted above, BE activities such as ecotourism, the game/wild meat industry, biotrade, etc. are not unique to Africa, with countries around the globe having markets for deer and boar meat, using indigenous plants in medicines, cosmetics and foods and having large ecotourism industries, all of which form part of the biodiversity economy. As mentioned above, in the context of management and use of wild species, they could also be categorised as “biodiversity-based activities, products and services”, which is a key element of Target 9 of the KMGBF focused on the benefits to people from sustainable use of biodiversity".

Snyman et al.’s (2021) research highlights that the biodiversity economy and bioeconomy offer a key development opportunity, especially for Africa and other developing countries given the comparative advantage of the biodiversity economy in these contexts as local



***Figure 1**: A graphical representation of the connection between the biodiversity economy and NCA.*

livelihoods and macro- economies are already heavily tied to, and reliant on, wildlife and other natural resources. Biodiversity conservation, ecosystem health, land and soil protection, and climate change all have the potential to be economic, social and welfare challenges with huge implications for the future wellbeing of societies (Snyman et al., 2021). Investment in, and growth of, the biodiversity economy, with governments seeing national wildlife (fauna and flora) as an economic asset, rather than as a resource or input, has the

potential, if managed correctly, to address some of these challenges (Snyman et al., 2021). Therefore, conservation and protection positively impact the ability to have a functioning bioeconomy.

In order to unlock and grow the biodiversity economy certain enablers are needed, including: a supportive and inclusive regulatory and institutional framework; adequate market access, and a supportive business environment for enterprise development; research and innovation; sufficient capacity to engage in the BE; efficient and effective environmental and social governance; the collection of consistent, comparable data for monitoring and evaluation; and supportive collaborations and partnerships across the sectors, as well as adequate human capital to enforce compliance with sustainability criteria.

In the context of Natural Capital Accounting (NCA), the BE is the sustainable use of the biodiversity natural resource asset base of the economy for subsistence, business and livelihoods, to generate revenues, taxes and employment. While NCA focuses on providing data on the value of the stock of natural resources (with some elements of the flow included), measuring the value of the BE provides information on the use (flow) of the natural resources and through value chains and multiplier analysis, includes direct, indirect and induced use values, giving a more holistic picture of the value of natural resources to be reported on to the CBD in terms of NBSAPs. For example, South Africa has a National NCA Strategy which provides national policy direction and includes the formulation of a Biodiversity Economy Satellite Account. See Figure 1 for a graphical representation of the connection between the biodiversity economy and NCA, with BE case studies and Satellite accounts, as well as NCA feeding into the UN System of Environmental Economic Accounting (SEEA) to ensure a comprehensive assessment and evaluation of the stock and flow of natural resources.

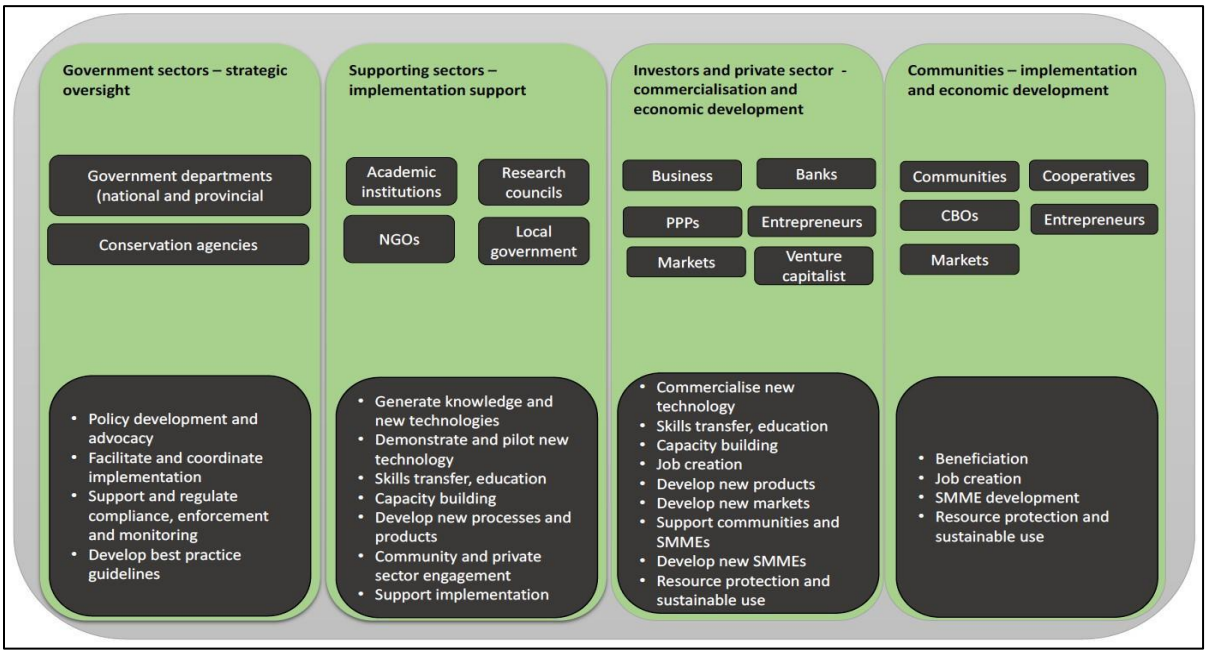


Figure 2: Role of different stakeholders in the biodiversity economy (DEA, 2016)

Other terms currently in use which overlap in many areas with the BE, include conservation economy, nature-based economy, nature positive economy, all of which are different to the green economy, the circular economy and the broader blue economy, elements of which are, however, also included in the BE. Additionally, due to the BE being complex, multi-sectoral, multi-stakeholder (as illustrated by Figure 2) it is difficult to measure the impact of the BE, with frequent issues of double-counting. For example, subsistence, artisanal and recreational fisheries fall within the BE, but are also included in calculations of the value of the blue economy and the fisheries departments within government. Given the complexity of the BE and the myriad terms related to the use of natural resources as an economic asset, some of which have numerous overlaps/similarities, but also often key differences, it is critical that a glossary of terms is established to allow for effective monitoring, evaluation and reporting, assessment of value and to ensure long-term inclusive, equitable sustainability.

Internationally, the KMGBF adopted by the CBD in 2022, supports the achievement of the SDGs and the Convention's objectives, aligning conservation and development and directly includes sustainable use, access, and benefit sharing, directly linking to the BE (CBD, 2024). The BE, therefore, can play a key role in the implementation of the KMGBF and the achievement of related Targets, several of which are directly applicable to the BE. The potential direct linkages are outlined in Table 1 (CBD, 2022).

***Table 1**: Potential linkages between the biodiversity economy and the KMGBF.*

Linkages between the biodiversity economy and the KMGBF	
KMGBF Target	**Biodiversity economy linkages**
Target 3: Conserve 30% of land, water and seas ...while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories.	Links directly with BE because it offers community conservancy, wildlife ranching, private nature reserves, respecting the rights of indigenous peoples and local communities and ensuring that activities are fully consistent with conservation objectives.
Target 5: Ensure sustainable, safe and legal harvesting and trade of wild species	Regulatory frameworks and good governance, necessary for the BE sustainability, will support the safe and legal harvesting and trade of products derived from wild species.
Target 9: Manage wild species sustainably to benefit people	Through the BE, which is dependent on the natural resource asset base, wild species are sustainably managed to support subsistence and to contribute to livelihoods and local, national and regional economies.
Target 10: Enhance biodiversity and sustainability in agriculture, aquaculture, fisheries and forestry	Key activities within the BE are regulated aquaculture, forestry and fisheries directly supporting the achievement of Target 10.

Linkages between the biodiversity economy and the KMGBF	
KMGBF Target	**Biodiversity economy linkages**
Target 11: Restore, maintain and enhance nature's contributions to people, including ecosystem functions and services.....through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature.	Many elements of the BE can be described as nature-based solutions and/or ecosystem-based approaches which, if sustainably managed, benefit people and nature.
Target 13: Increase the sharing of benefits from genetic resources, digital sequence information and traditional knowledge	Regulated bioprospecting is a key activity within the BE, with a focus on equitable benefit-sharing aligning too with the requirements of the Nagoya Protocol as well as other ABS instruments and the CBD objectives.
Target 14: Integrate biodiversity in decision-making at every level	Through raising the profile of the BE and its contributions to local, national and regional economies, highlighting the critical role of biodiversity for people, nature and the economy, will support the integration of biodiversity in decision-making at all levels.
Target 15: Business Disclosure of Information to consumers to promote sustainable consumption patterns	The private sector plays a role in the BE to make changes to their business practices and supply chains through initiatives such as the Wildlife Economy Sustainability Standards and Certification Scheme, and the Bioprospecting Access and Benefit Sharing Regulations.
Target 19: Innovative biodiversity financing, such as..... (d) Stimulating innovative schemes such as payment for ecosystem services, green bonds, biodiversity offsets and credits, and benefit-sharing mechanisms, with environmental and social safeguards;	The BE provides a key tool to mobilise and generate revenues, creating economies based on the sustainable use of nature. These economies, if sustainably and equitably managed, can support long-term development and conservation and are a more sustainable finance option. Nature markets and benefit sharing mechanisms are key contributors to an effective BE.
Target 21 & 22: Ensure equitable and inclusive participation of indigenous peoples and local communities at the same time recognising their traditional knowledge	The BE is anchored by traditional knowledge, innovations, practices and technologies of indigenous peoples and local communities and promotes free, prior and informed consent, in accordance with national legislation.

2 CURRENT MULTILATERAL DELIBERATIONS

2.1 The G20

A G20 Brazil 2024 technical paper titled "Payment for ecosystem services (PES): Scaling up PES to meet global environmental and climate crises" highlighted that PES promotes sustainable use at the local, regional and global levels and that IPLC rights and access to benefits are essential for long-term sustainability. This aligns with the key areas of the biodiversity economy, and highlighted by Snyman et al (2021) which states that Africa's wild

resources – both its wildlife (fauna and flora) and its natural landscapes – should be recognised for their economic, livelihood, and health contributions, including ecosystem goods and services that benefit industries, such as agriculture and commercial forestry which are, therefore, directly linked to wild resources. Additionally, the PES technical paper highlighted that "national integrated conservation policies and instruments are critical for scaling PES and that it is, therefore, necessary to strengthen institutional capacities at the national and sub-national levels to manage broad PES programs." This is consistent with the recommendations of this technical paper in terms of the biodiversity economy and the required institutional, policy and capacity strengthening to support the unlocking and growth of the biodiversity economy.

Supporting this technical paper is another Brazil G20 technical paper titled "Oceans: Advancing sustainable use, conservation, and climate action in oceans and coastal areas" which highlights that "...the health of marine and coastal ecosystems is important for the sustainable use of marine resources and the resilience of societies" and "efficient and participatory management of these ecosystems, which ensure health and provide various benefits to humans, is critical." This previous technical paper supports, and aligns with, the marine and coastal elements of the BE covered in this paper.

The G20 Initiative on the Bioeconomy (GIB), High-Level Principles agreed upon in Brazil in 2024 are all directly aligned with the requirements for the sustainable development of the BE as illustrated by the seven principles of SA's NBES:

- Conservation of biodiversity and ecological infrastructure;
- Sustainable use of indigenous resources;
- Fair and equitable beneficiation;
- Socio-economic sustainability;
- Incentive driven compliance to regulation;
- Ethical practices; and
- Improving quality and standards of products.

In South Africa, the bioprospecting economy sub-sector is a part of the health and trade related sectors of the country's 2013 Bioeconomy Strategy (Förster et al., 2021).

2.2 Other Multilateral Forums

The KMGBF was adopted during the fifteenth meeting of the Conference of the Parties (COP 15). It supports the achievement of the SDGs and includes four goals and 23 targets for 2030. As discussed in the introduction, the achievement of a number of these targets can potentially be supported by the development and growth of the biodiversity economy. Targets 3, 5, 8, 9, 10, 11, 13, 14, 19 and 20 are all linked to the BE, with Targets 5, 9, 10, 13,

14 and 19 being particularly relevant and directly linked (see Table 1). Through the development and growth of a BE, countries can be supported in meeting these targets sustainably, equitably and inclusively. Reporting to the CBD on the targets relevant to the BE can be achieved through the establishment of robust and comparable data systems within national government BE units utilising the reporting tools provided by the CBD.

It is important to note synergies with Priority Two of the G20 Research and Innovation Working Group (RIWG) "Biodiversity Information for Sustainable Development". This Priority and its implementation are key in terms of understanding the natural resource asset base of the BE to ensure long-term sustainable use and to support accurate reporting to the CBD. This Priority provides important baseline information for the implementation of Priority 1: Biodiversity and Conservation of the ESCWG. Peter Drucker's quote "you can't manage what you can't measure" highlights the important need to have a good understanding of biodiversity information in order to sustainably manage it now and in the future. The RIWG Priority Two, therefore, supports the ECSWG biodiversity economy focus, which requires data and information on biodiversity, as the asset base to be utilised in the biodiversity economy. Hence, there is no overlap, but rather supportive and collaborative complementarity between the two WGs.

At a regional level, the Southern African Development Community (SADC) has developed a Wildlife-Based Strategy Framework. This demonstrates the commitment of Member States to the regulated sustainable use of wildlife resources for the benefit of their populations, while recognising the vital ecosystems that this depends on and the need to protect and conserve biodiversity in the region.

South Africa, and most other African countries, is a contracting Party to the CBD. As part of domesticating the KMGBF national indicators have been developed, some of which are informed by the NBES. Additionally, the current revision of the NBSAP is centred on the BE as a key component. Moreover, the country's climate change Just Transition Framework recognises the BE programme as a key activity, supporting its outcomes by developing new economic clusters and opportunities, many of which will account for existing spatial disparities and support in addressing these intrinsic challenges (Presidential Climate Commission, 2022).

3 CURRENT INITIATIVES AND DEBATES

3.1 Global

The growing global recognition of the potential to sustainably utilise biodiversity to support economic development, as discussed earlier, has led to an increasing interest in the biodiversity economy. The United Nations Environment Programme (UNEP) is currently

exploring the application of the concept in other regions of the world beyond Africa, launching a global "Wild Biodiversity Economy" initiative in 2022 (UNEP, 2022).

In terms of the broader bioeconomy, the biodiversity economy is one sector within the wider bioeconomy and is broadly focused on the use of biodiversity in economic activities (World Bioeconomy Forum & Nature Finance, 2024). The World Bioeconomy Forum & Nature Finance (2024) calls for "the bioeconomy to turn its vision of an equitable, sustainable bioeconomy into practice.... emphasis was made on sustainable use of biological resources that advance an equitable global economy. The bioeconomy holds immense economic potential for significant job creation and economic growth. Beyond such quantitative potential, efforts must support the development of socio-bioeconomies that are localised and sustain cultural diversity embodied by the role of Indigenous Peoples and Local Communities, including farmers, in stewarding the world's biodiversity."

In general, in line with the aim of the broader bioeconomy, the BE can be a keystone in advancing equitable, climate-resilient, nature positive prosperity in the broader transition to sustainable development (World Bioeconomy Forum & Nature Finance, 2024).

Discussions towards a sustainable bioeconomy are ongoing under different multilateral fora, such as FAO, the G20 Initiative on the Bioeconomy (GIB), and also CBD and UNEP. It is important to enhance cooperation amongst these different fora, to develop a coherent narrative of a sustainable bioeconomy.

3.2 Regional

In 2019, a Wildlife Economy Summit, convened by UNEP and the African Union was hosted in Zimbabwe, describing a wildlife economy as one that "benefits people and nature, using habitats and wildlife in an ecological, economic and socially sustainable way" (UNEP, 2019). More recently, the African Leadership University (ALU) published a report exploring the state of the wildlife economy across the continent (Snyman et al., 2021) with continued national level reports and the development of a Wildlife Economy Investment Index (WEII) (see technical paper on this topic); and in 2023 the SADC published a Wildlife-Based Economy Strategy Framework (WBESF) (SADC, 2023) while Zimbabwe recently published a biodiversity economy status report (Govt of Zimbabwe, 2023) and, together with a number of other African countries, has shown growing interest in utilising the biodiversity economy as a tool for conservation and development, particularly post the COVID-19 pandemic and the realisation of the vulnerability of relying solely on ecotourism and donor funding for conservation and development.

3.3 National

In South Africa, the White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity provides the vision and principles for the sustainable use of the country's resources, where human and the natural environment coexist in harmony and people derive lasting benefits from the conservation and sustainable use of the country's rich biodiversity (DFFE, 2023b). It is a guiding policy tool for government, private sector, non-government organisations, academia, researchers and communities on the principles of conservation and sustainable use of the country's biodiversity. To this end, the White Paper has four main goals as well as two cross- cutting enablers (DFFE, 2023b) which focus on enhancing biodiversity conservation through sustainable use and equitable access and benefit-sharing. These goals and enablers form an important base for developing a sustainable, equitable, transformed BE. South Africa was the first country in the world to formalise the BE sector through the NBES, along with supportive legislation, policies and ongoing strategy development. Many lessons can be learned from the processes and experiences in South Africa. The regulatory framework to support the implementation of the NBES includes three main pieces of legislation: the National Environmental Management Act (Act no 107 of 1998) (NEMA), the National Environment Management: Biodiversity Act (Act no. 10 of 2004) (NEMBA) and the National Environmental Management: Protected Areas Act (Act no. 57 of 2003) (NEMPAA). Ensuring a supportive regulatory framework which provides the relevant property and use rights and benefit-sharing mechanisms to allow for equitable engagement in the BE is critical for long-term success. More recently, South Africa has worked on further supportive strategies and processes, including the Game Meat Strategy and the Wildlife Economy Sustainability Standard and Certification Scheme. The Game Meat Strategy (DFFE, 2023a) was developed with the aim of bringing together all stakeholders to collaborate towards ensuring that the industry offers the market a product that:

- is naturally, sustainably, and ethically produced with less or no impact on the environment and biodiversity;
- contributes to conservation and rural livelihoods; and
- is of high-quality; safe; traceable and produced within the regulatory framework governing the wildlife sector and food safety protocols.

In terms of impact, the BE has the potential to increase employment, support livelihoods, unlock greater revenues, provide more sustainable nature-based products and services, while at the same time conserving natural resources for future generations. For example, the revised NBES intends:

- To inject an additional 397 000 jobs and R127 billion to the economy per annum.
- Providing 100 million kilograms of game meat in the formal market, especially in far flung rural areas of the country by 2030 and thus contributing to food sovereignty.

- Promoting regenerative agriculture which aims to improve soil health, biodiversity and water management.
- Promoting the crop wild relatives to improve pests and disease resistance as well as the untapped genetic diversity.
- Mainstreaming the protein rich traditional edible insects such as mopani worms, locusts, termites and crickets.
- Implementing inclusive and sustainable small-scale fisheries and aquaculture strategies that ensures economies of scale and promotes market access for the fishing communities.
- Empowering all spheres of government to invest in ecological infrastructure and green economy that promotes corruption free innovative financing mechanisms that attract both public and private investment in biodiversity economy and sustainable use.

In a ground-breaking move towards fairness and respect for traditional knowledge, South Africa has witnessed a significant milestone in a form of first industry wide benefit-sharing agreement on traditional knowledge associated with Rooibos, an indigenous plant species. A benefit sharing agreement was successfully negotiated and concluded within the context of BE between the Rooibos Industry and the San and Khoi-Khoi Community in South Africa. Rooibos, scientifically known as *Aspalathus linearis*, is an endemic shrub species found in South Africa's Cape Floristic Region, while the San and Khoi-Khoi communities have deeply ingrained traditional knowledge about its uses. It is recognised globally as Rooibos tea and the plant holds immense cultural and commercial significance.

Overall, the BE provides an opportunity for the alignment of conservation and development goals ensuring a sustainable future for people and the planet. The South African example in terms of the NBES being a tool for sustainable, inclusive, equitable economic growth and biodiversity conservation, and using metrics to monitor the impact of activities, ensuring that the environmental sector is involved in national bioeconomy strategies can serve as an example to sustainably align conservation and development and to promote countries to include BE targets in their NBSAPs, aligning with the KMGBF targets and required reporting to the CBD.

To-date, situational analyses conducted for the development of the NBES and the SADC WBESF both found extensive contributions of the different BE activities to GDP, livelihoods and employment. Table 2 highlights values from the SADC WBESF, which together show a total contribution of the wild fauna sub-sector of USD 30.7 million and for the wild flora sector a total of USD 922.5 million in SADC. No data was found on the employment impacts, which would also be significant. Similarly, Snyman et al (2021) found extensive values for BE activities across Africa, with ongoing national country case studies highlighting that when well-regulated and sustainably managed, the BE has positive economic, employment and

conservation impacts. Given the lack of development in terms of value chains and infrastructure in many countries, it is likely that these impacts could be even greater.

***Table 2**: Contribution by the Member States to the wildlife-based economy of the SADC for 2019 (Source: Authors calculations in Sustento Development Services (2021)*

Member State*	Wild Fauna sub-sector (USD Million)	Wild Flora sub-sector (USD Million)
Angola	2,058	61.7
Botswana	209	6.2
Comoros	87	2.6
Democratic Republic of Congo	7,654	229.6
Eswatini	121	3.7
Lesotho	79	2.4
Madagascar	2,137	64.1
Malawi	1,011	30.4
Mauritius	265	7.9
Mozambique	1,298	38.9
Namibia	1,177	35.3
Seychelles	331	9.9
South Africa	9,365	280.9
Tanzania	2,886	86.6
Zambia	1,597	47.9
Zimbabwe	468	14.1
SADC	**30,751**	**922.5**

*Note: These calculations are indicative and not prescriptive due to data limitations.

Similarly, the SA NBES (DEA, 2016) found extensive contributions of the BE to local and national economies, including for example that the wildlife and bioprospecting industries contributed approximately ZAR 3 billion (approx. USD 167 million) to GDP in 2013. The Game Meat Strategy (DFFE, 2023a) also highlights extensive values related to game meat, specifically ostrich meat, for which South Africa has the largest market share of ostriches in the world.

Given the lack of comparable, consistent, updated, robust data related to the different activities within the BE, it is likely that all the figures available are understated. The establishment of supportive regulatory and governance frameworks and effective monitoring and evaluation are essential to ensure long-term sustainability and to allow for accurate reporting of the value of the biodiversity economy. A more accurate understanding of the value of the biodiversity economy to local, national and regional economies would likely result in much greater support for the sustainable management of the natural resource asset base which supports this economy.

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

The recommendations and considerations included here are potential actions identified as relevant to advancing the sustainability of the biodiversity economy and in so doing promoting the conservation and sustainable use of biodiversity and equitable sharing of benefits for sustainable development. To ensure the unlocking and development of a sustainable BE, there needs to be supportive national, regional and international regulatory and governance frameworks, as well as institutional support, with cross-sectoral collaboration and partnerships. The African Continental Free Trade Agreement (AfCFTA) (African Union, 2019) is a great start to supporting regional trade related to the biodiversity economy. For example, the legal trade in sustainable game/wild meat and forest products could be promoted, as one measure along with more control actions, to reduce illegal trade currently threatening biodiversity across the continent, as well as to provide increased employment and revenues across the value chain. The Kavango-Zambezi Transfrontier Conservation Area (KAZA-TFCA) Univisa makes it easier for tourists to travel between Zambia and Zimbabwe within the TFCA and free movement of people between Botswana and South Africa in the Kgalagadi TFCA, as well as other similar initiatives across Africa should be encouraged to promote ease of access to, and movement between, ecotourism destinations. The current restrictive high cost of travel within Africa inhibits the growth of national and regional ecotourism, which has the potential, directly and indirectly, to contribute significantly to more robust employment and revenues, directly and through the extensive related value chains and multipliers.

As has been seen in South Africa; to gain scale and have a tangible impact, the biodiversity economy needs to be embedded in national policies and have a dedicated team/unit focused on it. The BE and the associated value chains and multipliers, if sustainably unlocked and invested in, have the potential to create more resilient, equitable and inclusive economies, creating employment and generating revenues, aligned with the long-term biodiversity conservation objectives of the KMGBF.

Building local capacity for value-addition, through collaborations, partnerships and north-south learning, can create further employment and value, especially in terms of biotrade and bioprospecting. For example, a large percentage of natural resources, such as honey and other forest products, are exported raw from African countries (see Snyman et al., 2021), which can result in a lost opportunity to generate further employment and revenues through the value addition process locally and/or regionally. Many lessons can be learned from value chain development in developed countries.

4.1 General key proposed initiatives/ideas going forward:

- Encourage G20 countries to exchange experiences on biodiversity-based activities, products and services that enhance biodiversity

- There needs to be greater recognition, and promotion, of the BE as a key tool for sustainable development and to support countries in reporting to the CBD with respect to the KMGBF and the related Targets in particular with regards to promotion of conservation, the sustainable use of biodiversity and equitable sharing of benefits whilst recognising the rights and ownership of IPLCs on traditional knowledge associated with biological or genetic resources. This can include: a) the promotion of the conservation of natural resources/biodiversity which form the asset base essential for the long-term sustainability and successful implementation of the BE and b) the promotion and support for equitable benefit-sharing from the BE and rights to ownership and use of natural resources to support long-term conservation. As part of this, it is critical to incorporate IPLCs in decision-making, implementation and benefit-sharing to ensure fair participation and equitable benefit- sharing.
- Knowledge-sharing and capacity building with respect to the potential of the BE, supportive regulatory frameworks and institutions, as well as the expansion of sustainable value chains related to BE products and services (locally, nationally, regionally and globally) to generate greater value and create further employment including attracting investment, innovation and entrepreneurship.
- Engage and enable the private sector, through supportive regulatory frameworks and institutions, to support investment, innovation and entrepreneurial activities within the biodiversity economy. Also identifying ways to monetise ecosystem goods and services that are currently excluded from GDP calculations. This, in turn, requires targeted research and political dialogue on how to properly value these services and integrate them into existing economic systems such as the Biodiversity Economy Satellite Account.
- Enhance monitoring and evaluation through a standard tool or set of indicators for measuring the value of the BE, including dedicated teams to collect this information as well as ensuring long-term sustainability. See for example the “Experimental Biodiversity-Based Tourism Estimates for South Africa, 2013 to 2019” (Statistics South Africa, 2024) and other satellite accounts aiming to incorporate BE-related activities into the national economic reporting process.
- Promote collaboration and partnerships across sectors, countries, and Ministries to maximise impact and ensure a co-ordinated, robust, sustainable, well-regulated biodiversity economy.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Solidarity
Equality
Sustainability

People and Nature Thriving Together in Sustainable Living Landscapes

A Reimagined Conservation for South Africa

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EXECUTIVE SUMMARY

Mega Living Landscapes (large, interconnected areas with functional ecosystems) is a policy instrument in South Africa for achieving GBF targets whilst advancing economic development through inclusive conservation, and social justice. This Living Landscapes approach fits well within several G20 priorities that support biodiversity, livelihoods and climate resilience. The G20's multilateral environmental commitments create opportunities to support these landscapes, especially in the Global South.

1 INTRODUCTION

South Africa, one of the 17 megadiverse countries (Mittermeier et al., 1998), hosts a significant portion of the world's biodiversity, with many species found nowhere else. Additionally, South Africa's San rock art and significant palaeontological finds, make it a global treasure trove of cultural significance. However, the country remains highly vulnerable to climate change, which could significantly alter its ecosystems by 2050, leading to substantial biodiversity losses and adverse effects on human well-being. These environmental threats are compounded by persistently high levels of unemployment, poverty, and inequality, creating a complex web of socio-economic and environmental issues. The lingering effects of past race-based land dispossession further complicate these challenges, as Indigenous Peoples and local communities often have low participation in conservation efforts. Additionally, unsustainable production and consumption practices exacerbate biodiversity loss and ecosystem degradation, perpetuating cycles of ecological and socio-economic decline. To address these issues, it is crucial to rethink the economy beyond growth, focusing on redistribution and a just society given that South Africa is committed to meeting global environmental objectives, particularly the Kunming – Montreal Global Biodiversity Frameworks' (KMGBF) of halting and reversing the loss of biodiversity for the benefit of people and the planet by 2030.

Given that the country requires 13.35% of land and inland freshwater resources and 15.3% of its marine areas to be added to the current conservation estate in order to achieve its 30x30 GBF Target, a key strategy for achieving South Africa's conservation goals is the establishment of Mega Living Landscapes. A Mega Living Landscape is a conservation strategy designed to manage and conserve biodiversity on vast interconnected landscapes while promoting socio-economic inclusion and sustainability (Kumalo & Wilson, 2025). This approach integrates various land uses, such as protected areas, farmlands and community-managed conservation areas into vast, interconnected landscapes by co-creating a collaborative model of conservation (inclusive conservation). The Living Landscapes approach aims to contribute an additional 12.3% (approximately 14 million hectares) to South Africa's land conservation 30x30 targets. These landscapes will also drive economic

renewal and promote socio-economic inclusion as by provided for by the G20 approach to inclusive conservation practices.

2 CURRENT MULTILATERAL DELIBERATIONS

2.1 The G20

Since 2017, the G20 has increasingly prioritised environmental and conservation issues in the G20 Environment Ministers' meetings. Topics often included biodiversity, sustainable land use, protected areas and ecosystems restoration. Inclusive conservation is addressed by emphasising equitable participation of Indigenous Peoples and local communities in conservation planning and benefit-sharing. During the G20 Osaka Summit of 2019 in Japan, strong emphasis was placed on the Osaka Blue Ocean Vision to reduce marine plastic litter. The Summit highlighted the role of inclusive ocean governance involving coastal communities and civil society in addressing marine ecosystem threats. The launch of the Global Coral Reef Research and Development Accelerator Platform during the G20 Riyadh Summit in 2020 in Saudi Arabia encouraged multilateral cooperation, especially with small islands developing states. The Summit called for inclusive frameworks to support vulnerable countries in marine biodiversity conservation. The G20 Rome Leaders' Declaration in Italy in 2021 supported the implementation of the post-2020 Global Biodiversity Framework. Emphasis was placed on Nature-based Solutions and the promotion of integrating biodiversity in all sectors which recognise the need to involve local communities and indigenous peoples.

Insofar it relates to ongoing G20 multilateral engagements on inclusive conservation, the G20 2023 (India Presidency) focused on the theme "One Earth, One Family, One Future" which is reinforcing inclusive approaches to conservation under the LIFE initiative (Lifestyle for Environment) that promotes sustainable living with community participation. The G20 India Presidency supported the implementation of 30 x 30 biodiversity targets and encouraged just transition in conservation of terrestrial habitats. The G20 Global Initiative on Reducing Land Degradation and Enhancing Conservation of Terrestrial Habitats was a continuous collaboration stemming from the 2020 Saudi Arabia. This initiative promotes inclusive land restoration, engaging farmers, indigenous groups, and women in restoration efforts.

The G20 also provide support for UN Conventions, including:

- Convention on Biological Diversity (CBD)
- United Nations Convention to Combat Desertification (UNCCD)
- United Nations Climate Change Convention (UNFCCC)

2.2 Other Multilateral Forums

The concept of "Living Landscapes" is also in line with the KMGBF's targets and objectives, in particular the 30x30 target. It envisions large, interconnected areas that prioritize both biodiversity and the well-being of people living within and around them. This approach moves away from traditional, often exclusionary, conservation models and towards a more inclusive and sustainable approach.

In terms of Living Landscapes, the KMGBF refers to the following key concepts –

- Specific Goals: 30x30 Target - The KMGBF includes the "30x30" target, which calls for the effective conservation and management of at least 30% of the world's terrestrial, inland water, coastal, and marine areas by 2030.
- Restoring Degraded Ecosystems: Living Landscapes also focus on restoring degraded ecosystems and enhancing their resilience to climate change.
- Sustainable Use of Biodiversity: The framework also aims for the sustainable use of biodiversity, ensuring that natural resources are used in a way that meets present needs without compromising the ability of future generations to meet their own needs.
- Equitable Benefit Sharing: The KMGBF promotes equitable sharing of the benefits derived from the use of genetic resources and digital sequence information on genetic resources.

3 CURRENT INITIATIVES AND DEBATES

Following ever-more worrying news about the global biodiversity crisis (WWF, 2024), the international conservation debate has been shifting significantly over the last decade. Whereas earlier consensus emphasised market-based mechanisms and extension of protected areas as the key policy tools, the current consensus is driven by the need for transformative change (Visseren-Hamakers and Kok, 2022). Exactly what transformative change entails in conservation is widely debated, including through the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Recent important IPBES policy frameworks include the Natures Futures Framework, which emerged from the IPBES Assessment on Scenarios and Models (2018) and the 2022 IPBES Values Assessment. Central in the Natures Futures Framework is the recognition of plural ways in which people value nature (Pascual et al. 2023), while suggesting new policy tools to meet multiple values simultaneously (Pereira et al 2020).

The most recent IPBES transformative change assessment (IPBES 2024) is explicit on transformative change, which it conceptualises as a process of fundamental, system-wide shifts across views, structures and practices, that goes beyond incremental change or scaling up existing solutions. The focus, instead, is on seeking to transform root causes and changing underlying values, norms, institutional structures and behaviours. The assessment

also identified three overarching challenges to transformative change, which are particularly critical for the current technical paper: (a) disconnection from and domination over nature and people; (b) concentration of power and wealth; and (c) prioritization of short-term, individual and material gains (IPBES 2024).

A Living Landscapes approach responds to these urgent challenges by suggesting practical, innovative policy proposals that take steps in making transformative change a reality on the ground. Building on further recent academic and policy discussions on convivial conservation (Büscher and Fletcher, 2020), transformative finance for nature and climate (Fletcher et al, 2025), including conservation basic income (de Lange et al, 2023) and discussion on 'living landscapes' that combine biodiversity conservation and social justice[1], A Living Landscapes approach fully geared to make transformation a reality through (1) connecting people and nature by breaking down systems of domination; and (2) prioritizing long-term collective gains for a sustainable future.

Operationalising a Living Landscapes approach in practice involves a transformative shift in how conservation is approached - moving from isolated, fenced-off protected areas to inclusive, multifunctional landscapes that integrate biodiversity conservation with human well-being, climate resilience, and socio-economic development. For example, integrate protected areas with surrounding land uses, including agriculture, forestry, tourism, and community-managed areas wherein recognising diverse land activities as part of conservation when done sustainably. A key operational tool is the Contract National Park mechanism (for example under the South African National Environmental Management: Protected Areas Act) where the landowners, Indigenous Peoples and local communities voluntarily include their land in protected areas but they retain ownership and use rights, while committing to conservation-friendly practices. Similarly, the G20 Global Land Initiative[2] promotes integrated management across ecosystems including forests, grasslands, wetlands, and urban areas while CIFOR-ICRAF's projects establish platforms for dialogue and co-management for stakeholder collaboration to implement landscape approaches in Ghana, Indonesia, and Zambia [3].

1 G20 CONSIDERATIONS AND RECOMMENDATIONS

The G20 approach to inclusive conservation is gradually becoming more sophisticated, integrating social equity, indigenous rights and local knowledge into biodiversity and environmental agendas. While implementation varies by country, the G20 provides a strong

[1] https://plaas.org.za/living-landscapes/.
[2] Implementation Strategy | G20 Global Land Initiative
[3] Operationalising the landscape approach for biodiversity and benefits: Policy, practice and people | CIFOR-ICRAF Projects

multilateral platform for aligning economic, environmental and social development through inclusive conservation practices.

Creating vast interconnected living landscapes with functioning ecosystems foster thriving biodiversity and enhance Indigenous Peoples' and local communities' livelihoods, well-being, and resilience. By catalysing pro-nature and socially just forms of economic development, these initiatives aim to retain or improve biodiversity and ecosystem services while benefiting Indigenous Peoples and local communities and those parts of the private sector ready to embrace new economic thinking. Creating Living Landscapes will drive inclusive economic development by integrating biodiversity and conservation-linked opportunities into local economies, promoting equitable and sustainable community benefits. This approach stimulates inclusive economic development through biodiversity value chains and conservation-linked initiatives.

We call upon the G20 member states to consider and recommend the following for Living Landscapes, aligned with its sustainability, development and conservation agendas:

- Recognise that environmental and socio-economic challenges are intertwined, and these can be approached through an inclusive conservation policy such as Living Landscapes where people and nature thrive in sustainable landscapes. The long-term impact is increased livelihoods, human well-being, and resilience within vast interconnected living landscapes. Living Landscapes represent a nexus opportunity for the G20 since it fit well within the G20 priorities, including climate change and biodiversity, inclusive and equitable development, sustainable finance and investment, nature-based solutions, science innovation and knowledge sharing.
- Recognise the need for *commoning* in living landscapes wherein new policy discussions on transformative change (such as IPBES Natures Futures Framework) should encourage G20 member states to adopt a more flexible approach that values and promotes inclusive conservation policies which contribute to poverty eradication efforts and build commons systems where farmers, Indigenous Peoples and local communities and protected areas/wildlife reserves develop a joint process of restoring not just the ecosystem but more sustainable long-term human-nature relations, including through more equitable economic activities focused on common responsibility rather than private competition.
- Support community-based ecological restoration wherein countries building on and supporting local initiatives to restore landscapes that bring back biodiversity and allow for animal and plant movement, while including more sustainable forms of habitation for people and their livelihoods.
- Provide the policy basis for agro-ecological development as sustainable agricultural practices under Target 10 of the KMGBF, which recognizes other approaches, such as sustainable intensification as well as with the FAO Strategy on Mainstreaming

Biodiversity Across Biodiversity. Based on international discussions on agro-ecology and connecting this to policy initiatives in the agricultural field, this policy instrument aims to support local farmers (both commercial and communal) to develop forms of agro-ecology supportive of biodiversity.

- Adopt the development of landscape monitoring frameworks that track ecological, social and economic outcomes, including the alignment thereof with existing SDGs, GBF and climate targets.
- In acknowledging the critical role forests play in addressing climate change and the essential ecosystem services it provides for conserving biodiversity and supporting livelihoods, there is an urgent need to (a) halt and reverse forest landscape degradation and deforestation linked to agricultural commodity production and promote sustainable and transparent supply chains by 2030, and (b) strengthen the governance of forest living landscapes to address illegal land use activities.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Galvanising Multilateral Action on Crimes that Affect the Environment

A Cross-Cutting Global Threat Demanding an Integrated Response

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EXECUTIVE SUMMARY

Crimes that affect the environment are among the world's most damaging and lucrative illicit activities. As criminal markets for environmental products have expanded the world over, the impacts are only growing more serious. Across a fractured planet, crimes that affect the environment now act as a threat multiplier, exacerbating existing harms and creating heightened risk profiles. These crimes no longer simply present a threat in their own right. Rather, they are intrinsically linked to wider global challenges from growing extinction risks to the climate crisis and cascading security threats.

Bringing together countries across relevant environmental supply chains, the G20 is uniquely placed to make a difference. This technical paper makes the case for elevating the profile of crimes that affect the environment and raising levels of ambition across G20 countries. Strong G20 commitment would act as a strategic lever to accelerate progress on a wider set of global climate, environmental, sustainability, and development objectives. There is no pathway to deliver on these targets without tackling crimes that affect the environment.

The South African G20 presidency has a clear opening to address these intersections. This comes as the global response to crimes that affect the environment reaches an inflection point. A range of recent international convening exercises have recognised that additional measures are needed if our approach to disrupting these crimes is to keep pace. By grounding crimes that affect the environment at the centre of the Environment and Climate Sustainability Working Group's (ECSWG) deliberations, the South African G20 presidency can galvanise a more coherent global response.

This paper draws on leading research, expert dialogue and practical lessons to outline the debates and issues of greatest relevance. Key insights include:

- *Crimes that affect the environment present a multidimensional threat bridging today's most pressing environmental, development, governance and public health agendas.*
- *At a global level, these intersections have not yet been adequately recognised or addressed, with the topic still to receive the level of prioritisation it demands.*
- *Across existing multilateral engagements, crimes that affect the environment have at times been addressed in piecemeal ways, with a need to streamline efforts across the system.*
- *Definitional challenges persist, while the lack of a uniform set of standards for criminalisation creates legal gaps that are easily exploited.*

- *A range of options have been proposed to address these challenges, with recent discussion including the potential for an additional protocol(s) to the United Nations Convention against Transnational Organized Crime.*
- *There is a need for more strategic engagement of the private sector, as well as civil society, across multilateral discussions.*
- *More effective and focused action is needed to address persistent enablers, in the form of associated corruption and illicit financial flows.*

This paper presents nine policy options to G20 decision-makers:

1. ***Elevate the profile of crimes that affect the environment on political agendas,*** *spearheading a push to establish these crimes as an international priority.*
2. ***Formally recognise intrinsic interconnections with wider global targets****, drawing out the centrality of crimes that affect the environment to other high-priority multilateral agendas.*
3. ***Mobilise support for a more integrated global response,*** *garnering agreement on options for alignment with wider global processes.*
4. ***Broaden the range of countries committing to engage,*** *distilling a clear narrative on why crimes that affect the environment matter and mobilising global leaders with diverse priorities.*
5. ***Build consensus and adopt common positions*** *on the appropriate response to terminological debates and gaps in criminalisation, building consistency in the approach taken to these issues.*
6. ***Set out high-level principles to address common enablers****, expanding and updating those agreed under Germany's 2017 G20 presidency to cover broader crimes that affect the environment (G20, 2017).*
7. ***Bolster global focus on intersections between licit and illicit markets,*** *deepening data collection and ensuring more strategic engagement with private-sector actors.*
8. ***Consider legislative and implementation gaps in existing frameworks****, gauging levels of consensus on key proposals, for example, around the potential for an additional protocol(s) to the UN Convention against Transnational Organized Crime.*
9. ***Foster commitment to build the evidence base to advance the global response****, tackling the lack of reliable data on key aspects of the threat, and sharing lessons and best practice.*

Across these areas, G20 countries have the power to drive concerted collective action. Crimes that affect the environment represent a global problem that

demands global responsibility. An ambitious focus here would see the South African G20 presidency lead on a threat causing irreversible damage across the globe – and threatening our collective future.

1 INTRODUCTION

The priorities for this year's G20 Environment and Climate Sustainability Working Group (ECSWG) cover a range of critical environmental issues. These include biodiversity and conservation; land degradation, desertification and drought; chemicals and waste management; climate change and air quality; and oceans and coasts. There is a common – and rapidly expanding – threat that cuts across these issues and affects our efforts to address them. Indeed, there is no pathway to deliver on these priorities without addressing crimes that affect the environment.

Crimes that affect the environment is a term that has been used in multilateral decision, resolutions and declarations for several decades. The term is not defined but it has been stated to include activities such as illegal logging, illegal mining, illegal wildlife trade, illegal fishing and illegal movement and disposal of waste and hazardous substances. For example, all of these activities were included in the G20 Rome Leaders' Declaration, with countries committing to take concrete action to address crimes that affect the environment (G20 Information Centre, 2021).

Today, crimes that affect the environment comprise a multi-billion-dollar transnational industry. Perceived as 'low risk, high return', they generate an estimated $110–281 billion in criminal gains annually (FATF, 2021). The full economic value of illegal wildlife trade, illegal logging and illegal fishing alone has been placed at over $1 trillion per year (World Bank, 2019).

The impacts on nature, people and the planet are wide-ranging. Most directly, crimes that affect the environment destroy livelihoods that rely on stable ecosystems (Nellemann, 2014). Illegal fishing empties the waters where coastal communities once prospered (Haenlein, 2017). Illegal wildlife trade harms biodiversity, while denying communities revenues from ecotourism (UNODC, 2024). Illegal deforestation depletes the soil, forcing small-scale farmers off their land (UNODC, 2025). The impacts are often borne most heavily by countries of origin for trafficked environmental commodities. Here, the frontline defenders of forests and oceans, indigenous peoples and traditional communities, often face the brunt of the devastation (Global Witness, 2024).

The impacts appear on a global scale. From oceanic pollution that affects global food chains to illicit financial flows that enter global financial hubs, crimes that affect the environment undermine governance, fuel corruption and distort legitimate economies (FATF, 2021). They damage the integrity of the global financial system, foster sociopolitical instability and harm public safety. They threaten the rights of youth and future generations, compromising their

access to a healthy environment and secure livelihoods. They destroy the world's defences against climate change, exacerbating temperature rises felt the world over (UNODC and WWF, 2022). And they create the conditions for deadly pathogens to spread to people, posing acute public health risks in an era of global connectivity (UNODC, 2020).

These effects are only growing more serious. Across a fractured planet, crimes that affect the environment now act as a threat multiplier, fuelling other criminal markets, exacerbating global megatrends and creating elevated risk profiles. Straddling licit industry and the criminal underworld, they are entrenched in a wider ecosystem of criminality – a complex network of actors, groups and systems whose actions threaten our lives as we know them (Europol, 2022). These dynamics can no longer be viewed in isolation. Instead, they comprise a multilayered threat bridging today's most pressing environmental, development, governance and public health agendas.

The impacts on climate change are a case in point. As crimes that affect the environment wreak havoc on the planet's biodiversity, they disrupt ecosystem functions directly affecting our climate (UNODC and WWF, 2022). Illegal logging destroys forests acting as carbon sinks, reducing the Earth's ability to absorb CO2. Waste crime produces methane and carbon emissions many times greater than best-practice waste disposal (UNEP, 2015). Pollution crime affecting marine ecosystems disrupts the oceans' unrivalled capacity to sequester carbon (UNODC and WWF, 2022). Illegal wildlife trade can also affect carbon stocks, while triggering biodiversity loss. In just one example, the targeting of mega-herbivores disrupts their ability to reduce above-ground carbon through grazing and disturbance (UNODC, 2022).

These interplays mean that crimes that affect the environment are now major contributors to a vicious cycle of pollution and climate-related destruction. As such, they are central to a wider pattern of ecological insecurity that undermines resilience to extreme weather, deepens poverty, fuels instability and disrupts global supply chains. Exacerbating these threats are the dangers to public health: illegal wildlife trade and illegal logging have been linked to zoonotic disease outbreaks, with potentially far-reaching consequences in an age of global connectivity (UNODC, 2020).

At a global level, these intersections have not been adequately recognised. While the importance of tackling crimes that affect the environment is understood in some circles, these crimes have yet to receive the level of global prioritisation they demand (GI-TOC, 2025). Instead, the perception of a distant, abstract threat persists in many policy arenas. This has limited multilateral progress on an issue causing irreversible damage across the globe. It has also contributed to domestic under-prioritisation and under-resourcing of efforts to address crimes that affect the environment.

Indeed, crimes that affect the environment have not seen the same concerted focus as other related challenges. For example, significant progress has been made over the last 10–15 years in developing collective agreement on systemic solutions to other environmental challenges, including climate change (Paris Agreement, 2015), biodiversity loss (Kunming-Montreal Global Biodiversity Framework – KMGBF, 2022) and protection of the high seas (High Seas Treaty, 2023). Although key to all environmental targets, reducing crimes that affect the environment has not received the same level of global attention or consensus. This has impeded the development of a transnational response commensurate with the urgency of the issue.

This is not to say that crimes that affect the environment have been ignored at the multilateral level. Numerous parts of the multilateral system have engaged with these issues – from the Financial Action Task Force (FATF) to UN General Assembly resolutions (2015 onwards) to the Council of Europe. Progress has been made in key policy arenas, with sustained advocacy and member-state interest building momentum in the Conference of the Parties to the UN Convention against Transnational Organized Crime (UNTOC), Commission on Crime Prevention and Criminal Justice (CCPCJ), and United Nations Environment Assembly (UNEA), among others. The issue, instead, is that multilateral action has not always been sufficiently focused. At times, crimes that affect the environment have been addressed in siloes, with key initiatives pursued in disjointed ways. At others, they have continued to be addressed on the margins, not least in debates over other global priorities.

More must be done to raise the profile of crimes that affect the environment internationally. In parallel, concerted efforts must be made to address gaps and inconsistencies across current multilateral engagement with these issues (GI-TOC, 2025). Here, there is a pressing need to rationalise efforts across the system, coalescing a more coherent response (GI-TOC, 2025). This must be done while framing crimes that affect the environment as posing a cross-cutting global threat – accounting for the multilayered dynamics of a phenomenon bridging multiple agendas.

The G20 has a critical role to play in this regard. Building on recent international momentum, South Africa is well placed to ground crimes that affect the environment at the centre of deliberations across the ECSWG in 2025. This paper draws on rigorous research, expert discussions and practical lessons from past initiatives to outline the debates, positions and issues of greatest relevance to this effort. It concludes by presenting the policy choices available to galvanise a more effective global response.

2 CURRENT MULTILATERAL DELIBERATIONS

Crimes that affect the environment have been addressed through engagements across various parts of the multilateral system. While it is beyond the scope of this paper to list every relevant initiative, this section provides an overview of the most significant multilateral

engagements and their status. It begins by considering past G20 involvement in tackling these issues to date.

2.1 Past G20 Discussions

Crimes that affect the environment have been considered under several G20 presidencies to date. Notably, Germany's 2017 G20 presidency prioritised illegal wildlife trade (IWT) as a focus area, including the enabling role played by corruption. This resulted in the agreement of a set of 'High Level Principles on Combatting Corruption Related to Illegal Trade in Wildlife and Wildlife Products' (G20, 2017). In line with these, concrete steps were laid out in four areas: strengthening frameworks to combat corruption linked to IWT; establishing preventative measures; implementing concrete actions on investigation, prosecution and sanctioning; and undertaking (self-)assessment of progress (G20, 2017).

Beyond IWT, the G20 has affirmed a commitment to end illegal, unreported and unregulated fishing. This has been set out under multiple G20 presidencies, as per the 2019 Osaka Leaders' Declaration, 2021 Rome Leaders' Declaration, 2022 Bali Leaders' Declaration and 2023 New Delhi Leaders' Declaration, among others (G20, 2023). In 2021, G20 leaders made commitments in relation to wider crimes that affect the environment (G20 Information Centre, 2021). They did so by pledging to address a spectrum of activity bridging illegal logging, illegal mining, IWT and illegal movement and disposal of waste and hazardous substances (G20 Information Centre, 2021).

Focus has often been placed on the financial aspects of these crimes. In 2021, G20 leaders called on countries 'to fight money laundering from environmental crime' in line with FATF guidance (G20 Information Centre, 2021). In 2022, G20 leaders welcomed specific FATF efforts to promote implementation of international standards on virtual assets and transparency of beneficial ownership, recognising 'their role in the fight against systemic corruption and environmental crimes' (G20, 2022). In 2024, meanwhile, the first Summit of Heads of Prosecution Services of G20 Members saw commitments to 'strengthen prosecution services with a view to safeguarding the environment, holding accountable those who commit crimes' (PG20, 2024).

The initiatives taken under past G20 presidencies are welcome. They signal a willingness to engage with an issue that is central to progress on multiple agendas. Yet more remains to be done to advance multilateral cooperation – and to ensure this filters into national priorities and targeted domestic initiatives. The 2025 South African Presidency is well placed to build on past G20 engagement, broadening the dialogue on crimes that affect the environment and galvanising global responses commensurate with the threat posed.

1.1 Other Multilateral Fora

Beyond the G20, crimes that affect the environment have been considered across the multilateral system more broadly. As they have, an array of multilateral environmental agreements and other instruments have grown up. At times, gaps in coordination have been witnessed – as discussed further in section 3. This sub-section provides a high-level overview of the most prominent forms of engagement across the wider multilateral system. As noted previously, not every initiative can be mentioned; instead, this section outlines the key directions of travel to date.

In general terms, there has been a progressive shift in the way crimes that affect the environment have been addressed in multilateral fora. Historically, attention has centred on IWT, with greatest focus on a few charismatic species. The issue was mainly addressed through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), as an instrument aimed at regulating international trade in wild fauna and flora. One of the world's first multilateral environmental agreements, CITES has been recognised as a pioneer in areas from compliance to the involvement of non-governmental observers (Scanlon, 2025). Fifty years since entering into force, it continues to play a key role in regulating international wildlife trade, with the goal of ensuring that this is sustainable, legal and traceable, and does not threaten the survival of species in the wild.

Another longstanding multilateral environmental agreement can be seen in the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. Adopted in 1989 following public outcry over toxic waste imported by a range of developing countries. The Convention outlines a legally binding definition of 'illegal traffic', to which its 191 Parties are bound. Parties are obliged to ensure adequate legislation exists to prevent and disrupt trafficking activity, and to report on closed trafficking cases annually (Secretariat of the Basel Convention, n.d.). The Rotterdam and Stockholm Conventions address trafficking risks in related areas, with efforts to promote synergies across conventions on combating and preventing trafficking in hazardous waste and chemicals since 2017 (Secretariat of the Basel, Rotterdam and Stockholm Conventions, n.d.).

Beyond these agreements, progressive advances in other multilateral discussions have seen a growing focus across other crimes that affect the environment. Here, there has been increasing recognition of these phenomena as serious crimes in need of a concerted criminal justice response. Alongside these shifts has come broadening multilateral engagement with these crimes, as key platforms have targeted different facets of the problem (Muggah & Szabó de Carvalho, 2025).

Across the UN system alone, decisions, declarations and resolutions on crimes that affect the environment have come from a range of quarters. In 2015, the first-ever UN General

Assembly Resolution on 'Tackling illicit trafficking in wildlife' was adopted by consensus (CITES, 2015). This followed the creation of the Group of Friends in 2013 and the convening of two high-level UN events by Gabon and Germany in 2013 (CITES, 2013) and 2014 (CITES, 2014). Numerous follow-on UN General Assembly resolutions have been adopted since 2015, the most recent in 2025 (UN, 2025). In 2021, meanwhile, the UN General Assembly endorsed the first-ever resolution on wider crimes that affect the environment, adopted by the CCPCJ following the Kyoto Crime Congress (UNODC, 2021).

The profile of crimes that affect the environment has risen particularly in Vienna-based UN crime and justice fora. Here, a range of recent milestones have been reached. Among others, in 2019, the Conference of the States Parties to the UN Convention against Corruption (UNCAC) passed Resolution 8/12 – the first to specifically address corruption in the context of crimes that affect the environment (UN, 2019). In 2022, the CCPCJ adopted Resolution 31/1 – the first to reference a possible new global agreement to prevent and combat wildlife trafficking (UN, 2022). And in 2024, UNTOC CoP12 adopted Resolution 12/4, creating an intergovernmental expert group to identify gaps in the international legal framework to combat crimes that affect the environment and articulate potential solutions (UN, 2024). Most recently, in 2025, CCPCJ Resolution L.8 was adopted, encouraging States to consider all aspects of the fight against crimes that affect the environment.

UN engagement with the topic has bridged a range of other fora. These include UNEA 5.2 in March 2022, where discussions were initiated on a global plastic pollution treaty. In parallel, there have been discussions at UNEA about further approaches on mining and minerals. Crimes that affect the environment have generally not been addressed in depth in fora such as the CBD and the UN Framework Convention on Climate Change (UNFCCC).

Beyond the UN system, multilateral action on crimes that affect the environment has taken other forms. Crucially, this decade, the FATF has led on efforts to tackle money laundering linked to environmental offending. In 2020, it released a landmark report on IWT – referencing the billions in criminal proceeds generated (FATF, 2020). For the first time, it called on countries to act – by assessing their exposure to the proceeds of IWT, ensuring national legislation allows authorities to disrupt the finances of wildlife traffickers, and pursuing financial investigations in relevant cases (FATF, 2020).

The FATF has since expanded its focus to wider crimes that affect the environment. In 2021, it published a report on the profits generated from illicit markets bridging forestry, mining and waste (FATF, 2021). It did so calling on countries to address risks of criminals misusing their domestic financial and non-financial sectors to hide the relevant proceeds (FATF, 2021). It also called for strengthened cooperation between financial investigators and environmental agencies to ensure more effective financial investigations.

Such efforts have come alongside initiatives to strengthen governance and address related corruption risks, such as those of the Organisation for Economic Co-operation and Development (OECD, 2016). These include work within the Forum on Responsible Mineral Supply Chains, among other examples. Further OECD initiatives in this space include the 2023 adoption of the Recommendation of the Council on Environmental Compliance Assurance (OECD, 2023); the OECD Compendium of good practices in promoting, monitoring and enforcing environmental compliance (OECD, 2021); and the publication of in-depth working papers on key aspects of the threat (Yamaguchi, 2023).

Other multilateral structures have engaged with the issue in parallel. For its part, the G7 has made progress in focusing high-level attention on the topic. Its approach has evolved since wildlife crime was introduced as a then-G8 topic at the 2013 Lough Erne Summit. Under the 2019 French G7 presidency, the focus was expanded to cover crimes that affect the environment more broadly (G7, 2019).

This came as the French G7 presidency moved responsibility for the issue from Environment to Interior Ministers. It also came as G7 Interior Ministers established crimes that affect the environment as an explicit priority (G7, 2019). They did so by recognising the threat posed by illegal activities bridging logging, deforestation, fishing, mining, waste and trade in chemicals. Commitments were made to advance key aspects of the response – from enhancing national law-enforcement capacity to strengthening international cooperation and bolstering legislation to provide effective criminal sanctions (G7, 2019).

Under the UK's 2021 presidency, G7 Leaders and Interior Ministers further recognised the need "to step up efforts to counter crimes that affect the environment" as part of a shared 2030 Nature Compact (Home Office, 2021). They committed to "tackle illicit threats to nature … as serious organised crimes, including intensifying efforts to combat money laundering of the criminal proceeds" (Home Office, 2021). They also tasked relevant Ministers to respond to FATF calls to address related money laundering risks. In 2023, meanwhile, G7 Climate, Energy and Environment Ministers pledged to "strengthen international and transboundary cooperation" on wider crimes that affect the environment, committing to "raise awareness about these crimes within multilateral environmental fora and develop global responses against them" (G7 Information Centre, 2023).

These engagements are by no means the only ones of relevance. At a regional level, notably, further initiatives have coalesced. The Council of Europe Convention on the Protection of the Environment through Criminal Law marks the first international legally binding instrument to address crimes that affect the environment (Council of Europe, n.d.). The purpose of the Convention is to prevent and combat crimes that affect the environment, promote national and international cooperation, and establish minimum legal standards to guide states in their national legislation – providing the basis for a stronger and better harmonised criminal justice response (Council of Europe, n.d.).

Elsewhere, the 2023 Belém Declaration saw State Parties to the Amazon Cooperation Treaty renew commitments to tackle crimes that affect the environment as part of a wider development agenda (Presidência da República, 2023). The Amazon Cooperation Treaty Organisation has further established a Special Commission on Public Security and Transnational Crime, with a strong focus on crimes that affect the environment (UNODC, 2025). For its part, the BRICS grouping has identified IWT and broader crimes that affect the environment as points of mutual concern and cooperation, per recent BRICS declarations (BRICS, 2024).

Across the relevant multilateral engagements, however, the challenge remains that of ensuring coherence and coordination, maintaining momentum and, ultimately, translating commitments into meaningful collective action that effectively counters this threat.

3 CURRENT INITIATIVES AND DEBATES

Across the various engagements outlined above, an array of policy-relevant debates are playing out. Many of these relate to challenges and opportunities to more effectively address crimes that affect the environment at the multilateral level – and to ensure this translates into meaningful ground-level action (Muggah & Szabó de Carvalho, 2025).

On this point, it is widely recognised that existing international frameworks and agreements are insufficient to respond to the fast-evolving threat posed to biodiversity, climate, people and the planet (GI-TOC, 2025). There is broad consensus that a different approach is needed. Yet there is as yet a lack of agreement on the most effective course to chart a more impactful global response (GI-TOC, 2025).

3.1 Gaps in criminalisation

At a foundational level, an enduring set of challenges relate to definitions and gaps in criminalisation. Crucially, a range of unresolved conceptual dilemmas stem from the lack of a universally accepted definition or adequate international legal framing of crimes that affect the environment. The use of inconsistent terminology across international initiatives has at times posed challenges in terms of implementation. In other cases, under existing definitions, focus has been placed on some crimes that affect the environment to the exclusion of related issues. This has at times resulted in siloed thinking, and in the entrenchment of disparate multilateral efforts (GI-TOC, 2025).

These points link to the difficulties inherent in classifying the relevant activities. These challenges relate to the diversity of today's offending patterns. Indeed, there is growing evidence of the sheer scale and scope of the activities and enablers driving crimes that affect the environment (World Bank, 2019) (UNODC, 2024). The perpetrators involved are fast-moving and opportunistic, exploiting parallel legal markets in ever-evolving ways. Those

driving these operations often engage in other forms of illicit activity, with diversified criminal enterprises resisting easy definition (Wildlife Justice Commission, 2023). As illicit environmental economies adapt to extinction risks, the resultant market shifts may further challenge classification efforts.

The diversity of actors involved presents further definitional challenges. Notably, the terminology that accompanied the early global spotlight on IWT does not necessarily hold across the board. Here, the usual framing of IWT actors as individuals or groups of organised criminals does not read easily across to other types of environmental offending, many of which are committed by ostensibly legal businesses (Europol, 2022). Thriving in a near-invisible zone at the intersection of the criminal underworld and licit industry, these activities take place off the books – entrenched in the relevant companies' operating models (Europol, 2022). Laundering of illegally sourced commodities via legal supply chains is a key dynamic, in many cases aided by corrupt officials (UNODC, 2025). In this context, work is needed to develop a common language bridging crimes that affect the environment as a collective of diverse and evolving illicit activities.

While no universal legal definition of crimes that affect the environment exists, 'political definitions' may exist in the form of non-exhaustive lists of activities in relevant declarations and resolutions (GI-TOC, 2024). Paragraph 87 of the 2021 Kyoto Declaration, for example, articulates a list of crimes that affect the environment, while referencing associated money laundering and corruption (UNODC, 2021). A range of crimes are excluded, however, with criminal exploitation of energy transition sectors – among other dynamics – under-considered in relevant discussions (Atal, et al., 2022).

Arguably more significant issues arise where these activities are only partially criminalised. Crucially, the lack of a uniform set of standards for criminalisation creates legal gaps that are easily exploited. As noted by the UN Office on Drugs and Crime (UNODC), 'no single international legal instrument comprehensively protects the environment, criminalizes all behaviours that harm the environment, nor defines crimes that affect the environment' (UNODC, 2025). Instead, UNODC describes 'a complicated patchwork of international and regional agreements ratified and transposed to varying degrees into national legislative frameworks' (UNODC, 2025). At a multilateral level, this global landscape of poorly harmonised laws and regulations poses significant barriers to progress.

3.2 Gaps in the multilateral system

These and other challenges have contributed to the dispersed shape of current engagements across the multilateral system. Often, such fragmentation has occurred as different parts of the system have acted from different directions, engaging different constituencies (GI-TOC, 2025). At times, the resultant agreements fail to read across to those reached through parallel multilateral processes. Meanwhile, crimes that affect the environment have not

featured prominently in multilateral fora designed to address global warming and biodiversity loss, despite the importance of these crimes to relevant climate and environmental targets.

In this context, there is growing concern that current policy and multilateral approaches are not having the desired results. Today, it is clear that crimes that affect the environment are growing and adapting more quickly than we are responding. A range of imbalances are recognised – with a particular lack of prioritisation of demand-side interventions. There has also been a lack of investment in evaluation of what works (and what does not) across the breadth of interventions seen to date – from those aimed at strengthening legal frameworks to those aimed at building law-enforcement capacity (Haenlein, 2025).

In light of these observations, there is increasing recognition of the need to reconsider the balance of existing effort and investment to address crimes that affect the environment. There is also a need to distil a more integrated response, bridging gaps across the multilateral system (Muggah & Szabó de Carvalho, 2025). In parallel, there is rising awareness of the importance of elevating the profile of crimes that affect the environment and their links with broader multilateral climate, environmental and development agendas (Carvalho, 2020).

Various options have been proposed to address these challenges. While some stakeholders view certain gaps as more pressing than others, particular recent focus has been placed on the potential for an additional protocol or protocols to the UNTOC, to sit alongside existing protocols on trafficking in persons, smuggling of migrants and trafficking in firearms.

Proponents cite the benefits a new protocol would bring. The Global Initiative to End Wildlife Crime (EWC) argues that this would represent 'a major step forward in the fight against these serious crimes by embedding them into the international criminal law framework' (Global Initiative to End Wildlife Crime, n.d.). Indeed, for many supporters, the principal advantage would be that of harmonising legislation, by tackling head-on the patchwork of legal frameworks that persists at national level.

The potential advantages may extend further. EWC points to other benefits that might be gained. Here, the organisation's Chair argues that a new protocol could clarify definitions – thus "facilitat[ing] … a convergence in national approaches and support[ing] efficient international cooperation" (Scanlon, 2025). It could also bring value in terms of signalling: for EWC, adoption of a new protocol "would signify an unequivocal recognition by States Parties of the devastating scale, nature and consequences of such crimes, [and] of the need to scale up collaborative efforts to prevent and criminalize them" (Global Initiative to End Wildlife Crime, n.d.).

Other perspectives on the matter exist. For some stakeholders, debates on strengthening international frameworks distract from real-world challenges (Gitari-Mitaru, 2021). For those

of this persuasion, the core barriers to effective action relate not to a lack of legal instruments, but to shortfalls in resourcing for law enforcement and judicial structures (GI-TOC, 2025). Ultimately, such debates boil down to the appropriate balance – and inherent trade-offs – between strengthening international frameworks and improving their implementation in practice.

Further points of relevance are made by those who stress the need to assess the record of the UNTOC and its protocols to date. A key concern revolves around accountability for implementation. As noted by Mark Shaw et al., "The UNTOC implementation review mechanism (IRM), which is the only official way of assessing implementation, is running behind schedule, and has limited resources and low reservoirs of political will. After 25 years, no country has yet been reviewed on its implementation of the convention" (Shaw, et al., 2024). While issues with the review mechanism do not negate the potential utility of an additional protocol(s) for many stakeholders, other experts have called for a strengthened oversight and accountability system for any new UNTOC protocol (GI-TOC, 2025).

3.3 Collaboration across sectors

A further set of debates centre on the role of the private sector in combatting crimes that affect the environment. The close connections between 'licit' and 'illicit' in this sphere have already been flagged in this paper. Indeed, the widespread use of corporate entities and abuse of legal supply chains are key features of illicit environmental markets (Europol, 2022). The laundering of proceeds via the formal financial sector is another core characteristic (Haenlein & Keatinge, 2017). Many argue that multilateral discussions to date have failed to engage sufficiently with these issues – or to adequately consider business perspectives across the relevant supply chains (GI-TOC, 2025).

Many stress the need to engage private-sector actors in a more strategic manner. They do so highlighting these actors' key roles in protecting legal value chains from criminal infiltration. Concerted engagement with these stakeholders is particularly important where sustainable use and trade policies form a central plank of domestic economies (Department of Forestry, Fisheries and the Environment, 2023). The importance of the biodiversity sector to the relevant countries should not be underestimated. Here, the specific risks and incentives legal markets create for illicit actors must be considered in a holistic manner.

Yet critical knowledge gaps persist on these interplays across key sectors. There is evidence that swathes of the private sector remain unaware of the characteristics of the relevant risks (Haenlein & Keatinge, 2017). Further questions relate to incentives and accountability structures facing businesses in engaging with these issues. Still other debates centre on the application of sanctions where corporate entities are found to be complicit. Where this results in large-scale environmental harm, researchers cite a lack of effective tools to hold 'legal persons' accountable (GI-TOC, 2025).

Across the board, private-sector engagement is key to efforts to tackle associated financial crime and corruption. Progress has been made as the FATF has placed crimes that affect the environment firmly on its agenda (FATF, 2021). Major players in the banking sector have pledged to implement measures to improve identification and reporting of related suspicious activity (United for Wildlife, 2018). Work has also been done to develop typologies (Environmental Investigation Agency, 2020) (Themis and WWF, 2024), and to build capacity to follow financial leads across relevant supply chains (Weeden, et al., 2023).

The momentum around this issue, however, has not always translated into impact. In a range of cases, there is a lack of clarity on the right metrics to assess private-sector action in this space. Here, the very engagement of FATF with crimes that affect the environment has at times been positioned as a success (GI-TOC, 2025). Yet ground-level realities point to ongoing gaps. For example, there is concern that mapping of the financial dimensions of crimes that affect the environment in some countries' national risk assessments remains largely superficial.

The prevailing response to associated corruption has also been subject to debate. As a critical enabler of many forms of environmental offending, a more structured international approach has been called for. Here, there is growing focus on the need to strengthen existing anti-corruption frameworks – and to invest in preventative approaches. This comes alongside rising awareness of prevention as a wider gap in multilateral engagements. Among other dimensions, there is a need to strengthen efforts to raise popular awareness and undertake targeted engagement with affected communities as a core part of preventative efforts. As noted by GI-TOC, however, "the multilateral system currently lacks a coherent and consolidated approach to preventing environmental crime" (GI-TOC, 2025). A lack of clarity – and evidence – persists on the best means to address this gap.

A final point concerns the wider role of civil society in efforts to address these matters. In a context of pervasive corruption, the real dangers facing environmental defenders cannot be ignored (Global Witness, 2024). Their frontline role and subject matter expertise point to the need for stronger inclusion of these actors in multilateral and other relevant discussions. In some fora, active civil society engagement has been welcomed, with CITES held up as a case in point (Scanlon, 2025). In others, civil society remains sidelined (GI-TOC, 2025), with a more inclusive approach required. Across the board, a stronger focus is required on the specific risks and vulnerabilities facing indigenous peoples and traditional communities directly impacted by crimes that affect the environment (World Resources Institute, 2020).

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

The G20 is well positioned to address a number of these debates. It spans a wide range of countries affected by crimes that affect the environment – including supply, transit and destination countries for a range of relevant commodities. It is well placed to raise the profile

of the issue across G20 members, to expand the conversation to diverse constituencies, and to work to garner greater consensus on key points. In looking to do so, based on the contents of this paper, the following policy options should be considered:

4.1 Elevate the profile of crimes that affect the environment on political agendas

The G20 ECSWG has a unique opportunity to act as a rallying point to drive a more ambitious response to crimes that affect the environment. It is well placed to galvanise concerted collective action by fostering awareness of the severity of the threat posed. In garnering commitments among members to adopt a more ambitious posture, G20 leaders can spearhead a push to establish crimes that affect the environment as an international political priority. This will involve crystalising a contemporary global narrative with public and political resonance commensurate with the urgency of the issue.

4.2 Formally recognise intrinsic interconnections with wider global targets

In raising the profile of the issue, the G20 has an opening to reposition crimes that affect the environment in the public and political consciousness. This must involve explicitly drawing out the centrality of the threat to other high-priority global agendas. G20 members are encouraged to treat crimes that affect the environment as posing a cross-cutting challenge domestically, embedding action on these crimes at the heart of national biodiversity, climate and development strategies.

4.3 Mobilise support for a more integrated global response

In 2025, the ECSWG has an opportunity to build connections across disparate multilateral engagements. It can act as a common forum for G20 members to address debates raised on crimes that affect the environment in diverse fora. It can also work to garner agreement on appropriate measures to align key issues with wider global processes. This should be done mindful of the need to avoid overloading any individual forum, with options for work to address fragmentation in the system to be led either in Vienna or elsewhere.

4.4 Broaden the range of countries committing to engage on the topic

Significant variations in engagement with crimes that affect the environment exist between different countries. While some drive the agenda and display strong commitment, others remain on the margins. The G20 ESCWG offers a platform to broaden interest and participation in the agenda – meaningfully engaging a wider range of countries in the debate. Distilling a clear narrative on why this threat matters internationally will be key to mobilising leaders with diverse priorities.

4.5 Build consensus and adopt common positions on the appropriate response to terminological debates and gaps in criminalisation

The G20 ESCWG is well equipped to consider appropriate positions in relation to debates on terminology and gaps in criminalisation. In doing so, breadth and flexibility must be considered – mindful of the fast-paced criminal adaptations witnessed. In particular, progress on identifying common positions on gaps in criminalisation could help to address a global landscape of poorly harmonised laws and regulations that act as a significant barrier to a more effective global response.

4.6 Set out high-level principles to target common enablers

Formal G20 guidance on crimes that affect the environment is limited to the 2017 'High Level Principles on Combatting Corruption Related to Illegal Trade in Wildlife and Wildlife Products' (G20, 2017). Eight years on, there is scope to build on this precedent, garnering consensus on key principles as they relate to wider crimes that affect the environment. Corruption and illicit finance remain critical enablers, with existing responses failing to keep pace. The G20 is well placed to propose a more structured international approach – elevating and prioritising efforts to fight corruption and follow the money.

4.7 Bolster global focus on intersections between licit and illicit markets

Abuse of legal value chains is central to the commission of a range of crimes that affect the environment. The ESCWG has the option to draw explicit global attention to critical knowledge gaps in this space. These gaps severely limit collective efforts to reduce environmental offending. Commitments are encouraged among G20 members to work more closely with the private sector, to deepen data collection in this area, and to identify and design out vulnerabilities to criminal infiltration. In the process, the G20 could develop a blueprint to guide joint working with private-sector actors across relevant sectors.

4.8 Consider legislative and implementation gaps in existing frameworks

The ESWCG offers a valuable forum to consider existing multilateral proposals to accelerate action on crimes that affect the environment, including those targeting legislative and implementation gaps in existing frameworks. There is value to be gained from gauging levels of consensus on specific proposals as the G20 – and pursuing areas where greater alignment might be achieved. This includes matters under discussion as part of the open-ended intergovernmental expert group to identify gaps that exist in the international legal framework as well as potential responses to these gaps, including the possibility, feasibility and merits of any additional protocol under UNTOC. There is also scope for the G20 to galvanise

commitment to address gaps in areas such as demand reduction, where greater investment and prioritisation is required.

4.9 Foster commitment to build the evidence base to advance the global response

There is an urgent need for more data and analysis on the complex and wide-ranging nature of environmental offending. The current lack of reliable data spans key aspects of the threat – in turn limiting the power of existing responses. G20 members are encouraged to invest in deepening the knowledge base, to support dedicated units for analysis and investigation of environmental crime, and to coordinate internationally to deepen knowledge of common risks and trends. They can do so while formally sharing best practice and lessons learned across the responses deployed.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Strategies for Building Resilient Economies through Cost-Effective Investment in Restoration

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EXECUTIVE SUMMARY

This paper discusses what is needed to scale up adoption of land restoration investments that will build economic resilience and meet land restoration targets. The paper starts with an overview of the challenges faced by extensive land degradation and the argument for why restoration builds economic resilience. The paper then presents the theory of change, followed by an overview of key global and regional multilateral initiatives to provide the policy context for incentivising investment in land restoration. The paper then builds the evidence of benefits of investing in land restoration by summarising the main types of on ground activities that protect and restore land and ecosystems including costs and social and economic benefits provided by the activities. The evidence is drawn as much as possible from published research in developing countries. The types of incentives needed to enhance cost-effectiveness and encourage adoption of land restoration activities are then discussed. The paper concludes with recommendations for scaling up land restoration that meets targets and increases economic resilience particularly in Sub-Saharan Africa.

1 INTRODUCTION

Land degradation impacts about 2 billion hectares globally (UNCCD Global Mechanism, 2024), or up to 40% of the Earth's land. In recent years the extent of global land degradation has increased by about 100 million hectares[2]. In Africa, it's estimated that 65% of agricultural land is already degraded, and if degradation continues unabated, over half of all of Africa's arable land will be uncultivable by 2050 (Zingore et al., 2015). Other parts of the world face similar land degradation challenges. For example in South Asia, the FAO estimate that 41% of all land is affected by human-induced degradation, of which 70% is severely degraded[3].

There are many impacts of such widespread land degradation, including reduced food security, rural poverty, loss of biodiversity, declines in water quality and quantity, contribution to climate change from increased greenhouse gas emissions, reduced resilience to climate change and economic shocks. A 2016 study estimated that global land degradation costs over US$6 trillion annually through lost ecosystem services (Sutton et al., 2016).

In Sub-Saharan Africa, land degradation is estimated to cause an estimated annual GDP loss of up to 9% in some countries (Collins et al., 2025). There is growing evidence of the direct relationship between increased land degradation and poverty (Barbier and Di Falco, 2021) and other forms of low human security such as conflict and forced migration in developing

[2] https://www.preventionweb.net/news/least-100-million-hectares-healthy-land-now-lost-each-year
[3] https://openknowledge.fao.org/server/api/core/bitstreams/bc8810ae-2a13-4cfe-b019-339158c7e608/content/src/html/chapter-1-2.html

countries (Barbut and Alexander, 2016). Extensive land degradation also increases the burden on Government spending on food imports and natural disaster relief (von Keyserlingk et al., 2023), further impacting economic resilience. The impacts are most felt by those reliant on subsistence agriculture which is a characteristic of many parts of Africa. Restoring degraded land therefore can yield significant economic benefits, including increased agricultural yields and productivity, job creation, poverty reduction, increased national self-sufficiency and enhanced natural capital and ecosystem services.

Land restoration provides economic, climate and drought resilience by improving ecosystem health, enhancing soil and water systems, and supporting livelihoods. For example, restoration actions such as mulching, composting, cover cropping and reforestation increase soil organic matter, enhance water retention and make soil significantly more drought resilient (Zizinga et al., 2022). These actions also reduce soil susceptibility to wind (Cong et al., 2016) and water erosion (Fan et al., 2023), sequester carbon (Almaraz et al., 2023), provide food and protection for livestock (Baker et al., 2018), diversify farmer's income streams and enhance biodiversity (Staton et al., 2022, Torralba et al., 2016), which collectively reduce risk from climate extremes such as drought and intensive rainfall events.

Initiatives such as the Bonn Challenge and the UN Decade on Ecosystem Restoration (2021–2030), and the Sustainable Development Goals Target 15.3 to achieve Land Degradation Neutrality include commitments to restore about 1 billion hectares by 2030, requiring a cumulative $2.6 trillion in investment (UNCCD Global Mechanism, 2024). A large proportion of the restoration commitments come from less developed countries, particularly in Sub-Saharan Africa (Verhoeven et al., 2024), which places a disproportionate cost on these countries. Verhoeven et al. (2024) estimate the cost may range from 6% to 38% of GDP in developing countries. International finance from both public and private sources is needed to have any chance these restoration targets will be achieved.

Despite the cost, achieving restoration targets in the Bonn Challenge alone would generate a global net benefit up to US$9 trillion (Verdone and Seidl, 2017). The UNCCD further estimates that restoring over one billion hectares (or about one half of the land currently degraded globally) would generate up to $US1.8 trillion annually in benefits (UNCCD Global Mechanism, 2024). The economic arguments are clear – reducing land degradation is an economic imperative.

1.2 Theory of Change

This section presents the Theory of Change supporting the goal of building economic resilience through adoption of affordable land restoration activities. The Theory of Change consists of five major components (Inputs, Activities, Outputs, Outcomes, Impact) for achieving the desired goal – these components make up the causal pathway from the current situation to goal achievement. Also described here are a set of underlying assumptions that

need to be in place to achieve the desired goal. It is important to note that the Theory of Change proposed below assumes uniform conditions across countries. Due to the diversity of national contexts and development priorities, including variation in land tenure, not all the components equally apply.

The components of the Theory of Change described below form the basis of the rest of this Discussion Paper, with a focus on the components that can be influenced by Governments and investors, i.e. the Inputs and Activities of the Causal Pathway.

1.2.1 Desired Goal

Widespread adoption of affordable land restoration actions that delivers long-term economic resilience and sustainability benefits for landholders, communities, and ecosystems.

1.2.2 Underlying Assumptions

- Landholders respond positively to both financial and non-financial incentives
- Land restoration generates measurable economic returns to landholders and broader communities
- Monitoring, evaluation and reporting systems provide credible metrics to inform landholder payments
- There exist mature and stable market-based instruments such as payments for ecosystem services (PES), and carbon and biodiversity offset markets
- Policies remain consistent and supportive over time
- Local knowledge is integrated and respected
- Land tenure rights are secure

1.2.3 Causal Pathway

Inputs

- Government-led initiatives, policy and legal frameworks that support adoption of land restoration and protection actions
- Research to:
  - quantify evidence of costs and benefits of land restoration actions
  - identify spatial priorities to target land restoration
  - monitor and report on the effectiveness of investments
- Financial incentives to encourage adoption of restoration:
  - Public funding and nature and climate finance (e.g. subsidies, green bonds, government expenditures)

  - Philanthropic and private capital (e.g. blended finance, carbon and biodiversity offsets, PES)
- Collaborations and partnerships between all stakeholders – landowners, investors, governments and broader civil society

Activities

- Design and implement financial and economic incentive schemes (e.g. PES, biodiversity/carbon credits and offsets)
- Develop blended finance instruments to share risk and attract investors
- Invest in research and capacity building to plan, manage, and monitor projects
- Invest in local engagement & co-design of land restoration plans
- Improve market access and transparency (e.g. for biodiversity credits)
- Integrate restoration into national and local development and sustainability plans

Outputs (Immediate Results)

- Availability of long-term, flexible contracts with clear incentives
- Reduced financial and regulatory barriers to adoption
- Functional carbon/biodiversity/ecosystem service markets
- Trained local stakeholders and delivery institutions
- Coherent national and regional land restoration plans and reporting
- Demonstration of early economic success stories

Outcomes (Behavioural & Systemic Change)

- Landholders perceive restoration as economically viable
- Widespread adoption of affordable restoration practices (e.g. sustainable land management practices, agroforestry)
- Increased investment flows from public and private sectors
- Restoration projects bundled into livelihood strategies
- Growth of restoration-related businesses and the restoration economy (e.g. sustainable timber production, ecotourism, biochar, clean water supply)

Impact (Long-Term Results)

- Improved supply of ecosystem services (e.g. carbon sequestration, water regulation, biodiversity)
- Increased resilience to climate change and drought
- Improved food and nutrition security and livelihoods

- Economic development, new employment opportunities and resilient economies
- Net positive returns on restoration investments (e.g. US$7–30 per US$1 invested (Ding et al., 2017))
- Achievement of land restoration targets (e.g. Bonn Challenge, UN Decade on Ecosystem Restoration, SDG 15.3)

2 CURRENT MULTILATERAL DELIBERATIONS

There are several global and regional-scale multilateral agreements and initiatives that provide policy and strategic frameworks and finance to support widespread uptake of land restoration. Central are the three Rio Conventions (UNCCD, UNFCCC and CBD) that emerged from the 1992 Rio Earth Summit. The Rio Conventions play a leading role in supporting countries to prevent environmental degradation, restore land and ecosystems and build resilient and sustainable societies. The Rio Conventions also support the delivery of major regional-scale initiatives (e.g. Great Green Wall; Middle East Green Initiative) through coordinated international actions across monitoring and reporting, mobilisation of finance, scientific and technical guidance, and multi-national collaboration. The chapter briefly summaries the three Rio Conventions and the key regional-scale initiatives that provide the policy and legal frameworks and conditions to support widespread adoption of land restoration.

2.1 Rio Conventions

Established in 1994, the United Nations Convention to Combat Desertification (UNCCD) is the key international agreement focused on land degradation. Its 2018–2030 Strategic Framework emphasizes achieving Land Degradation Neutrality (LDN), a state where land degradation is balanced by restoration and sustainable land use (UNCCD, 2020). So far 131 countries[4] have committed to voluntary LDN targets, integrating them into national plans and actions. The LDN framework operates through a “response hierarchy” of avoid, reduce, and reverse land degradation (Cowie et al., 2018). Countries are encouraged to conduct baseline assessments, identify hotspots, and implement cost-effective interventions.

Adopted in 1992 at the Rio Earth Summit, the United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty created to address the global challenge of climate change by reducing greenhouse gas emissions and enhancing resilience to climate impacts. The core objective of the UNFCCC is to prevent severe climate change impacts while allowing ecosystems to adapt, ensuring food production is not threatened, and enabling sustainable economic development. The UNFCCC has 198 Parties and they meet annually to make decisions on reducing greenhouse gas emissions and

[4] https://www.unccd.int/land-and-life/land-degradation-neutrality/projects-programmes/ldn-target-setting

adapting to climate change. At the 2015 Paris Conference of Parties (COP), known as the Paris Agreement, parties agreed to *holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change*[5]. The UNFCCC also provides the framework and facilitates processes for countries to communicate, review, and enhance their climate actions.

Also adopted in 1992 at the Rio Earth Summit, the Convention on Biological Diversity (CBD) is the key global agreement focused on the conservation and sustainable use of biodiversity and the fair and equitable sharing of benefits arising from the use of genetic resources. Central to the CBD are the Kunming-Montreal Global Biodiversity Framework's 23 global targets for 2030, including restoring 30% of all degraded ecosystems, protecting 30% of land and marine areas ("30 by 30"), halving invasive species introduction, phasing out or reforming subsidies harmful to biodiversity in a proportionate, just, fair, effective and equitable way, and mobilizing $200 billion/year in biodiversity finance[6].

While each Rio Convention has a distinct mandate, their ambitions are inextricably linked. Reducing climate change impacts (remit of the UNFCCC) will benefit ecosystems and species (CBD remit) and reduce the risk of land degradation (UNCCD remit). Reducing land degradation and restoring degraded land (UNCCD and CBD remit) will reduce greenhouse gas emissions, sequester carbon (UNFCCC remit) and improve biodiversity (CBD remit). And halting biodiversity loss (CBD remit) increases ecosystem resilience and the productivity of land (UNCCD remit) and its ability to adapt to climate change (UNFCCC remit). As a result, there is increasing coordination among the conventions to ensure complementarity in policy, science, and finance.

2.2 Decade on Ecosystem Restoration (2021 – 2030)

Led by UNEP and FAO, the UN Decade on Ecosystem Restoration is a global initiative to prevent, halt, and reverse ecosystem degradation. It aims to restore at least 1 billion hectares of degraded land by 2030, aligning with SDG 15.3 on Land Degradation Neutrality. Almost half of the land restoration commitments are from Sub-Saharan African countries (UNEP, 2022). The initiative encourages collaboration across governments, civil society, Indigenous peoples and local communities, and the private sector. Focus areas include forests, farmlands, grasslands, and wetlands. It promotes science-based restoration principles, knowledge sharing, and financing mechanisms.

[5] https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf
[6] https://www.cbd.int/gbf/targets

2.3 Bonn Challenge

Launched in 2011, the Bonn Challenge is a global effort to restore 350 million hectares of degraded forest and agricultural land by 2030. As of 2023 over 210 million hectares have been pledged by over 75 countries, states, and organizations. Regional goals include the AFR100 (129 million hectares of restoration pledged by 34 African countries), the Initiative 20x20 (~52 million hectares pledged by 18 Latin American and Caribbean countries), and ECCA30 (30 million hectares pledged by countries in Europe, Caucasus and Central Asia). These restoration efforts are supported by governments, NGOs, research institutions, Indigenous peoples and local communities, and the private sector.

2.4 Great Green Wall Initiative

The Great Green Wall Initiative (GGWI) is a major land restoration initiative in Africa that was launched in 2007[7] by the African Union (AU) with full ratification in 2014. By 2030, the GGWI aims to restore 100 million hectares of degraded land, sequester 250 million tonnes of carbon and create 10 million green jobs in rural areas of the Sahel by 2030. Eleven countries formed a green band across the Sahara and Sahel at the inception of the GGWI. This has expanded to include an additional 22 countries from North Africa, East Africa, Southern Africa and West Africa, embracing a more continent-wide approach (African Union, 2023). The GGWI is backed by many organisations including the UNCCD, African Development Bank (AfDB), the European Commission, the World Bank, the European Investment Bank, the Green Climate Fund, and the Global Environment Facility. More than US$14 billion has been pledged to the GGWI in the Sahel, and by 2022 over 18 million hectares had been restored, creating more than 350,000 jobs and sequestering significant amounts of carbon[8].

Recognising, the importance of a comprehensive continental approach to tackling land degradation, desertification, drought, climate change and biodiversity loss, the recently endorsed ten-year GGW Strategy (2024-2034) promotes a point of convergence for the three Rio Conventions (UNCCD, UNCBD and UNFCCC), and a more integrated and holistic approach to land rehabilitation and climate-resilient development amongst AU Member States, Regional Economic Communities (RECs), agencies and partners. The GGW Strategy (2024 – 2034) is positioned as a crucial component of the AU Agenda 2063 and is intended to ensure its contribution as a cornerstone programme of the Decade for Ecosystem Restoration and to meet key targets of the Sustainable Development Goals (SDGs). It sets out an objective to build and enhance landscape resilience of African communities, ecosystems and economies by transforming the socio-political and bio-physical productivity of the targeted areas.

[7] https://au.int/sites/default/files/documents/43834-doc-SUMMARY_BRIEF_AU_GGW_Strategy_2024_Final-1.pdf
[8] https://www.unccd.int/our-work/ggwi/great-green-wall-accelerator

Inspired by the GGWI of the Sahel, the Southern African Great Green Wall Initiative (SA GGWI) was endorsed by the SADC Ministers of Environment and Natural Resources meeting convened in 2015. Due to the slow progress in implementation, decision 9/COP16 of UNCCD, and decision 9/COP15 of UNCCD encouraged the GEF to support the implementation of the SA GGWI, a priority for South Africa's G20 Presidency Environment and Climate Sustainability Work Group (ECSWG).

3 BENEFITS OF TARGETED LAND RESTORATION

Many on-ground actions are available to restore degraded land and all have varying costs to implement and provide a varying range of economic, social and environmental benefits. To encourage widespread adoption of actions, the benefits and costs need to be clear and measurable, and the benefits must ultimately outweigh the costs. In the past, governments have viewed restoration targets such as those in the Bonn Challenge and Great Green Wall as too costly and a poor investment because the costs of land restoration were thought to outweigh the benefits (de Groot et al., 2013). This perception was due to a number of factors, including incomplete accounting of the benefits of restoration, ecologically inappropriate time horizons and high discount rates (Verdone and Seidl, 2017).

In the last decade the perception has changed significantly, and governments and broader society now better understand that the benefits of restoration extend to many non-market values associated with ecosystem services (de Groot et al., 2013, Willemen et al., 2018, Banerjee et al., 2020, Crossman et al., 2017). There has also been significant research into the relationship between land degradation and human security (Barbut and Alexander, 2016), including links to increased poverty, conflict and migration, and natural disaster risk (Barbier and Hochard, 2018, UN-Habitat/GLTN, 2022). There is now significant evidence that land degradation contributes to low economic resilience (Egidi and Salvati, 2020) and restoring the condition of land will increase the resilience of national economies and create a restoration economy (BenDor, 2024).

With the change in perception has come a growth in projects that invest in improving the supply of ecosystem services (and more recently nature-based solutions). For example, data collected for a recent World Bank study shows that investment in nature-based solutions projects for climate resilience in Sub-Saharan Africa increased by an average of 23% annually from 2012 to 2021, with the number of projects increasing by an average of 15% annually (Collins et al., 2025). The United Nations Environment Assembly of the UNEP adopted Resolution 5/5 in 2022 that recognises nature-based solutions as an important tool for sustainable development.

This chapter draws on the large body of research across the agricultural, economic and environmental sciences to present a summary of the main restoration actions and their costs and benefits. Figure 3 provides a graphical summary with details provided in Table 1. In

addition to the direct financial and environmental benefits reported in Figure 3 and Table 1, there are flow on benefits to local economies from all the listed actions that improve land productivity. These include stronger business models and supply chains in sectors dependent on natural resources and environment, such as the agriculture, forestry, mining and energy sectors (Aubert and Angerer, 2024).

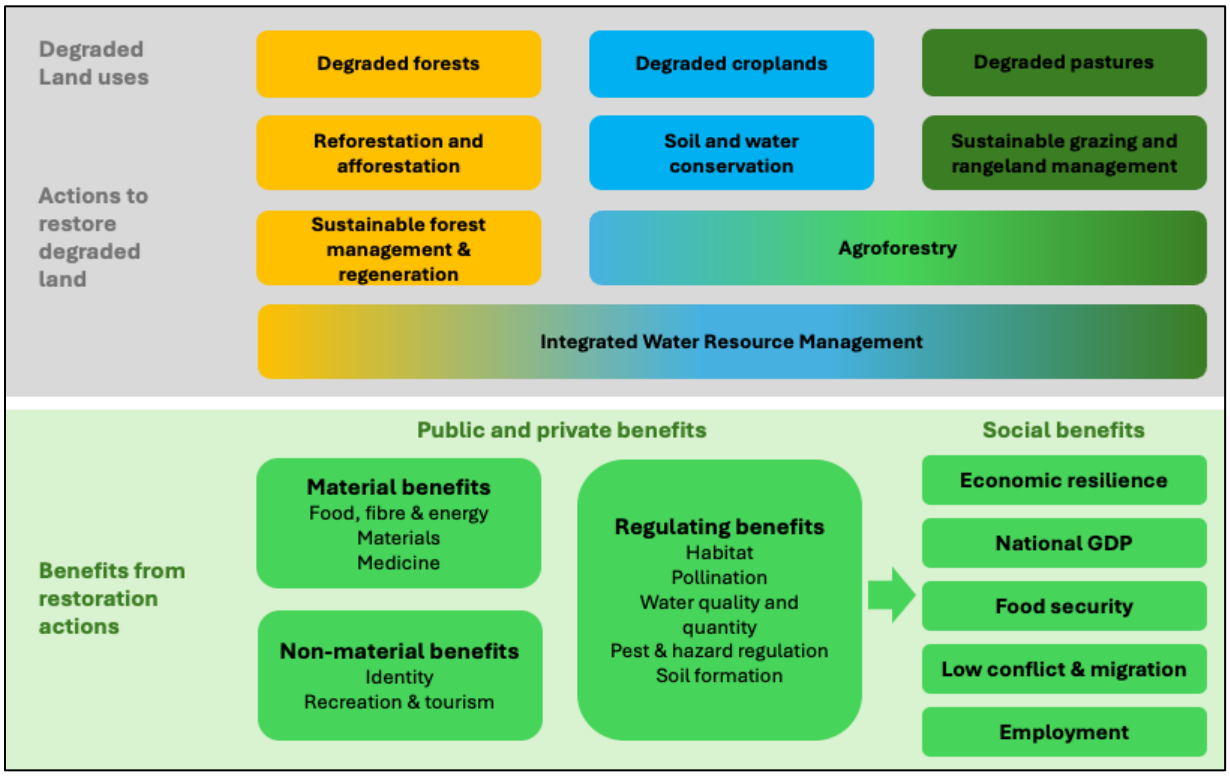


Figure 3. Summary of the main land restoration actions and the ecosystem service, economic and social benefits they provide (Source: adapted from World Resources Institute: https://www.wri.org/insights/restoration-one-most-overlooked-opportunities-economic-growth)

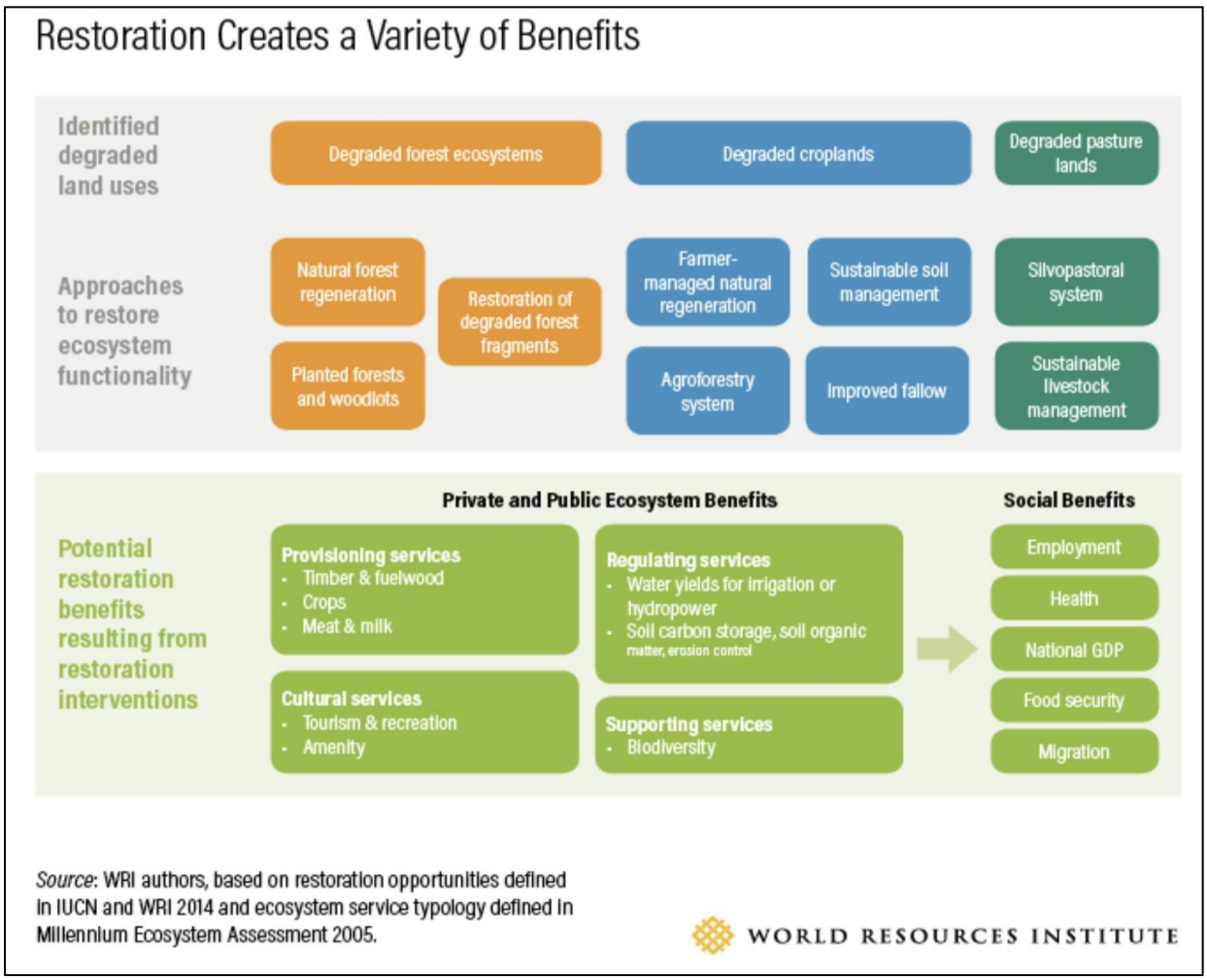

Restoration Creates a Variety of Benefits
Identified degraded land uses
Degraded forest ecosystems
Degraded croplands
Degraded pasture lands
Approaches to restore ecosystem functionality
Natural forest regeneration
Planted forests and woodlots
Restoration of degraded forest fragments
Farmer-managed natural regeneration
Agroforestry system
Sustainable soil management
Improved fallow
Silvopastoral system
Sustainable livestock management
Potential restoration benefits resulting from restoration interventions
Private and Public Ecosystem Benefits
Social Benefits
Provisioning services
Timber & fuelwood
Crops
Meat & milk
Regulating services
Water yields for irrigation or hydropower
Soil carbon storage, soil organic matter, erosion control
Cultural services
Tourism & recreation
Amenity
Supporting services
Biodiversity
Employment
Health
National GDP
Food security
Migration
Source: WRI authors, based on restoration opportunities defined in IUCN and WRI 2014 and ecosystem service typology defined in Millennium Ecosystem Assessment 2005.
WORLD RESOURCES INSTITUTE

Table 1. Costs and benefits of the main land restoration actions (figures in 2020 USD – see WOCAT et al. (2022))

Action	Description	Benefits	Costs	Further reading
Reforestation and afforestation	Reforestation involves replanting trees in deforested or degraded areas. Afforestation introduces tree cover to previously non-forested but degraded lands, and must not replace non-forest natural ecosystems. These actions restore ecosystem function, reduce erosion, and enhance carbon sequestration.	• Carbon sequestration: Up to 15 tonnes CO_2 per hectare per year depending on location and species used. • Ecosystem services: Improved water regulation, biodiversity, and air quality. • Economic returns: Potential for timber, non-timber forest products, and ecotourism. • A global meta-analysis estimated that reforestation can yield a benefit-cost ratio of 1.6 to 2.8	• Costs are highly variable depending on location and whether reforestation is active or passive. • $500–$10,000 per hectare, including site preparation, fencing, seedlings, labour, and maintenance. • In tropical regions, reforestation costs can be lower due to natural regeneration potential. • Can have negative impacts such as soil damage, increased water use, invasive species, land grabbing that must be prevented.	Griscom et al. (2017), Busch et al. (2024), Vincent et al. (2021)
Agroforestry	Agroforestry integrates trees with crops and/or livestock systems, enhancing soil health, microclimate, and farm resilience.	• Increased farm income: Studies in Africa and Asia report up to 50% income gains due to diversified outputs. • Soil improvement: Trees contribute organic matter and stabilize soil. • Reduced input costs: Less need for synthetic fertilizers and pesticides. • Benefit-cost ratio of up to 10 possible, depending on location and practice.	• Establishment costs range from $1,000–$1,500 per hectare depending on location, species, density, and local labour costs. • Ongoing maintenance includes pruning, pest control, and fencing.	Mbow et al. (2014), Muthuri et al. (2023), Datta et al. (2024), Namaswa (2022), FAO and UNDP (2020), Awazi et al. (2025)
Soil and Water Conservation (SWC)	SWC includes physical structures (e.g., terraces, bunds, check dams) and vegetative measures (e.g.,	• Yield improvements: Studies show average of 12% increase in crop yields from conservation agriculture practices, and up to 40% in corn (Ren et al., 2023)	• Construction of terraces or bunds: Up to $900 per hectare	Wolka et al. (2018), Srivastava et al. (2024)

Action	Description	Benefits	Costs	Further reading
	grass strips, cover crops, mulching and composting, biochar) that reduce erosion, enhance water retention, increase carbon and restore fertility.	• Reduced sedimentation: Preserves downstream reservoirs and irrigation systems. • Cost-effective over the medium to long term: Benefit-cost ratios often exceed 2.0 after 5–10 years.	• Improved ground cover: Up to $2,000 per hectare	
Sustainable Forest Management (SFM) / Assisted Natural Regeneration (ANR)	SFM / ANR supports the natural regrowth of vegetation by protecting and managing degraded land, typically through fencing, weeding, and fire management.	• Biodiversity recovery: Encourages native species without external inputs. • Carbon benefits: Can sequester up to 5 tonnes CO_2/ha/year depending on site. • Highly cost-effective: Benefit-cost ratios often exceed 3.0, particularly in community-managed areas.	• Average of $2,100 per hectare, up to $5,000 in developed countries. • Relies primarily on local labour and existing vegetation.	Buthelezi et al. (2025), de Jong et al. (2024), Mishra and Agarwal (2024)
Sustainable Grazing and Rangeland Management	Improving grazing practices includes rotational grazing, reseeding degraded pastures, managing herd size, and controlling invasive species.	• Increased livestock productivity: Restored rangelands support more animals per hectare, improving incomes. • Soil carbon restoration: Improved pastures can store 1–2 tonnes CO_2/ha/year. • Drought resilience: Better ground cover reduces vulnerability to climate shocks. • Benefit-cost ratios range from 1.5 to 3.5, especially when implemented with community participation.	• Initial investments: $250 per hectare, mainly for fencing, water points, and seeding • Long-term maintenance depends on livestock management systems.	Teague and Kreuter (2020)
Integrated Water Resource Management	A coordinated approach to managing water, land, and ecosystems with the goal of maximizing social and economic benefits while ensuring sustainability	• Efficient water use, increased climate and drought resilience, increased productivity • Improved water quality, ecosystem restoration, environmental flows	• Can be high for initial infrastructure and institutional investment • Complex monitoring requirements	Bilalova et al. (2023)

4 INCENTIVES TO ENHANCE COST-EFFECTIVENESS AND ENCOURAGE ADOPTION OF LAND RESTORATION

A large body of evidence demonstrating that land restoration actions are cost-effective and can provide a wide range of private and public benefits is presented in the previous chapter. Yet this economic evidence alone is insufficient to encourage wide-spread uptake due to several adoption barriers. More economic, policy, legal and institutional incentives are needed to overcome many of these barriers and governments have a major role in leading these. This chapter begins with a description of a range of economic, institutional, policy and legal incentives that offer much potential to encourage widespread uptake of land restoration for economic resilience. The chapter then concludes with overview of the main barriers to adoption with a focus on developing countries. While this chapter outlines a variety of policies, incentives and tools, it is important to note that the policy mix will differ from country to country based on circumstances and contexts.

4.1 Economic Incentives

The major economic instruments and incentives are summarised in Figure 4 with links to the main funders. This section explains each and provides examples where possible.

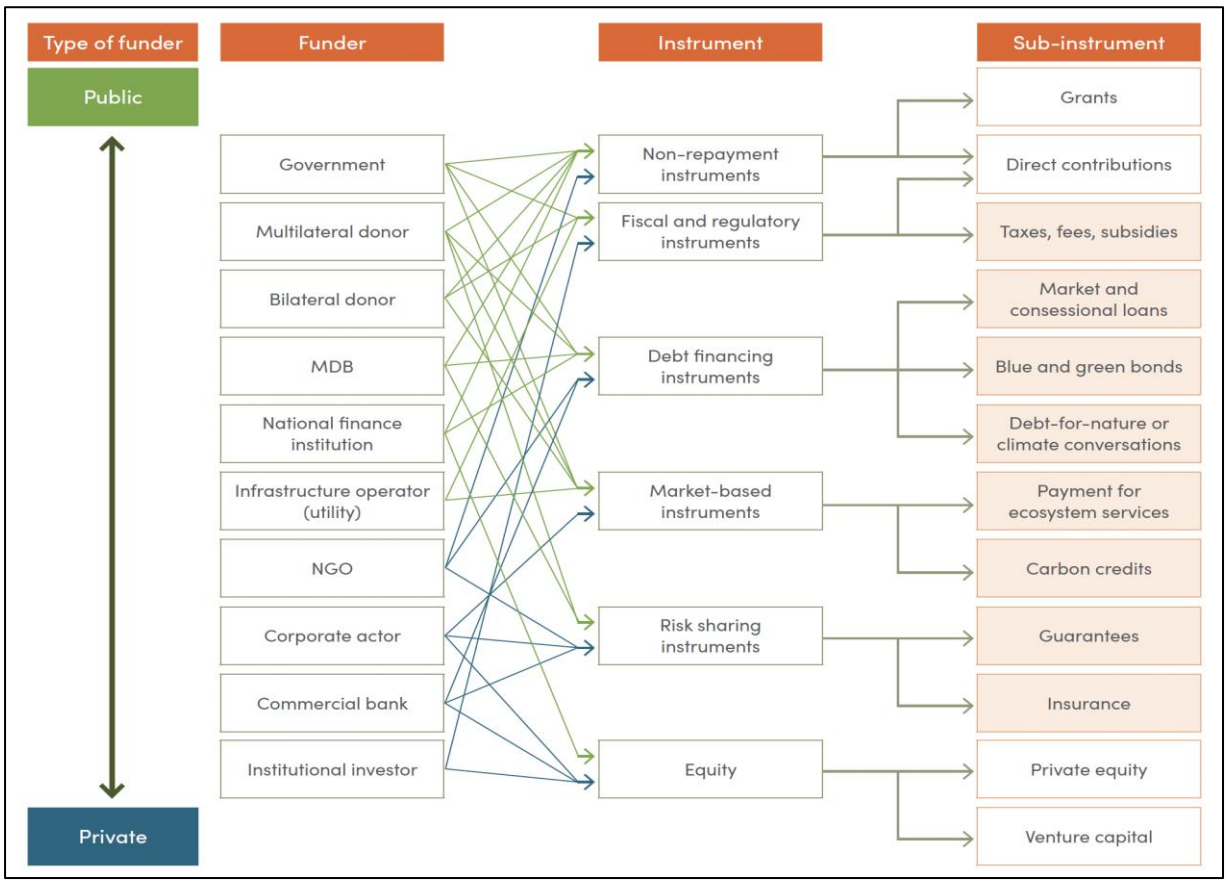


Figure 4. Major types of funders and financial instruments for nature-based solutions in Sub-Saharan Africa (Source: Collins et al. (2025)).

4.1.1 Direct Payments & Cost-Sharing Programs

Direct payments and cost-sharing programs incentivize land restoration by reducing the financial burden on land holders. These programs typically involve governments or local donors providing subsidies, grants, or in-kind support, such as seedlings, fencing materials, or technical assistance, to farmers, pastoralists, or communities undertaking restoration activities. Cost-sharing arrangements may require land holders to contribute a portion of the total costs, thereby promoting ownership and long-term commitment. Such programs have been effective in many contexts, particularly where restoration involves delayed benefits or high upfront investment. For example, in Ethiopia's Productive Safety Net Programme direct payments have led to some large-scale land rehabilitation while supporting rural livelihoods (Demissie et al., 2024, Adimassu and Kessler, 2015).

When well-designed, these incentives can align national environmental objectives with local economic incentives. However, success depends on transparent targeting, sufficient funding, and institutional capacity to administer payments and monitor outcomes. Without these, such programs risk inefficiency and poor compliance without lasting impact. But when integrated with broader land tenure, extension, and market access reforms, direct payments and cost-sharing programs can be very effective at scaling up land restoration in developing economies. Examples of note include the Land Tenure Regularisation programs in Ethiopia and Rwanda (Bizoza and Opio-Omoding, 2021) and the successful Payments for Ecosystem Services programs in Mexico that support rural communities (ejidos) with communal land rights to conserve and restore forests and watersheds (Pfaff et al., 2019).

4.1.2 Tax Rebates and Fees Redirection

Tax rebates offer financial relief to individuals or businesses that engage in approved restoration activities, such as reforestation, erosion control, or agroforestry. These can take the form of income tax deductions, property tax exemptions, or reduced import duties on restoration inputs like seedlings or tools. Tax-related policies can be shaped in a variety of ways to incentivize or direct resources to tackling land degradation and the configuration, design and set of policies will differ from country to country based on national circumstances. For example, in South Africa environmental service payments and water-use fees have been partially redirected to fund reforestation and watershed restoration (Turpie et al., 2008, Kotze, 2021).

The success of tax-related policies depends on strong fiscal governance, economic impact, alignment with national circumstances, transparent fund allocation, and political viability. These tools may require external technical assistance and public awareness campaigns to be effectively implemented.

4.1.3 Blended Finance & Risk-Sharing

Blended finance and risk-sharing mechanisms can mobilize private investment in land restoration, particularly where financial risks are high and returns are uncertain. Blended finance combines public or philanthropic capital with private sector investment, using tools like concessional loans, guarantees, or first-loss capital to reduce perceived risks of restoration projects. This approach helps overcome barriers such as long payback periods, high transaction costs, and market volatility that can deter private actors from investing in sustainable land use. Risk-sharing mechanisms, including insurance schemes, co-investment models, and guarantee facilities, further enhance investor confidence by mitigating potential losses from climate shocks or project failure. The Land Degradation Neutrality (LDN) Fund, co-managed by Mirova and supported by the UNCCD, is a leading example of blended finance supporting land restoration across degraded land globally[1]. Such instruments enable the scaling of commercially viable restoration initiatives while ensuring positive environmental and social returns. Blended finance must be well-targeted, transparently governed, and aligned with national restoration priorities, ensuring that risk-sharing benefits extend to local communities.

4.1.4 Market-Based Instruments & Certification

Market-based instruments and certification schemes create economic incentives linked to sustainable land use and environmental performance. These instruments include PES, tradable credits (e.g., biodiversity or carbon credits), green labelling, and restoration-linked supply chain certification. By assigning monetary value to the ecosystem benefits of restored land, such as carbon sequestration, water filtration, or biodiversity habitat, market-based tools provide direct financial rewards to land holders who invest in restoration. Certification schemes like Rainforest Alliance, Forest Stewardship Council (FSC) assure consumers that products originate from responsibly managed, restored, or rehabilitated landscapes.

These schemes help growers access premium markets, improve traceability, and attract impact investors. In countries like Brazil, Costa Rica, and Kenya, certification has incentivized farmers and cooperatives to adopt agroforestry and soil conservation practices (Garrett et al., 2021). However, high compliance costs, limited market access, and technical barriers can limit uptake (Garrett et al., 2021). Market-based instruments should be accompanied by institutional support, capacity building, and equitable benefit-sharing, so that that smallholders, indigenous peoples and local communities can participate in and benefit from restoration-related markets.

[1] https://www.unccd.int/land-and-life/land-degradation-neutrality/impact-investment-fund-land-degradation-neutrality

4.2 Institutional, Policy and Legal Frameworks and Incentives

4.2.1 Long-term Contracts & Secure Tenure

Long-term contracts and secure land tenure are essential when uncertainty over land rights is a major barrier to adoption and land restoration actions. When land users have legal assurance that they can access, use, and benefit from the land over an extended period, they are far more likely to invest in restoration practices such as reforestation, agroforestry, or soil rehabilitation that typically offer delayed but long-term returns. Conversely, insecure tenure discourages restoration because landholders fear losing access to land before realizing the benefits of their investments. Studies show that secure land tenure can lead to significant increases in land productivity and restoration adoption (Yang et al., 2022). For example, Mexico is piloting the implementation of the Voluntary Guidelines on the Responsible Governance of Tenure (VGGTs), which aims to reduce gender inequality in land access and land tenure (Sobrino-García, 2023). Long-term leases, community land registration, and formal recognition of customary land rights can be used by governments and development partners to provide this security.

4.2.2 Cooperative and Community-Based Approaches

Cooperative and community-based approaches are useful where collective land use and resource management are common. These approaches involve local groups, such as farmer cooperatives, Indigenous Peoples and local communities, or village associations, jointly planning, implementing, and managing restoration activities, often based on shared goals and customary practices. By pooling labour, resources, and knowledge, communities can reduce individual risks and costs while benefiting from economies of scale. Community-led restoration also fosters a sense of ownership, social cohesion, and accountability, which enhances long-term stewardship and sustainability. There are increasing examples of community-based watershed management and reforestation programs that have successfully regenerated degraded landscapes while improving livelihoods and food security (Fanta et al., 2024). Moreover, cooperatives can facilitate access to finance, extension services, and markets to support inclusive participation and equitable benefit-sharing. When backed by legal recognition, supportive policies, and technical assistance, community-driven models can achieve landscape-scale restoration outcomes that are both ecologically effective and socially just. They also help embed restoration in local governance systems, making initiatives more resilient to political and economic changes over time.

4.2.3 Evidence-Based Cost-Benefit Analysis (CBA)

Evidence-based CBA demonstrates the tangible economic, social, and environmental returns of restoration investments. Decision-makers and land users are more likely to support restoration when clear, context-specific evidence shows that the long-term benefits outweigh the costs. CBA quantifies benefits such as increased agricultural productivity,

carbon sequestration, reduced disaster risk, and improved water quality, and compares them against the upfront and ongoing costs of restoration activities. Studies have shown that every $1 invested in restoration can yield $7 to $30 in economic benefits (Ding et al., 2017), including avoided losses from land degradation.

When CBA is tailored to national or local contexts and communicated effectively, it can influence policy decisions, attract private investment, and strengthen public support. It also helps prioritize restoration actions with the highest returns, ensuring more efficient use of limited funds. Integrating CBA into restoration planning and financing frameworks provides a compelling, evidence-driven rationale for scaling up land restoration efforts, aligning ecological goals with economic development priorities.

4.2.4 Innovations in Reporting

Reporting innovations such as ESG (Environmental, Social, and Governance) reporting and enhanced monitoring and evaluation (M&E) frameworks linked to Rio Convention requirements create formal mechanisms for governments, businesses, and investors to demonstrate environmental responsibility, track restoration outcomes, and align with global sustainability commitments. ESG reporting increasingly requires companies and financial institutions to disclose the environmental impacts of their operations and investments, including land use and restoration efforts. This transparency drives demand for sustainable land practices and opens access to nature and climate finance, carbon markets, and responsible investment portfolios. Simultaneously, national governments are strengthening their monitoring systems to report progress on LDN targets, Nationally Determined Contributions (NDCs), and National Biodiversity Strategies and Action Plans (NBSAPs). These reporting obligations incentivize governments to integrate land restoration into policy and planning frameworks and to support restoration programs that contribute to international goals.

4.3 Barriers to Adoption

Despite the clear economic argument for land restoration activities, their widespread uptake is hampered by several barriers, summarised in Table 2. This section explains each, including why they are barriers and how they can be overcome.

4.3.1 Weak Institutions and Fragmented Policy

Land restoration requires coordinated planning, monitoring, and enforcement across sectors which may be absent in developing economies due to weaker institutions and limited technical capacity at local and national levels. Furthermore, restoration responsibilities are frequently fragmented across multiple ministries and agencies (e.g. agriculture, forestry, environment) with limited coordination or shared data. This leads to overlaps, inconsistencies, and inefficiencies in program delivery. Even where restoration is prioritized

in national plans (such as those supporting the Rio Conventions), implementation is hindered by low staff capacity, insufficient budget allocations, and a lack of monitoring and evaluation systems.

Table 2. Key barriers to adoption

Barriers to adoption	
Policy	• Weak institutions and fragmented policy
Financial	• High transactions costs • Immature environmental markets • Limited access to finance
Social	• Low security land tenure • Cultural constraints and gender inequalities • Low trust and high risk aversion to change land practices
Technical	• Limited knowledge, data and technical capacity

4.3.2 High Transaction Costs

High transaction costs are a major barrier to participation in biodiversity and carbon markets for land holders in developing and developed countries, significantly hindering the adoption of land restoration activities. These costs include the expenses associated with project design, monitoring, reporting, verification, certification, legal compliance, and negotiations with market intermediaries. These costs can account for 30–50% of total project budgets, making small-scale or community-led projects economically unviable (Iftekhar et al., 2017).

For carbon markets, establishing a project that meets international standards like the Verified Carbon Standard (VCS) or Gold Standard requires detailed baseline assessments, third-party audits, and long-term monitoring which is often beyond the technical or financial capacity of many local organizations and land holders. In biodiversity markets, the absence of streamlined protocols for credit generation and trade adds additional complexity. These burdens disproportionately affect Indigenous Peoples and local communities, smallholders, and rural communities who often lack access to legal support, data systems, or technical expertise. As a result, even when restoration projects deliver measurable ecological benefits, they may fail to access markets or attract investment. Reducing transaction costs through simpler methodologies, bundled projects, technology transfer and local capacity-building will enable equitable and effective participation in environmental markets in less developed countries.

4.3.3 Land Tenure and Tenure Security

Insecurity of land tenure is a significant barrier across much of the developing world. Many farmers, particularly women, Indigenous Peoples and local communities, and pastoralists, lack formal or recognized rights to the land they manage. This discourages long-term investments in land restoration, as individuals are unlikely to improve land they do not own

or risk losing. In Africa, for example, more than 60% of land is held under customary systems, but only a fraction is legally recognized[2]. This creates uncertainty over land use rights, access to benefits, and eligibility for land restoration finance. Studies have shown that when land rights are strengthened, land restoration efforts become significantly more successful (Lawry et al., 2017, Rakotonarivo et al., 2023).

4.3.4 Market Maturity

One significant barrier to land restoration in developed and developing countries is the immaturity of biodiversity markets, which limits financial incentives and undermines investment in restoration activities. Biodiversity markets, such as PES, biodiversity credits, and habitat banking, aim to monetize the ecological benefits of restored or conserved land. However these markets remain under-developed, poorly regulated, or entirely absent. This leaves land holders and communities with few opportunities to generate income from land restoration that has a biodiversity benefit, despite the global value of biodiversity conservation.

The lack of robust verification standards, market infrastructure, and buyer confidence further discourages private sector participation. In addition, many local land holders lack the technical capacity or legal recognition needed to access biodiversity finance mechanisms. Addressing this barrier requires building transparent, inclusive, and scalable biodiversity markets that ensure fair benefit-sharing and support long-term ecological and economic sustainability in restoration efforts.

4.3.5 Limited knowledge and technical barriers

Land holders may lack access to information, skills, and tools needed to implement land restoration practices effectively. Extension services, especially in developing countries, can be weak or absent, and training programs do not reach remote or marginalized communities. Land holders may not be aware of viable restoration techniques or may be uncertain about their potential benefits and risks. Additionally, technical guidelines and research are frequently developed without adaptation to local ecological, cultural, and social-economic contexts. Restoration techniques that work in one region may fail in another due to differences in rainfall, soils, land tenure, or labour availability. Participatory approaches that integrate local knowledge and preferences are needed to increase adoption.

4.3.6 Access to Finance

Lack of affordable financing for land holders, communities, and governments is a significant barrier to land restoration. Restoration practices such as agroforestry, terracing, or reforestation often require upfront investments in labour, materials, seedlings, and ongoing maintenance which can be unaffordable for many land holders in the absence of subsidies

[2] https://rightsandresources.org/wp-content/uploads/FactSheet_WhoOwnstheWorldsLand_web2.pdf

or access to credit. Public and private finance for restoration is not widely available or accessible in many less developed countries. In regions such as Sub-Saharan Africa, fewer than 10% of smallholders have access to formal credit systems[3]. This restricts their capacity to invest in long-term restoration actions, especially where returns are delayed.

Economic incentive structures often favour unsustainable practices like overgrazing, deforestation, or monoculture farming, which deliver short-term profits at the expense of long-term land soil and ecosystem health. Without shifts in market systems, taxation, or subsidy policies to reward restoration efforts, adoption remains financially unviable for many land users.

4.3.7 Cultural Constraints, Gender and Inequalities

Social norms, cultural values, and local power dynamics can significantly influence whether and how land restoration practices are adopted. Gender inequality is a major barrier. Women often play a central role in land use and restoration but in some cases face systemic exclusion from land ownership, decision-making, training, and financial services. Restoration projects that overlook gender inclusion may unintentionally reinforce existing inequalities and limit effectiveness.

4.3.8 Risk Aversion & Low Trust

Developing economies are among the most vulnerable to droughts, floods, and temperature extremes. These risks reduce the perceived reliability of restoration outcomes and discourage investment. If farmers fear crop failure or livestock loss due to climate shocks, they may be reluctant to experiment with new land management practices, especially without guaranteed returns.

5 G20 CONSIDERATIONS AND RECOMMENDATIONS

Given the various incentives that can be used to encourage widespread uptake of land restoration and the barriers to adoption described above, this chapter makes recommendations to G20 countries for scaling up land restoration to build resilient economies:

5.1 Integrate Land Restoration into National Development, Biodiversity and Climate Policies

- Embed land restoration in national plans and policies, including National Development Plans, NDCs, and NBSAPs, and ensure alignment with the goals of the UNCCD, the UN Decade on Ecosystem Restoration, and the Kunming-Montreal Global Biodiversity Framework.

[3] https://www.fao.org/e-agriculture/news/farmdrive-improves-access-credit-smallholder-farmers

- Align national targets with regional and global initiatives like the Great Green Wall and Decade on Ecosystem Restoration
- Create inter-departmental working groups and task forces to ensure coherence across sectors (e.g. agriculture, environment, finance & treasury).

5.2 Empower Community-Led Restoration and Strengthen Local Institutions

- Provide training, resources, and legal backing for community-based natural resource management.
- Support traditional authorities, women's groups, and cooperatives to lead restoration activities.
- Support participatory mapping, planning, and decision-making processes at the landscape level.

5.3 Secure Land Tenure and Customary Land Rights

- Strengthen and formalize customary and communal land tenure systems to ensure long-term investment in land.
- Prioritize legal frameworks that recognize the land rights of Indigenous peoples and local communities, pastoralists, and women.

5.4 Mobilize Blended Finance and De-Risk Private Investment

- Develop national pipelines of land restoration investment projects to attract blended finance from public, philanthropic, and private sources.
- Expand financial instruments such as guarantees, concessional loans, and green bonds tailored to land restoration.
- Collaborate with development finance institutions to increase the amount invested in agricultural landscapes.

5.5 Create Ecosystem Services Markets and Promote Certification

- Support establishment of carbon credit schemes, biodiversity credits, and water payment programs that benefit smallholders.
- Promote access to certified sustainable markets (e.g. fair trade).
- Partner with the private sector to develop restoration-linked supply for agricultural products

5.6 Implement Nature-Based Solutions for Climate Resilience

- Scale up watershed rehabilitation, reforestation, rangeland restoration, and wetland recovery in regions more vulnerable to climate change impacts such as drought.
- Integrate restoration into climate adaptation plans.
- Prioritize restoration in drought-prone areas.

5.7 Build Technical Capacity and Strengthen Extension Services

- Train agronomists and community facilitators in cost-effective restoration techniques.
- Reinvest in public agricultural and land extension systems, with a focus on youth employment and digital tools.
- Partner with research institutions and Indigenous knowledge holders to co-develop locally adapted solutions.

5.8 Establish National Restoration Monitoring Systems

- Continue to invest in geospatial data to monitor land cover, restoration progress, and degradation hotspots, defined as locations undergoing rapid land degradation caused by multiple drivers and with severe impacts on the environment and communities.
- Link national monitoring to reporting under Rio Conventions, including improved coherence and synergies in land restoration targets and actions across national plans and programs of the Conventions.
- Encourage transparency and citizen science tools to involve communities in tracking impacts.

5.9 Use Evidence-Based Cost-Benefit Analysis to Guide Investment

- Conduct cost-benefit and return-on-investment assessments to identify priority locations for land restoration.
- Prioritise land restoration investment in hotspot locations, defined as areas undergoing rapid land degradation caused by multiple drivers and with severe impacts on the environment and communities.
- Integrate ecosystem services values into government investment decisions.
- Share economic evidence with ministries of finance, planning, and investment to justify scaling up land restoration funding.

6 CONCLUSION

This paper demonstrates that cost-effective investment in land restoration is both an environmental priority and essential for achieving long-term economic resilience, social stability, and climate resilience. Land degradation undermines food security, erodes livelihoods, and reduces national economic productivity. Land restoration generates significant social, economic and environmental benefits, including improving soil fertility, increasing agricultural productivity, stabilizing rural incomes, reducing disaster risk, and sequestering carbon to meet climate goals. The G20, representing the world's largest economies, is uniquely positioned to catalyse widespread investment in land restoration by mobilizing finance, harmonizing policy frameworks, and de-risking private sector participation.

Central to success is the recognition that land restoration must be embedded in broader development goals and actions. This means integrating land restoration targets into national plans, policies and strategies for biodiversity protection and restoration, climate change adaptation and mitigation, and land management, and economic development. Doing so would also align with global frameworks such as the UNCCD's LDN targets, the Paris Agreement, and the Kunming-Montreal Global Biodiversity Framework. Also important is strengthening enabling conditions—secure land tenure, robust institutions, effective monitoring and evaluation systems, and inclusive governance that empowers Indigenous peoples and local communities, women, and smallholders.

Innovative financing is another critical factor in encouraging widespread land restoration. Blended finance instruments, green bonds, and payments for ecosystem services can leverage private capital while protecting smallholders from excessive risk. Expanding biodiversity and carbon markets and simplifying their transaction costs and verification requirements is essential to make restoration a viable livelihood strategy. The G20 can accelerate these mechanisms by encouraging public-private partnerships, standardising metrics, and encouraging investment into high-impact land restoration opportunities. The ultimate goal should be a restoration economy that generates jobs and diversifies rural economies.

The G20 has a unique role to play in promoting coherence between climate, biodiversity, and land agendas. By aligning restoration finance with adaptation and mitigation priorities, the G20 can demonstrate to the world that restoring degraded land is a high-return investment. Doing so would not only help achieve the Bonn Challenge, the Decade on Ecosystem Restoration, and SDG 15.3 but would also deliver a more inclusive, food-secure, and climate-resilient future.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Commercialising Innovation: A Strategic Outlook on Technology Use Cases for Land Restoration and Climate Support

The Business Case for Technology and Innovation

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[1] *This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.*

EXECUTIVE SUMMARY

The world is facing an escalating environmental crisis, with land degradation, climate change, pollution, and biodiversity loss collectively threatening both ecosystems and human well-being. More than 3.2 billion people are already affected, and 70 per cent of ice-free land is altered by human activity. By 2050, that figure may rise to 90 per cent. This degradation fuels poverty, food insecurity, and instability—but also presents an opportunity. Restoration is increasingly recognised not as a cost, but as a forward-looking investment, with every dollar yielding up to $30 in economic returns.

The "restoration economy" is now emerging as a rapidly growing sector, valued at $37 billion today and projected to reach $70 billion by 2031. With the potential to generate trillions in economic value and millions of jobs, restoration is comparable in transformative potential to past industrial revolutions. International commitments, including the UN Decade on Ecosystem Restoration, the UNCCD Strategic Framework, and successive G20 declarations, such as the Global Land Initiative's ambition to halve degraded land by 2040, are accelerating this shift, turning environmental goals into powerful market drivers.

Technological innovation is a central component of this transformation. Remote sensing, drones, and AI enable predictive modelling, early warning, and precision interventions. Biotechnology and ecological engineering, from microbial soil enrichment and phytoremediation to drought-resistant species and biochar, offer scalable ways to restore ecosystems. Advanced water management, including smart irrigation, fog harvesting, and renewable-powered desalination, is critical for drylands. Sustainable land management practices such as precision agriculture, agroforestry, and climate-resilient infrastructure integrate productivity with restoration, creating multiple co-benefits.

But innovation carries risks. High costs risk widening the gaps between countries and communities; ecological concerns surrounding modified species or water-intensive technologies underscore the need for safeguards. Data privacy and sovereignty issues also require careful governance. Technology must empower people and strengthen ecosystems, rather than undermining integrity, rights, or social justice. Adoption will depend on socio-cultural acceptance, co-creation with communities, voluntary and mutually agreed terms of technology transfer, and institutional capacity.

For the G20, the challenge is to harness innovation while addressing these barriers. This report highlights debates on how best to transfer technologies while fostering local innovation, mobilise finance while maximising existing funds, and balance nature-based and technological interventions. It recommends a strategic framework built around six areas: aligning policies and regulations, mobilising finance, strengthening research and demonstration, enhancing

knowledge management, building capacity and partnerships, and enabling private sector engagement.

Taken together, these approaches can accelerate progress towards Land Degradation Neutrality while delivering co-benefits for climate, biodiversity, and sustainable development.

1 INTRODUCTION: THE DAWN OF THE RESTORATION ECONOMY

The world is confronting an escalating environmental crisis, with land degradation, climate change, and biodiversity loss now affecting more than 3.2 billion people and altering over 70% of ice-free land, a figure projected to reach 90% by 2050 (IPBES, 2018; UNCCD, 2022). These pressures erode ecosystem services, drive food and water insecurity, and heighten the risks of poverty, conflict, and migration. Addressing degradation is therefore not only an ecological necessity but also a foundation for stability, resilience, and sustainable growth.

In this context, a "restoration economy" is rapidly emerging. Every dollar invested in restoration is estimated to return between $7 and $30 in economic benefits (UNEP, 2021). The sector is projected to grow from $37 billion today to $70 billion by 2031 (G20 Global Land Initiative, 2024). Beyond financial returns, restoration holds the potential to create millions of jobs and generate up to $2 trillion in value through revitalised ecosystems and sustainable livelihoods (UNCCD, 2022). Technological innovation, including remote sensing, artificial intelligence, biotechnology, advanced water management, and sustainable land practices, is at the core of this shift, enabling faster, more precise, and cost-effective action. The restoration economy thus represents a strategic investment in both planetary health and long-term prosperity.

1.1 Global Context: Scale of Land Degradation and Climate Crisis

Unsustainable agricultural practices remain a primary driver, eroding soils at rates 10 to 100 times faster than natural replenishment (UNCCD, 2022; Mulvihill, 2021). Each year, an estimated 100 million hectares of additional land are degraded, undermining the productivity and ecological integrity of roughly one quarter of the Earth's terrestrial surface (IPBES, 2018). Africa is particularly impacted, having experienced the highest rate of net forest loss globally between 2010 and 2020, with around 3.9 million hectares lost annually (FAO, 2020).

The accelerating pace of land degradation is not merely an environmental concern; it has profound socio-political implications. Degraded land undermines water security, disrupts rainfall patterns, and exacerbates extreme weather events such as droughts and floods. These cascading effects amplify the impacts of climate change, driving social and political instability and deepening poverty, conflict, food insecurity, and migration for millions globally (UNCCD, 2018; IPCC, 2019). This profound connection between environmental health and human security broadens the investment case for land restoration beyond

environmental, social, and governance (ESG) considerations to encompass geopolitical stability, humanitarian security, and development priorities.

Historically, land restoration was often perceived as cost-intensive and economically burdensome. However, there is a growing recognition that restoration is a strategic and cost-effective investment. Recent studies estimate that degradation leads to annual economic losses of USD 6.3–10.6 trillion globally in lost ecosystem services, while every USD 1 invested in restoration can yield up to USD 30 in economic benefits through enhanced productivity, climate resilience, and ecosystem services (ELD Initiative, 2015; UNEP, 2021). This juxtaposition of staggering costs of inaction against the multiple co-benefits of restoration has created a compelling business case for investment.

In this context, land restoration is increasingly framed as a core solution to the "triple planetary crisis" of climate change, biodiversity loss, and pollution (UNEP, 2022). Furthermore, global commitments such as SDG 15.3 on Land Degradation Neutrality (LDN), the Paris Agreement, and the Kunming-Montreal Global Biodiversity Framework reinforce the urgency of scaling up restoration as a cross-cutting response that aligns climate, biodiversity, and development agendas (CBD, 2022; UNCCD, 2022).

1.2 International Commitments and Policy Drivers

The global community has responded to the land degradation and climate crises with ambitious international commitments and policy initiatives that are actively shaping a new market for restoration technologies and services. The United Nations Decade on Ecosystem Restoration (2021–2030) emphasises the urgent need for large-scale ecological restoration worldwide (UNEP & FAO, 2021). Complementing this, the UNCCD Strategic Framework (2018–2030) and Sustainable Development Goal (SDG) 15.3 commit Parties to achieving Land Degradation Neutrality (LDN) by 2030 (UNCCD, 2018; United Nations, 2015).

The G20 Global Land Initiative, launched under the Riyadh Leaders' Declaration (2020), aims to prevent, halt, and reverse land degradation, with a voluntary ambition to reduce degraded land by 50% by 2040 (G20, 2020). This ambition has been reiterated across subsequent Presidencies in Rome (2021), Bali (2022), and New Delhi (2023), embedding restoration firmly within the G20 agenda (G20, 2021; G20, 2022; G20, 2023).

Other global frameworks reinforce these commitments. The Bonn Challenge seeks to restore 350 million hectares of degraded and deforested land by 2030 (IUCN, 2020). The Paris Agreement (2015) emphasises the importance of sustainable land use in achieving its long-term goals of mitigation, adaptation, and aligning financial flows (UNFCCC, 2015). The Kunming-Montreal Global Biodiversity Framework (2022) aims to halt and reverse biodiversity loss by 2030, with specific targets for ecosystem conservation and restoration (CBD, 2022). At the regional level, the EU Nature Restoration Law (2023) has set binding targets for ecosystem restoration across terrestrial and marine ecosystems in Europe (European Commission, 2023).

These international and national policy targets are transcending environmental aspirations to become direct, powerful drivers of the "restoration economy." By setting ambitious goals and, in some cases, mandating restoration activities, they create compelling demand for innovative solutions and actively incentivise private sector engagement. The G20 Global Land Initiative, for instance, aims to engage private actors in supporting land restoration efforts and promoting sustainable land management. This demonstrates a clear cause-and-effect relationship: policy is not only a guideline but also a market-shaping force, generating regulatory and financial incentives that attract investment and transform environmental imperatives into economic opportunities.

1.3 The "Restoration Economy" and its Economic Significance

The "restoration economy" is emerging as a distinct and rapidly expanding sector that provides jobs, stimulates innovation, and generates substantial economic returns while delivering environmental and social co-benefits. It encompasses a wide array of activities, ranging from large-scale ecological restoration planning and implementation to monitoring services, seed banks, nurseries, and technology-enabled solutions such as remote sensing, drones, and digital toolkits (BenDor et al, 2024; UNCCD, 2022).

The experience of the United States illustrates the tangible benefits of this sector. In 2014, the U.S. restoration economy generated USD 9.47 billion in direct economic output, directly supporting 126,111 jobs and producing approximately USD 6.27 billion in labour income. When accounting for indirect and induced impacts, total economic output reached USD 24.86 billion, supporting over 221,000 jobs (Kelmenson, BenDor, & Lester, 2016; Federal Reserve Bank of Boston, 2016). Similar trends are observed in Europe, where ecosystem restoration often yields benefits that far exceed the costs. Recent assessments indicate that restored wetlands can generate ecosystem service values up to ten times greater than the restoration expenses (Grygoruk et al., 2025). Broader EU analyses estimate returns ranging from €8 to €38 for every euro invested, depending on the ecosystem type (European Commission, 2024).

A key indicator of the sector's financial attractiveness is its high return on investment (ROI). In some cases, restoration of forest landscapes has been estimated to yield between USD 7 and USD 30 in economic benefits for every USD 1 invested, particularly through enhanced productivity, carbon sequestration, water security, and disaster risk reduction (Verdone & Seidl, 2017; UNEP, 2021). These consistent findings demonstrate that the restoration economy is not only environmentally necessary but also economically compelling.

The growing recognition of restoration as a smart, forward-looking investment has catalysed greater interest from both governments and the private sector. Policies such as the UN Decade on Ecosystem Restoration (2021–2030) and the G20 Global Land Initiative (2024), as well as regional frameworks like the EU Nature Restoration Law (2024), are creating strong demand signals. Combined with innovative financing approaches, including blended finance

to de-risk private investments, the restoration economy is positioned to become a trillion-dollar industry central to addressing the triple planetary crisis while securing livelihoods and economic resilience worldwide.

2 CURRENT MULTILATERAL DELIBERATIONS

Multilateral platforms have increasingly recognised the importance of land restoration as an integrated solution to address climate change, biodiversity loss, and the Sustainable Development Goals. This section outlines the key deliberations and policy directions emerging from the G20 and other global forums. It sets the context for how international commitments, strategic dialogues, and financing mechanisms are shaping the uptake and scaling of technology and innovation for land restoration worldwide.

2.1 The G20

The G20 has increasingly placed environmental sustainability at the centre of its agenda, recognising that collective action by the world's largest economies is critical to halting land degradation, restoring ecosystems, and tackling the triple planetary crisis of climate change, biodiversity loss, and pollution (Andersen, 2022).

In 2020, under Saudi Arabia's Presidency, G20 leaders launched the Global Initiative on Reducing Land Degradation and Enhancing Conservation of Terrestrial Habitats, setting a voluntary ambition to reduce degraded land by 50% by 2040 (G20, 2020). Coordinated with the UN Convention to Combat Desertification (UNCCD), this was a landmark political signal that land restoration is integral to sustainable development and climate action.

In the 2021 Rome Leaders' Declaration, G20 members reaffirmed the voluntary ambition to reduce degraded land by 50% by 2040 and committed to striving toward Land Degradation Neutrality by 2030, while linking these goals to sustainable recovery from the COVID-19 crisis and environmental resilience (G20, 2021).

In 2022, Indonesia's Presidency reinforced the centrality of restoration. The G20 Environment and Climate Ministers in Bali pledged to "continue and scale up" efforts against desertification, land degradation, and drought, with a clear call to achieve LDN by 2030 (G20, 2022). They highlighted the UN Decade on Ecosystem Restoration (2021–2030) and called for mainstreaming ecosystem and forest restoration into recovery and development plans. G20 members also reaffirmed the Glasgow Leaders' Declaration on Forests and Land Use (COP26), pledging to halt and reverse forest loss by 2030. The Chair's Summary stressed the importance of engaging the private sector, Indigenous Peoples, women, and youth in land restoration, underscoring the inclusive approach of the G20's Global Land Initiative.

In 2023, under India's Presidency, the theme of "One Earth, One Family, One Future" provided a holistic framing. The Chennai Environment and Climate Ministers' Outcome emphasised integrated action across the three Rio Conventions (climate, biodiversity,

desertification) and welcomed the adoption of the Kunming-Montreal Global Biodiversity Framework (GBF) (CBD, 2022; G20, 2023). G20 members are committed to enhancing ecosystem resilience through protection, conservation, sustainable use, and restoration, including through nature-based solutions to optimise co-benefits for climate and biodiversity. Importantly, they reaffirmed their 2020 pledge to reduce degraded land and endorsed High-Level Principles on Lifestyle for Sustainable Development (LiFE), highlighting sustainable consumption and production patterns as critical to addressing climate and land pressures.

In 2024, Brazil assumed the Presidency, bringing a strong focus on the nexus of biodiversity, climate, and social inclusion. Recognising its role as steward of the Amazon and other tropical ecosystems, Brazil emphasised the role of Indigenous Peoples and local communities in safeguarding land and biodiversity. Payments for ecosystem services, equitable livelihoods, and community-centred restoration approaches gained prominence (G20, 2024). Leaders emphasised the need to address the triple planetary crisis in an integrated manner, framing land restoration as a cross-cutting solution that can slow climate change, restore ecosystems, and create employment opportunities. Brazil also incorporated sustainability into discussions on finance, agriculture, and energy, reinforcing that land and nature are both economic and ecological priorities.

This cycle of G20 leadership by emerging economies, Indonesia (2022), India (2023), Brazil (2024), and South Africa (2025), has elevated restoration to the forefront of the global economic agenda. Together, these Presidencies have ensured continuity and ambition in multilateral deliberations, embedding land restoration and nature-based solutions as central strategies for sustainable growth as the world approaches the 2030 targets for LDN, biodiversity, and climate action.

2.2 Other Multilateral Forums

In parallel to the G20 process, a range of multilateral forums and international agreements are advancing policies and actions to combat land degradation, biodiversity loss, and climate change. These forums provide legally binding frameworks, voluntary initiatives, and financial mechanisms that collectively shape the enabling environment for land restoration. Their deliberations not only reinforce G20 priorities but also set the global standards, goals, and resources that underpin national and regional action.

2.2.1 UNCCD, UNFCCC, COP26, COP27, COP29

The United Nations Convention to Combat Desertification (UNCCD) plays a central role in the global land restoration agenda, serving as the only legally binding international agreement dedicated to addressing desertification, land degradation, and drought (DLDD). Established in 1994 as one of the three Rio Conventions, the UNCCD provides a strategic policy framework for Parties to develop national and regional strategies that promote

sustainable land management and achieve Land Degradation Neutrality (LDN) by 2030, in line with SDG target 15.3 (United Nations, 2015; UNCCD, 2018). The Convention facilitates coordination among governments, civil society, and the private sector, while supporting technology transfer on a voluntary and mutually agreed-upon basis, capacity building, and monitoring efforts through initiatives such as the LDN Target Setting Programme. The Global Mechanism of the UNCCD mobilises financial and technical resources to scale up restoration, strengthen investment frameworks, and create enabling conditions for implementation. In recent years, the UNCCD has increasingly urged greater alignment with the UNFCCC and CBD, highlighting land restoration as a platform for synergy across climate, biodiversity, and desertification goals and underscoring its contributions to resilience, food security, poverty reduction, and climate action (Fuchs et al., 2022; UNCCD, 2023).

Under the United Nations Framework Convention on Climate Change (UNFCCC), land and ecosystems have gained prominence as essential elements of climate solutions. Nearly all countries include land-use sectors, particularly forestry and agriculture, in their Nationally Determined Contributions (NDCs). The Paris Agreement (2015) explicitly recognises the importance of “sinks and reservoirs” of greenhouse gases, underscoring the central role of forests and ecosystems in mitigation and adaptation strategies.

At COP26 in Glasgow (2021), over 130 world leaders, representing more than 90% of global forests, endorsed the Glasgow Leaders’ Declaration on Forests and Land Use, pledging to halt and reverse forest loss and land degradation by 2030 (UNFCCC, 2021). This was supported by a USD 12 billion Forest Finance Pledge (2021–2025) aimed at protecting and restoring forests.

At COP27 in Sharm El-Sheikh (2022), governments formally recognised Nature-Based Solutions (NbS) in the UNFCCC process for the first time, underscoring the importance of ecosystem protection and restoration for mitigation, adaptation, and resilience (UNFCCC, 2022).

On climate finance, recent data from the OECD (2024) confirm that developed countries met and exceeded the USD 100 billion goal in 2022, mobilising USD 115.9 billion in climate finance (OECD, 2024). This marks a milestone in addressing longstanding shortfalls. Furthermore, the New Collective Quantified Goal (NCQG) on Climate Finance was formally adopted at COP29 in Baku (2024), setting a post-2025 goal aligned with the Paris Agreement’s long-term objectives, mitigation, adaptation, and alignment of financial flows (UNFCCC, 2024).

The UNFCCC process has also advanced mechanisms that directly link climate action with restoration. The REDD+ mechanism (Reducing Emissions from Deforestation and Forest Degradation) provides a multilateral framework that incentivises forest protection and restoration in developing countries, channelling climate finance toward land-based solutions. In addition, the UNFCCC has promoted ecosystem-based adaptation and scaled

up support for nature-positive investments, reflecting the growing recognition that climate, land, and biodiversity are interdependent challenges that require integrated solutions.

2.2.2 CBD, UNEA

The Convention on Biological Diversity (CBD) has placed ecosystem restoration at the heart of the global biodiversity agenda. In December 2022, 196 Parties adopted the landmark Kunming–Montreal Global Biodiversity Framework (GBF), which will guide international action through 2030 (CBD, 2022). Among its four overarching goals and 23 targets, restoration is emphasised as a core pillar. Target 2 commits Parties to ensure that at least 30% of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration by 2030. This ambitious restoration goal complements the more widely known "30×30" pledge (Target 3), which seeks to protect 30% of the planet's land and oceans by 2030.

The GBF recognises that restoration is essential not only to reverse biodiversity loss but also to secure ecosystem services, enhance resilience to climate change, and support human well-being. To enable implementation, the GBF includes a strong resource mobilisation framework: Parties agreed to increase financial resources for biodiversity to USD 200 billion per year by 2030 from all sources, including domestic budgets, private finance, and innovative mechanisms. Developed countries further committed to scale up international biodiversity finance to USD 20 billion annually by 2025 and USD 30 billion by 2030 (CBD, 2022). To facilitate this, a Global Biodiversity Framework Fund has been established under the Global Environment Facility (GEF), serving as the principal multilateral channel to support developing countries in implementing the GBF.

The United Nations Environment Assembly (UNEA), the world's highest-level environmental decision-making body, complements the CBD by reinforcing political consensus and catalysing cross-cutting environmental action. UNEA resolutions have increasingly highlighted restoration as a central response to the triple planetary crisis. For example, UNEA-4 (2019) adopted resolutions on the conservation and sustainable management of peatlands and mangroves, urging countries to safeguard and restore these carbon-rich ecosystems (UNEA, 2019; UNEP, 2019). UNEA-5 (2022) marked another milestone by formally adopting a definition of NbS, thereby providing governments and stakeholders with a common framework to integrate NbS into climate, biodiversity, and development strategies (UNEA, 2022; UNEP, 2022; IUCN, 2022). UNEA has also served as an incubator for new global agreements, most notably the ongoing negotiations for a treaty to end plastic pollution, recognising the pervasive impacts of pollution on ecosystems.

Through these commitments and processes, the CBD and UNEA have elevated restoration to a top-tier global priority. They complement the UNCCD and UNFCCC by providing clear restoration targets, dedicated financing mechanisms, and consensus-based policy tools. Together, these multilateral platforms underscore the importance of restoring degraded

ecosystems in halting biodiversity loss, advancing climate action, and ensuring sustainable development.

2.2.3 Voluntary Partnerships and Coalitions

Beyond intergovernmental treaties, several voluntary partnerships and coalitions have emerged as powerful vehicles for advancing restoration efforts on the ground. These initiatives often operate at regional or global levels, complementing formal agreements by mobilising political will, fostering innovation, and accelerating implementation.

A prominent example is the Bonn Challenge, a global initiative launched in 2011 by Germany and the International Union for Conservation of Nature (IUCN). It calls for the restoration of 350 million hectares of degraded and deforested land by 2030. As of the mid-2020s, more than 70 countries and other entities have made pledges totalling approximately 210 million hectares (IUCN, 2024). The Bonn Challenge has also catalysed regional initiatives such as AFR100 (the African Forest Landscape Restoration Initiative) and Initiative 20×20 in Latin America, which together advance knowledge sharing, financing, and implementation (IUCN, 2020; WRI, 2020). The initiative has established a global community of practice focused on forest landscape restoration, serving as a bridge between high-level targets and practical, on-the-ground action.

Another flagship effort is the African Union's Great Green Wall initiative, which aims to restore 100 million hectares of degraded land by 2030, creating productive landscapes, improving food security, and generating livelihoods across the Sahel (UNCCD, n.d.; Global Environment Facility, n.d.). Similarly, more than 120 countries have set voluntary LDN targets under the UNCCD, reinforcing the global objective of achieving no net loss of healthy land by 2030. These bottom-up commitments strengthen global ambition by embedding restoration into national development agendas.

In the climate arena, voluntary coalitions have played a crucial role in shaping momentum. The High Ambition Coalition for Nature and People (with 100+ member countries) has strongly advocated for the 30×30 target, while the Leaders' Pledge for Nature, signed by over 90 heads of state, commits to reversing biodiversity loss by 2030, explicitly including restoration actions (CBD, 2022). These coalitions demonstrate the influence of political partnerships in driving consensus, many of which directly contributed to the adoption of the Kunming–Montreal Global Biodiversity Framework.

The REDD+ mechanism, under the UNFCCC, is also relevant for restoration. It provides results-based payments to developing countries for verified emission reductions from forests, often through the avoidance of deforestation, conservation, and sustainable management. As of 2023, more than 60 developing countries have reported REDD+ activities under the UNFCCC, together accounting for an estimated 13.5 gigatonnes of greenhouse gas emission reductions and removals (UNFCCC Secretariat, 2023; Coalition for Rainforest Nations, 2024). While REDD+ is not a voluntary coalition in the same sense as the Bonn

Challenge, it represents a key multilateral instrument that many voluntary initiatives align with to access finance and technical support.

Taken together, these voluntary partnerships and coalitions complement formal multilateral processes by testing innovative models, mobilising actors, and generating political momentum. They create a reinforcing cycle: voluntary initiatives provide innovation and momentum that inform intergovernmental policy, while global agreements set targets that inspire and scale up on-ground action. This synergy underscores their importance as both incubators of innovation and accelerators of global restoration goals.

2.2.4 GEF, GCF, LEAF

The growing ambition for restoration and climate commitments has been accompanied by the mobilisation of dedicated financial mechanisms designed to support implementation. These funds are crucial to ensuring that global commitments on biodiversity, climate, and land are translated into tangible action on the ground.

The Global Environment Facility (GEF) serves as a financial mechanism for the CBD, UNCCD, and UNFCCC. Since 2006, it has provided approximately US$5.2 billion for sustainable land management, leveraging additional co-financing and enabling countries to rehabilitate degraded lands, conserve habitats, and strengthen local livelihoods (GEF, 2024). Through its latest replenishment cycle (GEF-8, 2022–2026), the GEF is channelling record resources into integrated programmes that address biodiversity, land degradation, and climate change simultaneously (GEF, 2022; GEF, 2024; UNEP, 2022). This includes investment in landscape restoration as part of climate change adaptation, food security, and sustainable value chains, recognising that restoration is inherently cross-sectoral.

The Green Climate Fund (GCF), the largest dedicated climate finance instrument under the UNFCCC, is also central to restoration-related finance. In late 2023, it announced pledges amounting to US$12.8 billion for its second replenishment (2024–2027). However, following the subsequent withdrawal of U.S. pledges, the confirmed figure has been revised downwards, highlighting the fragility of voluntary pledging systems (GCF, 2023; GCF, 2024). Even so, the GCF's replenishment remains significant, and the Fund continues to support large-scale forestry and ecosystem programmes across regions, including Brazil, Indonesia, and sub-Saharan Africa. Importantly, G20 members and partners have emphasised that the focus should remain on enhancing existing funds, rather than creating new, fragmented mechanisms.

In addition to the GEF and GCF, several targeted partnerships and facilities complement multilateral funds. For example, the Global Biodiversity Framework Fund (GBFF), established in 2023 under the GEF, is specifically designed to channel resources toward achieving the CBD's Kunming–Montreal Global Biodiversity Framework targets, including ecosystem restoration (World Bank /FIF Trustee, n.d.; CBD, 2023). Likewise, the LEAF Coalition (Lowering Emissions by Accelerating Forest Finance), launched at COP26, has mobilised over US$1

billion in public–private finance for tropical forest conservation, with payments linked to verified emission reductions (LEAF Coalition, 2021; EDF, 2021). Development banks and bilateral initiatives, such as the World Bank's PROGREEN fund (PROGREEN, n.d.) and Germany's support for the Great Green Wall (Gravesen & Funder, 2022), further strengthen restoration financing by embedding it within broader development strategies.

Overall, the international community has recognised that meeting restoration pledges requires scaled-up, predictable, and coordinated financial support. While financing still falls short of estimated global needs, replenished mechanisms like the GEF and GCF, alongside targeted initiatives such as LEAF, are increasingly aligned with restoration and sustainable land management. A priority from now on is to improve coherence, avoid duplication, and maximise synergies across these funding streams, ensuring that scarce resources are deployed effectively to deliver both environmental and social co-benefits.

2.3 Implications for the G20

The global landscape of multilateral action on land restoration is both dense and dynamic, shaped by a range of complementary frameworks and initiatives. The UNCCD provides the core normative and technical foundation for achieving LDN, and the UNFCCC increasingly integrates land and ecosystems into climate strategies through mechanisms such as REDD+ and the recognition of nature-based solutions. The CBD has positioned restoration as a central element of the Kunming–Montreal Global Biodiversity Framework, and UNEA, together with the UN Decade on Ecosystem Restoration, have strengthened political will and coherence. Voluntary coalitions and partnerships, including the Bonn Challenge, the Great Green Wall, and the High Ambition Coalition, continue to build momentum from the ground up. Financial mechanisms such as the GEF, GCF, and LEAF Coalition are mobilising billions of dollars to support restoration, though essential gaps remain.

The G20 does not need to create new structures or duplicate existing mandates in this evolving context. Its comparative advantage lies in providing political leadership to keep land restoration and sustainable land management at the forefront of the global economic agenda. The G20 can promote policy coherence by encouraging alignment across the UNCCD, UNFCCC, CBD, UNEA, and relevant regional initiatives, thereby helping to reduce fragmentation. It also has a role in strengthening the effectiveness of financing by advocating for enhanced coordination and resourcing of existing mechanisms, such as the GEF, GCF, and GBFF, rather than establishing parallel funds. The G20 is also uniquely positioned to leverage innovation and private sector engagement, using its collective economic influence to accelerate the adoption and scaling of new approaches. A further priority is ensuring inclusivity by supporting Indigenous peoples, local communities, women, and youth as central actors in restoration efforts.

The G20's role is to bridge the gap between global ambition and practical implementation. By reinforcing, rather than replicating, multilateral commitments, it can create enabling

conditions that advance innovation, mobilise finance, and elevate political visibility. This positions the G20 as a strategic amplifier of global restoration efforts, directly contributing to the achievement of the 2030 targets under the Rio Conventions while advancing its own voluntary ambition to halve degraded land by 2040.

3 CURRENT INITIATIVES AND DEBATES

The acceleration of technological innovation presents a transformative opportunity to tackle land degradation at the scale and pace required. Innovations in remote sensing, biotechnology, artificial intelligence, and water management are increasingly shaping the "restoration economy", creating new markets, improving monitoring, and enabling more cost-effective interventions.

Yet, while these tools carry enormous potential, their deployment must be assessed in light of institutional, financial, and capacity barriers, especially in developing countries. High upfront costs, limited technical expertise, and weak enabling infrastructure often constrain the adoption of many technologies. As such, adoption must be phased and context-specific, with strong emphasis on capacity-building, equitable access, and alignment with local priorities.

This section highlights key emerging and innovative technologies that can drive effective restoration, while also acknowledging their risks, limitations, and enabling conditions. It underscores that innovation should serve as a complement to nature-based approaches and traditional knowledge, not a substitute for them.

3.1 Remote Sensing and Geospatial Technologies

Remote sensing and geospatial tools form the indispensable foundation for modern land monitoring, assessment, and restoration planning. They provide unparalleled capacity to understand degradation dynamics, identify intervention sites, and rigorously track outcomes at local, regional, and global scales.

3.1.1 Satellite Imagery and Data Analytics

Satellite technologies and advanced data analytics are revolutionising land monitoring by offering continuous, high-resolution, and large-scale coverage:

- High-Resolution Satellite Imagery: Publicly accessible constellations (e.g., Sentinel, Landsat) and commercial providers (e.g., Planet Labs, Maxar) now deliver increasingly fine-grained imagery. These datasets allow precise mapping of land cover change, vegetation health (via indices such as NDVI), soil moisture, and land surface temperature. Such insights enable the prioritisation of degraded areas and long-term monitoring of ecological recovery

- Change Detection Algorithms: Powered by AI and machine learning, advanced algorithms analyse time-series data to detect subtle land condition changes, identify degradation hotspots, and evaluate restoration impacts. These tools strengthen adaptive management by providing near-real-time feedback.
- Digital Elevation Models (DEMs): Satellite-derived DEMs supply critical topographic data for hydrological modelling, erosion risk assessment, and water-harvesting design (e.g., contour bunds, check dams, terracing). This supports more climate-resilient infrastructure in restoration sites.
- Global Land Cover and Use Mapping: Continuous data streams underpin updated global and regional land cover maps, providing baselines against which degradation and restoration progress can be quantified. This strengthens reporting under frameworks such as the UNCCD's Land Degradation Neutrality Target Setting Programme.

3.1.2 Drones for Mapping, Monitoring, and Application

Unmanned Aerial Vehicles (UAVs), or drones, are increasingly valued for their flexibility, affordability, and ultra-local precision in restoration:

- High-Precision Mapping: Equipped with multispectral sensors, LiDAR, or high-resolution cameras, drones can produce 3D models and vegetation health assessments at the site scale, allowing for highly targeted interventions.
- Real-Time Monitoring: Frequent drone surveys provide granular updates on indicators such as vegetation growth, erosion, and water retention, enabling responsive and adaptive management.
- Precision Seeding and Application: Specialised drones can disperse seed pellets, fertilisers, and soil amendments across remote terrain. AI-guided "precision seeding" has demonstrated cost reductions of up to 80% compared to manual methods, while improving survival rates.
- Early Warning Systems: By integrating drone data with satellite imagery, countries can build early warning systems for drought, fire, and pest outbreaks, helping to safeguard restored landscapes and prevent new degradation.

3.2 Artificial Intelligence and Machine Learning

Artificial Intelligence (AI) and Machine Learning (ML) are transforming the way land degradation is analysed, predicted, and managed. By moving beyond descriptive analysis to predictive and prescriptive capabilities, these technologies can enhance restoration planning, optimise resource allocation, and strengthen adaptive management. When combined with local knowledge and NbS, AI and ML become powerful complements rather

than substitutes, but their adoption requires careful consideration of capacity, cost, and data governance.

3.2.1 Predictive Modelling and Optimisation

AI and ML tools enable proactive planning and risk management by analysing large, multi-dimensional datasets:

- Degradation Forecasting: Algorithms integrate climate histories, soil profiles, land-use change, and socio-economic drivers to identify areas most vulnerable to degradation, allowing preventative interventions.
- Restoration Success Prediction: Models estimate the likelihood of different interventions succeeding under specific conditions, guiding investment toward the most cost-effective strategies.
- Climate Change Impact Assessment: Scenario models explore how shifting rainfall, temperature, and extreme events may affect land health and ecosystem services, helping design climate-resilient restoration projects.

3.2.2 Automated Decision Support Systems

AI-powered systems streamline the design and management of restoration initiatives by integrating real-time data with optimisation tools:

- Automated Site Selection: Multi-criteria analysis combines environmental and socio-economic variables to identify optimal locations for activities such as reforestation, water harvesting, or soil remediation.
- Resource Optimisation: ML tools balance seedlings, water, labour, and capital inputs to maximise ecological outcomes while minimising costs and waste.
- Real-Time Anomaly Detection: Continuous monitoring of satellite, drone, and IoT data enables the early detection of vegetation stress, erosion patterns, pests, or fires, allowing rapid corrective action.

3.2.3 Expanding Applications and Safeguards

Beyond planning and monitoring, AI and ML can play wider roles across restoration systems, but require strong safeguards:

- Enforcement and Compliance: Image recognition can help detect illegal clearing or non-compliance with restoration obligations.
- Stakeholder Engagement: Dashboards and visualisation tools simplify complex datasets, enabling inclusive decision-making with communities and local authorities.
- Capacity and Equity Considerations: Adoption must be phased and context-specific, with training, affordability, and data sovereignty central to deployment strategies.

- Safeguards: Clear frameworks for data privacy, Indigenous rights, and voluntary and mutually agreed terms of technology transfer are essential to ensure that AI/ML empower communities rather than displaces them.

3.3 Biotechnology and Ecological Engineering

Biotechnology and ecological engineering offer targeted interventions to enhance soil health, bolster plant resilience, and restore essential ecosystem functions. When applied responsibly and in alignment with international frameworks such as the CBD and the Cartagena Protocol on Biosafety, these tools can complement nature-based solutions by addressing specific ecological challenges. Their effective use requires science-based risk assessment, strong enabling conditions, and equitable access through capacity-building and technology transfer.

3.3.1 Bioremediation and Soil Enhancement

Bioremediation and soil enhancement techniques harness biological processes to restore degraded soils and contaminated landscapes. By rebuilding soil fertility, structure, and water retention, they create the foundation for sustainable ecosystem recovery.

- Microbial Biotechnology: Strategic use of beneficial microorganisms (e.g., mycorrhizal fungi, nitrogen-fixing bacteria, phosphate-solubilising bacteria) to enhance nutrient cycling, soil structure, and water retention in degraded landscapes.
- Phytoremediation: Use of hyperaccumulator plant species to absorb, stabilise, or transform pollutants (e.g., heavy metals, hydrocarbons), rendering land suitable for broader ecological restoration.
- Biochar Application: Incorporating biochar into soils enhances carbon sequestration, improves water-holding capacity (especially in arid regions), and increases nutrient availability, boosting soil fertility and plant productivity.
- Hydrogels and Soil Conditioners: Application of polymers and natural compounds improves soil aggregation and moisture retention, critical for dryland restoration and seedling establishment.

3.3.2 Drought-Resistant Species and Genetic Engineering

As climate stress intensifies, drought-resistant species and advanced breeding techniques become increasingly crucial to the success of restoration efforts. These methods must be applied in a science-based, transparent, and context-specific manner, while also respecting cultural values and international biosafety agreements.

- Native Species Propagation: Advanced propagation methods (e.g., tissue culture, micropropagation) support the mass cultivation of locally adapted, climate-resilient native species, ensuring ecological compatibility and long-term success.

- Genetic Improvement: Through science-based non-GMO breeding programmes and, where appropriate, advanced techniques such as gene editing, new varieties can be developed with enhanced drought tolerance, pest resistance, and nutrient efficiency. Such innovations must undergo robust, science-based risk assessment in line with Articles 15 and 16 of the Cartagena Protocol.
- Seed Banks and Cryo-Conservation: Expanding seed banks and cryo-conservation facilities safeguard biodiversity and ensure access to diverse genetic resources for future restoration. This requires enhanced technology transfer, scientific and technical cooperation, and capacity-building, particularly in developing countries, to establish and maintain adequate infrastructure.

3.4 Advanced Water Management Technologies

Water scarcity is both a major driver and a consequence of land degradation, particularly in arid and semi-arid regions. Effective water management is therefore indispensable for restoration. New technologies, such as precision irrigation and fog harvesting, can enhance water efficiency and availability; however, their deployment must be carefully integrated into local ecological and societal contexts. Restoration interventions that ignore hydrological realities risk unintended impacts such as groundwater depletion, salinisation, or inequitable water access. Integrating traditional knowledge with modern innovations offers the most sustainable pathway.

3.4.1 Smart Irrigation Systems

Smart irrigation systems integrate advanced technologies to maximise water use efficiency in restoration projects. By combining real-time data, precision delivery, and water recycling, they ensure that scarce water resources are used effectively. This is especially critical for plant establishment and growth in arid and water-stressed landscapes.

- Sensor-Based Irrigation: In-situ soil moisture sensors, real-time weather stations, and evapotranspiration models provide precise data on plant water needs. This enables the optimisation of irrigation schedules, avoiding overuse and ensuring water reaches the roots efficiently, which is crucial for high-value restoration nurseries and early establishment phases.
- Drip and Micro-Irrigation: These systems deliver water directly to plant root zones, minimising evaporation and runoff. When integrated with sensor technologies, they further improve the efficiency and resilience of restoration efforts in drylands.
- Recycled Water Technologies: Advanced wastewater treatment now enables safe reuse of treated municipal or agricultural water in restoration. This conserves freshwater supplies and supports circular water economies, provided local regulations and safeguards are observed.

3.4.2 Water Harvesting and Desalination Innovations

Water harvesting and desalination are expanding the portfolio of solutions for water-stressed regions. However, their effectiveness depends on ecological feasibility, long-term maintenance, and socio-economic context.

- Passive Water Harvesting Structures: Modern hydrological engineering, supported by remote sensing data, enhances traditional methods such as terracing, check dams, and runoff diversion. These interventions strengthen soil moisture infiltration, recharge aquifers, and mitigate erosion when tailored to local topography and rainfall patterns.
- Fog and Dew Collection: In coastal or mountainous regions prone to fog, mesh or net-based collection systems can provide supplementary water sources for young plants and communities. While highly context-specific, such systems can diversify local water portfolios.
- Small-Scale, Renewable Energy-Powered Desalination: Advances in membranes and renewable energy (solar, wind) enable modular desalination units. While still costly, they can provide critical freshwater for nurseries and early planting in coastal drylands. Their viability should be carefully evaluated, given their high energy needs and risks associated with brine disposal.

3.5 Sustainable Land Management Practices

Sustainable Land Management (SLM) practices have long been integral to restoration strategies. What is changing rapidly is the integration of proven practices with advanced technologies, which significantly enhances their scalability, precision, and resilience. By combining digital tools, ecological knowledge, and innovative infrastructure, SLM now represents a bridge between agricultural productivity, ecosystem restoration, and climate adaptation. Importantly, these practices must be adapted to local ecological, cultural, and socio-economic contexts to ensure that technological interventions strengthen, rather than displace, community-based land stewardship.

3.5.1 Precision Agriculture and Agroforestry

Precision agriculture and agroforestry are transforming how productive landscapes are managed and restored. Advanced data analytics, automation, and targeted interventions enable the enhancement of resource efficiency, reduction of environmental impacts, and increased yields, while simultaneously delivering ecological benefits.

- Variable Rate Technology (VRT): GPS- and sensor-enabled systems allow for precise application of seeds, fertilisers, and water, ensuring resources are applied only where and when needed. This reduces environmental impact and maximises yield efficiency, especially in landscapes that integrate agroforestry or restoration crops.

- Digital Farm Management Platforms: Integrated platforms combine weather data, soil sensor outputs, satellite imagery, and market intelligence to provide comprehensive decision support. These tools allow farmers and restoration managers to plan sustainable crop rotations, design resilient agroforestry systems, and align land management with climate-smart strategies.
- Robotics in Agriculture: Autonomous vehicles and drones increasingly support restoration-linked farming through targeted planting, precision weeding, and selective harvesting. These innovations lower labour costs, improve efficiency, and facilitate large-scale reforestation or mixed-use landscape restoration.

By blending technology with ecological restoration approaches such as agroforestry, these practices enhance both food security and ecosystem resilience.

3.5.2 Climate-Resilient Infrastructure

Climate-resilient infrastructure provides the backbone for sustaining restored landscapes and protecting vulnerable communities. By combining engineered solutions with nature-based approaches, these interventions reduce vulnerability to hazards, safeguard restoration investments, and deliver multiple environmental and social co-benefits.

- NbS with Engineering: Bioengineered embankments, constructed wetlands, and urban green infrastructure combine ecological and structural approaches. For example, wetlands not only treat wastewater but also enhance biodiversity, while green roofs and corridors reduce urban heat and manage stormwater. The IUCN Global Standard for NbS offers a widely recognised benchmark for ensuring these projects deliver measurable ecological and social outcomes.
- Green Infrastructure Development: Designing and implementing networks of natural and semi-natural areas in urban and peri-urban contexts (e.g., parks, permeable surfaces, urban forests) provides ecosystem services that reduce heat, mitigate flooding, and restore soils, while supporting biodiversity and human well-being.
- Early Warning Systems for Climate Hazards: Integrating meteorological data, satellite imagery, and AI-driven analytics enables real-time monitoring and early warning for floods, droughts, and landslides. These systems allow proactive interventions that protect both communities and restored landscapes.

3.6 Adoption Pathways and Readiness Conditions

Emerging technologies such as AI, remote sensing, and bio-innovations offer significant opportunities to accelerate land restoration, but their adoption is highly context-dependent. Developing countries in particular often face persistent challenges related to capacity, financing, and long-term operation and maintenance. If these constraints are not addressed, technologies risk remaining pilot projects that cannot be sustained or scaled.

A phased and context-specific approach is therefore essential. Rather than assuming universal applicability, the readiness of local institutions should guide technological choices, as well as the availability of skills and finance, and the cultural and social acceptance of the solutions. This ensures that restoration interventions are not only technically sound but also politically legitimate, socially inclusive, and financially viable.

By embedding readiness assessments and incremental scaling into the innovation agenda, countries can move from experimentation to widespread adoption, reducing risks and maximising benefits. The following table, Table 1, outlines the key actions, enabling conditions, and illustrative examples for each stage of this adoption pathway, highlighting how risks can be managed and effectiveness maximised.

Table 1: Phased Adoption Pathway for Restoration Technologies – Key Actions, Enabling Conditions, and Illustrative Examples

Phase	Key Actions	Enabling Conditions	Illustrative Examples
Phase 1 – Readiness Assessment	• Conduct country- and community-level diagnostics of needs and restoration priorities. • Map institutional capacity, financing availability, and social acceptance.	• Political commitment and clear land tenure. • Basic digital infrastructure and extension services.	Baseline mapping of degraded land in Sahel countries using open-source satellite imagery.
Phase 2 – Piloting & Capacity Building	• Test priority technologies at small scale with close monitoring. • Provide training to local institutions and communities. • Establish O&M systems and financing plans.	• Targeted capacity-building programs. • Seed funding and technical assistance. • Partnerships with universities, SMEs, and NGOs.	AI-driven irrigation pilots in Morocco; drone seeding trials in India supported by state forestry agencies.
Phase 3 – Scaling with Finance & Policy Integration	• Expand successful pilots through blended finance models. • Integrate proven technologies into national restoration strategies. • Foster private sector engagement and long-term service contracts.	• Access to MDB and climate fund resources. • Supportive national policy frameworks. • Market demand for ecosystem services (e.g., carbon, biodiversity credits).	Community-led forest monitoring in Kenya scaled up through government-NGO partnerships.

This phased approach recognises that no single pathway fits all contexts. By sequencing adoption according to readiness and drawing on successful case studies, countries can ensure that restoration technologies are both practical and sustainable. The G20 can support this process by promoting knowledge exchange, mobilising finance through existing institutions, and encouraging context-sensitive deployment strategies.

3.7 Risks, Limitations, and Unintended Consequences of Technological Interventions

Technological innovations hold transformative potential for scaling up land restoration, but they are not without risks. Recognising these risks, limitations, and unintended consequences is crucial to ensuring that technologies complement, rather than substitute for, sound ecological practices, community rights, and broader policy frameworks. Achieving balance requires context-specific deployment, inclusive governance, and adherence to international obligations, particularly under the CBD and its Cartagena Protocol on Biosafety.

3.7.1 Equity and Access Gaps

Advanced technologies often demand substantial financial investment, skilled technical expertise, and supportive infrastructure. For many smallholder farmers, Indigenous Peoples, and least developed countries, these requirements remain prohibitive. If not accompanied by adequate capacity-building, financial support, and technology transfer on a voluntary and mutually agreed-upon basis, innovations risk widening inequalities, creating dependence on external providers, and undermining local ownership.

3.7.2 Technological Dependence and Maintenance Challenges

High-tech tools, such as drones, sensor-based irrigation systems, or AI-driven decision platforms, require reliable power, connectivity, and specialised maintenance. In remote or resource-constrained areas, these prerequisites may be absent, resulting in equipment failures or underutilisation. Strengthening local capacity for operation and maintenance is essential to avoid wasted investments and ensure long-term sustainability.

3.7.3 Ecological Risks of Bioengineering and Modified Species

The introduction of genetically engineered or drought-resistant species can strengthen resilience, but it also raises ecological concerns. These include the risk of invasiveness, genetic interaction with native species, or disruption of local ecosystems. However, it is important to note that such risks are already addressed under existing international frameworks. The CBD and its Cartagena Protocol (Secretariat of the Convention on Biological Diversity, 2000) on Biosafety have adopted robust decisions to guide science-based risk assessment and management of Living Modified Organisms (LMOs), as outlined

in Articles 15 and 16 of the Protocol. Ensuring compliance with these obligations helps avoid duplication and reinforces confidence in the safe deployment.

3.7.4 Data Privacy, Ownership, and Sovereignty Concerns

Remote sensing, drones, and AI generate vast amounts of spatial and ecological data. The absence of clear governance frameworks creates risks related to data privacy, misuse, and the erosion of community sovereignty over land-use information. Protecting the data rights of Indigenous and local communities and respecting national sovereignty are essential. To address these concerns, data-sharing frameworks must emphasise transparency, prior informed consent, and safeguards against misuse.

3.7.5 Environmental Footprint of Emerging Technologies

Certain restoration technologies present environmental trade-offs:

- Desalination units can produce concentrated brine waste that poses risks to coastal and marine ecosystems.
- Biochar production, if based on unsustainably sourced biomass, may contribute to deforestation or localised air pollution, counteracting restoration objectives.

Mitigation measures must ensure that new technologies do not undermine the very ecosystems they aim to restore.

3.7.6 Carbon and Biodiversity Market Risks

Carbon and biodiversity credits are increasingly seen as financing tools for restoration. However, their premature use risks offsetting, greenwashing, and misrepresentation of ecological outcomes. Concerns include:

- Inaccurate or unverified measurement and reporting of restoration outcomes.
- Commodification of ecosystem services, which may shift focus towards marketable outputs at the expense of holistic ecological and social objectives.

Given the preliminary stage of biodiversity credit schemes and the widespread concerns, their use should be approached with caution, ensuring robust monitoring, transparency, and safeguards against misuse.

3.7.7 Scalability vs. Context-Specific Effectiveness

Many technologies are designed for large-scale efficiency, yet land restoration often requires fine-tuned, locally adapted approaches. Applying generic solutions risks overlooking ecological complexity, cultural values, and local livelihoods. Restoration strategies should therefore be co-developed with communities, ensuring that technologies enhance, rather than override, traditional practices and local knowledge.

3.7.8 Over-Reliance on Technological Solutions

Framing land degradation primarily as a technological challenge risk ignoring its deeper systemic drivers: insecure land tenure, weak governance, inequitable access to resources, and socio-political marginalisation. Technology can support, but not replace, reforms in governance, policy, and social equity that underpin lasting restoration.

3.8 Challenges and Enabling Conditions for Technology Adoption in Land Restoration

Technological innovation alone cannot guarantee the success of land restoration. Its effectiveness depends on the broader socio-cultural, institutional, and political economy contexts in which it is deployed. Removing barriers and strengthening enabling conditions are therefore essential to realise the full potential of technology in advancing restoration goals.

3.8.1 Socio-Cultural Barriers to Technology Adoption

Despite their technical potential, restoration technologies often face resistance rooted in socio-cultural contexts:

- Traditional Knowledge and Practices: Communities may prioritise well-established land management practices. If new technologies are introduced without respecting or integrating local knowledge systems, uptake is likely to remain low.
- Perceptions and Trust: Lack of trust in externally developed technologies, especially those with limited local demonstrations, can hinder adoption. Participatory pilots and co-designed demonstrations help build confidence.
- Gender and Social Inclusion Constraints: Women, youth, Indigenous groups, and marginalised communities often lack equal access to financing, training, and extension services. Without targeted measures, new technologies risk reinforcing inequalities.
- Ownership and Benefit-Sharing Concerns: When local communities do not see clear, equitable benefits or ownership opportunities, adoption rates remain low, jeopardising long-term sustainability.

3.8.2 Technology Transfer Challenges and Intellectual Property Issues

Technology transfer is central to global restoration efforts, but it must occur on voluntary and mutually agreed-upon terms, as consistently reaffirmed in multilateral processes. Challenges and enabling practices include:

- Intellectual Property (IP) Systems: Some stakeholders raise concerns about the costs and accessibility of proprietary technologies. It is important to recognise, however, that

intellectual property rights are designed to stimulate innovation and enable technology diffusion. Access barriers that do exist are often context-specific, and solutions include voluntary licensing, patent pools, public-private partnerships, and open-source models, rather than weakening IP frameworks.

- The DeserTech Model: An emerging example from dryland regions, this model emphasises co-creation, co-development, and co-ownership of technologies with local entrepreneurial ecosystems, ensuring adaptation to specific ecological and socio-economic contexts.
- Co-Creation and Co-Ownership: Successful transfer requires inclusive participation across design, piloting, and scaling phases. This approach enhances local stewardship, builds technical capacity, and strengthens social acceptance.
- Return on Investment Timelines: Many restoration technologies require long ROI horizons, often ranging from 7–15 years for landscape-scale interventions. Public incentives, including concessional finance, payments for ecosystem services, or blended finance schemes, are necessary to bridge gaps and encourage private sector participation.

3.8.3 Institutional Capacity Requirements

Institutional capacity is critical for technology deployment and scaling:

- Technical Skills and Workforce Development: Significant gaps persist, even in advanced economies, in operating AI platforms, drones, and precision irrigation systems. Capacity-building and vocational training are essential.
- Policy and Regulatory Frameworks: Effective adoption requires clear, enabling regulatory frameworks for safe and equitable deployment, including streamlined permitting processes and adherence to environmental safeguards.
- Maintenance and Operational Capacity: Lack of local repair and servicing ecosystems can lead to equipment failures. Building local manufacturing and repair capacity ensures long-term sustainability.
- Extension Services: Strong, well-resourced extension systems are necessary to bridge the gap between innovation and community-level adoption. Yet in many countries, these remain underfunded or fragmented.

3.8.4 Political Economy Factors Affecting Implementation

The broader political and economic landscape often shapes technology adoption more than the innovations themselves:

- Taxes and Subsidies: Distortions arise where subsidies for conventional inputs (e.g., fertilisers) or tariffs on technology components discourage the adoption of sustainable alternatives.

- Resource Constraints: Limited availability of water, skilled labour, or raw materials can restrict adoption, even where technology is available.
- Incentives for Adoption: Well-designed schemes, such as payments for ecosystem services, tax credits, or direct subsidies, can lower entry barriers and accelerate uptake.
- Governance and Coordination: Fragmented mandates and weak intersectoral coordination remain significant challenges. Multi-stakeholder frameworks, such as the UNCCD Model Framework for Technology Transfer, offer pathways for strengthening coherence and avoiding duplication.

3.8.5 Political Economy Factors Affecting Implementation

Building on the preceding discussion of risks and limitations, Table 2 distils the key barriers that currently constrain innovation uptake and identifies practical enablers, many of which can be advanced through existing institutions and funds rather than new structures.

Table 2: Barriers to Technology Adoption in Land Restoration and Potential Enablers

Barrier Category	Typical Challenges	Illustrative Solutions / Enablers	Role of Existing Institutions
Financial	High upfront costs; limited risk appetite; fragmented smallholder demand; lack of collateral	Blended finance (public + private); risk-sharing facilities; aggregation models (coops, producer orgs); concessional lending for SMEs	Development banks and green finance facilities can extend guarantee schemes and channel concessional funds through local banks rather than setting up new vehicles
Regulatory / Policy	Slow permitting for biotech and nature-based infra; unclear tenure; lack of standards for credits/MRV	Streamlined regulatory approvals; land tenure reforms; harmonised MRV standards (carbon, biodiversity, land)	Ministries and existing multilateral standards bodies (UNCCD, VERRA, ISO) can be empowered instead of creating parallel authorities
Institutional Capacity	Limited extension services; weak local O&M systems; donor-driven pilots without continuity	Capacity building for local institutions; public procurement for innovative solutions; long-term service contracts	Strengthen extension agencies, farmer training schools, and municipal authorities; tap into the existing UNCCD Capacity Building Marketplace
Market / Demand-side	Low willingness/ability to pay; uncertain revenue streams from ecosystem services; volatile carbon/biodiversity markets	Advance purchase agreements (APAs); floor-price facilities for credits; corporate offtake commitments	Use multilateral climate/biodiversity funds to underwrite APAs via accredited entities

Barrier Category	Typical Challenges	Illustrative Solutions / Enablers	Role of Existing Institutions
Data / Knowledge	Lack of local MRV skills; fragmented datasets; low digital literacy	Open-access platforms; capacity in remote sensing and AI; interoperable data standards	FAO, GEO-LDN, and national stat offices can act as hosts instead of standing up new entities
Social / Equity	Exclusion of women, youth, and IPLCs; risk of elite capture; low trust	Inclusive governance; FPIC protocols; co-design processes; local ownership targets	Embed equity safeguards into existing funding guidelines (GEF, GCF, IFAD)

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

As the G20 continues to deliberate on strategies to achieve Land Degradation Neutrality (LDN), climate resilience, and biodiversity goals, it is critical to consider approaches that promote technology and innovation while aligning with national priorities and capacities. This section proposes debates, positions, issues, and recommendations that could guide consensus-building under the 2025 G20 round, providing insights into available policy choices and their potential trade-offs.

4.1 Debates and Issues for Consideration

4.1.1 Technology Transfer and Local Innovation

- Debate: Should the G20 prioritise direct technology transfer from advanced economies to developing countries, or focus on strengthening local innovation ecosystems?
- Policy considerations: Technology transfer must occur on voluntary and mutually agreed terms, consistent with multilateral frameworks. Direct transfer accelerates deployment but risks dependency if local capacity is underdeveloped. Supporting local innovation fosters long-term resilience and self-reliance, but it requires upfront investment in research and development (R&D), vocational training, and enabling ecosystems. A hybrid approach, where transfer is paired with co-creation, local adaptation, and capacity building, is likely to be the most sustainable.

4.1.2 Financing Restoration Technologies

- Debate: Should public finance focus on de-risking private sector investment in restoration technologies, or on direct public implementation programmes?
- Policy considerations: De-risking through blended finance can catalyse scalable private investment but requires strong safeguards to ensure environmental integrity and equitable benefits. Direct public programmes guarantee action but may lack long-term financial sustainability. The G20 can add value by:

- Promoting coherence and alignment across existing mechanisms (e.g. GEF, GCF, MDBs) rather than calling for new funds.
- Supporting partnerships that combine concessional finance with private capital, lowering entry barriers for smallholders and local enterprises.

4.1.3 Nature-Based Solutions vs. Technological Interventions

- Debate: How can the G20 frame the complementarity between NbS and technological innovations in land restoration policies?
- Policy considerations: Earlier drafts framed NbS and technological interventions as competing approaches. A more balanced view is needed:
  - NbS (e.g. agroforestry, ecosystem regeneration) deliver multiple co-benefits but may yield results more slowly.
  - Technological innovations (e.g. drones, AI, drought-resistant species) can accelerate productivity but may carry ecological or social risks if not context-specific.
  - When well-integrated, technologies can enhance NbS; for example, drones supporting forest regeneration, or AI improving watershed management. However, interventions that heavily modify ecosystems should be subject to science-based risk assessments (consistent with the CBD and Cartagena Protocol).

4.1.4 Global Standards for Restoration Technologies

- Debate: Should the G20 play a role in shaping standards and safeguards for restoration technologies?
- Policy considerations: There is broad agreement that standards and safeguards are essential, but care must be taken to avoid duplication of existing multilateral processes (e.g. CBD, Cartagena Protocol, IUCN NbS Global Standard).
- The G20's role could focus on:
  - Promoting knowledge exchange and best practices rather than developing new binding standards.
  - Encouraging the use of existing global references (e.g. WOCAT database, IUCN NbS Global Standard).
  - Supporting adaptation of safeguards to local contexts, ensuring community rights, biodiversity protection, and equitable benefit-sharing.

4.1.5 Business Models for the Restoration Economy

- Debate: What types of business models should be prioritised to drive the restoration economy?
- Policy considerations:

- Service-based models (e.g. “restoration-as-a-service”) can deliver at scale but may limit local ownership.
- Product-oriented models (e.g. biochar, seed technologies) build market value chains but depend on strong logistics and demand.
- Community-led enterprises enhance livelihoods, social equity, and cultural integrity but face challenges in scaling.
- Blended multi-actor models combine the strengths of each but require sophisticated governance and financing.

The G20 could encourage inclusive business models that integrate SMEs, local cooperatives, and indigenous-led enterprises into value chains, reinforcing the social legitimacy of the restoration economy.

4.2 Strategic Recommendations

To effectively harness new and emerging technologies for scaling up land restoration and achieving LDN, the UNCCD Global Mechanism (GM), in collaboration with the G20 Global Land Initiative and partners, should adopt a strategic, streamlined approach.

To focus attention on the most impactful and realistic outcomes, the recommendations are consolidated into five priority areas. The table below highlights not only the actions but also the distinct value-added that the G20 can bring, complementing rather than duplicating the roles of the UNCCD, MDBs, and the G20 Land Initiative.

Table 3: Priority Areas for G20 Value-Add in Advancing Land Restoration

Priority Area	G20 Value-Add (Distinct from UNCCD, MDBs, & G20 Land Initiative)
Finance & Investment	Signal to finance ministries, MDBs, GCF/GEF, IFAD, and bilateral donors to prioritise land restoration; promote coherence and de-risking instruments without creating new funds. Encourage the use of aggregation models to lower costs for SMEs and smallholders.
Standards, Metrics & MRV	Convene G20 members to endorse common restoration metrics (land productivity, carbon, biodiversity, co-benefits). Promote low-cost, interoperable monitoring systems. Build trust for ecosystem service markets.
Institutional Capacity & Governance	Use the G20 political platform to align ministries (agriculture, environment, finance, infrastructure) and strengthen governance. Signal importance of tenure security, streamlined regulations, and long-term O&M capacity.
Knowledge, Culture & Community Leadership	Elevate traditional knowledge, Indigenous Peoples, women, youth into the global agenda. Back South–South, North-South, and community-led innovation platforms. Ensure restoration strategies have political legitimacy and social inclusion.

Priority Area	G20 Value-Add (Distinct from UNCCD, MDBs, & G20 Land Initiative)
Political Leadership & Strategic Alignment	Clarify complementarity between the G20 Presidency (political convening) and the G20 Land Initiative (technical delivery). Position land restoration as a cross-cutting G20 agenda linked to food, climate, and biodiversity. Ensure alignment with UNCCD COP and other UN processes.

The following subsections elaborate on each priority area, outlining the specific actions and audiences where G20 leadership can catalyse system-wide impact.

4.2.1 Policy and Regulatory Alignment

Recommendation 1: Develop and Harmonise National Frameworks for Technology Adoption -- Support UNCCD Parties in developing policies, laws, and regulatory frameworks that enable the responsible deployment of restoration technologies. This includes:

- Streamlining permitting processes (e.g., drones, bioremediation trials).
- Establishing clear data governance, ownership, and sharing rules, while safeguarding intellectual property rights.
- Embedding technology adoption targets in National Action Programmes (NAPs).

Recommendation 2: Promote International Best Practices and Safeguards -- Instead of creating new standards, the GM should facilitate the exchange of best practices, drawing on existing international references (FAO, ISO, IUCN Global NbS Standard). This ensures safeguards for biodiversity, equity, and community rights while allowing flexibility for national contexts.

4.2.2 Catalysing Investment and Financial Mechanisms

Recommendation 3: Scale Up Blended Finance to De-Risk Private Sector Investment -- Prioritise blended finance models that combine concessional public finance with private capital. These should:

- Lower entry barriers for SMEs, smallholders, and local cooperatives.
- Safeguard environmental and social integrity through transparent monitoring.

Recommendation 4: Leverage Existing Funds, Not Create New Mechanisms -- Maximise coherence by mobilising resources through existing facilities (e.g., GEF, GCF, MDBs, GBF Fund, LEAF Coalition), avoiding duplication and fragmentation.

Recommendation 5: Strengthen Integrity of Carbon and Biodiversity Markets -- Support development of robust, transparent methodologies for measuring, reporting, and verifying outcomes. This ensures restoration projects can access carbon and biodiversity finance without risking offsetting or greenwashing.

4.2.3 Strengthening Research, Development, and Demonstration (RD&D)

Recommendation 6: Invest in Pilots and Demonstration Projects -- Support diverse pilot projects that validate technologies under different ecological and socio-economic conditions. Prioritise participatory approaches that co-create solutions with local communities.

Recommendation 7: Advance Demand-Driven Research and Innovation -- Foster interdisciplinary and transdisciplinary research tailored to real-world challenges, with a focus on affordability, scalability, and locally adapted solutions.

4.2.4 Promoting Knowledge Management and Dissemination

Recommendation 8: Strengthen Knowledge Platforms and South–South plus North-South Exchange -- Enhance the Global Restoration Information Hub to serve as a one-stop repository for case studies, handbooks, and toolkits. Facilitate South–South, North-South, and Triangular Cooperation to exchange locally developed, cost-effective technologies.

Recommendation 9: Build Skills and Institutional Capacity -- Develop targeted training programs for youth, women, and indigenous groups, focusing on technical operation, data interpretation, and project management. Strengthen extension services to connect innovations with communities.

4.2.5 Partnerships and Governance

Recommendation 10: Foster Inclusive Multi-Stakeholder Partnerships -- Encourage partnerships across government, academia, private sector, and civil society to co-develop and scale restoration technologies. Regional innovation hubs can anchor R&D, training, and demonstration efforts.

Recommendation 11: Support SMEs and Community-Led Enterprises -- Provide targeted support (seed funding, mentorship, regulatory facilitation) for SMEs and cooperatives engaged in the restoration economy. This reinforces local ownership and helps diversify markets for restoration-linked products and services.

4.2.6 Creating Enabling Environments for Private Sector Engagement

Recommendation 12: Build Business Cases for Restoration Technologies -- Develop and disseminate sector-specific investment cases that demonstrate the financial, social, and risk-mitigation benefits of restoration technologies, tailored for investors, insurers, and public–private coalitions.

Recommendation 13: Create Dialogue and Collaboration Platforms -- Establish high-level public–private forums to identify investable opportunities, resolve regulatory barriers, and co-develop innovative financing models.

5 CONCLUSIONS AND NEXT STEPS

The G20 has positioned itself as a central convening platform where economic leadership, technological innovation, and environmental ambition intersect. The debates outlined in this report underscore that while technology is an indispensable enabler of land restoration, it cannot substitute for strong governance, equity, and community stewardship.

The recommendations presented call for alignment, not duplication: leveraging existing global financing mechanisms (GEF, GCF), mainstreaming innovation within national policies, and embedding safeguards to ensure that technologies are deployed responsibly. The G20 can add unique value by catalysing blended finance, knowledge exchange, and partnerships that bring together governments, the private sector, research institutions, and communities.

As the world moves closer to 2030, with just five years remaining in the UN Decade on Ecosystem Restoration, the G20 should orient its discussions toward three strategic priorities:

1. Scaling Proven Technologies Responsibly – accelerating the uptake of AI, geospatial systems, biotechnology, and water management innovations, while ensuring safeguards for ecosystems and communities.
2. Financing at Scale – de-risking private sector investment, enabling SMEs and local enterprises to thrive, and ensuring that carbon and biodiversity markets deliver integrity and equitable benefits.
3. Building Capacity and Partnerships – prioritising South–South cooperation, youth and women's leadership, and regional innovation hubs that anchor long-term skills, jobs, and innovation ecosystems.

By embracing these priorities, the G20 can help translate multilateral commitments into tangible, cost-effective, and inclusive action. The forthcoming South Africa 2025 Presidency offers a timely opportunity to consolidate progress, reaffirm the 2020 Global Land Initiative, and anchor land restoration as both an economic opportunity and a global security imperative.

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SHERPA TRACK
Environment and Climate Sustainability Work Group (ECSWG)

Best Practice and Lessons Learned from Large-Scale Restoration Projects

A review of published literature

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[1] *This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.*

EXECUTIVE SUMMARY

This paper synthesizes good practices and key lessons from large-scale land restoration initiatives worldwide, recognizing both the growing urgency of restoration and the complexity of scaling up from local successes. Large restoration projects offer outsized ecological and socio-economic benefits, including enhanced biodiversity, resilience, and support for multiple land uses. However, they also face significant challenges in governance, funding, technical capacity, and stakeholder coordination.

Key success factors include robust governance structures, sustained community engagement, and tailored restoration strategies that incorporate both ecological science and traditional knowledge. The paper stresses that community involvement enhances ownership of the project, conflict resolution, and long-term sustainability. It also critiques the overemphasis on tree planting, advocating for more context-specific approaches such as natural regeneration and adaptive management.

A major obstacle to success is the chronic underestimation of long-term funding needs, especially for monitoring, governance, and project maintenance. There is a need for diversified financing models, including private sector engagement and results-based funding. Lastly, the paper highlights the need for improved monitoring, particularly of socio-economic outcomes, and for greater knowledge sharing to accelerate learning across projects. Successful large-scale restoration requires strategic planning, inclusive participation, and long-term commitment.

1 INTRODUCTION

A great deal of successful restoration happens at a very local scale. However, the extent of degraded land, and the urgency with which we need to address on-going decline makes it imperative that restoration moves from the local to the landscape scale. Scaling-up not only increases the area of land being restored, but the benefits of restoration increase non-linearly with size. For this reason, large restoration projects (individually ≥ 100 hectares or collectively ≥ 10,000 hectares) have become an increasing priority.

Nevertheless, although the benefits of land restoration increase rapidly as projects get bigger, so do the challenges. Large-scale land restoration demands coordinated land use and management across broad areas, typically involving multiple stakeholders and partners. It will often be the case that these people have very different needs and aspirations for restoration of their land, along with different capacities for participation. Large-scale restoration also embraces a range of different habitats and levels and history of land degradation, each requiring its own diagnosis and treatment. This multi-layered mosaic creates new technical, financial, and institutional challenges for land managers.

Scaling-up restoration projects has, in practice, often proved complex and expensive and there is a great deal to learn from the experiences of large projects that have begun in the last two decades. Frustratingly, thorough analyses of large project successes and failures are few and far between and much of the literature is not available to practitioners and policy-makers. The aim of this review is to summarise some of those experiences, as they have been documented in the scientific literature, and distil from them important policy implications.

2 CURRENT MULTILATERAL DELIBERATIONS

At its eleventh meeting held in Hyderabad, India, in 2012, the Conference of the Parties (COP) to the Convention on Biological Diversity adopted a decision inviting relevant organizations to support the compilation and dissemination of case studies, best practices, lessons learned, and information related to the socio-economic aspects and evaluation methods of restoration projects (UNEP, 2012). This decision is a clear commitment to an evidence-based approach to restoration. By analysing past experiences, new projects can avoid repeating mistakes and adopt proven approaches more quickly. The vision is that well-documented successes and challenges inform policy frameworks, enabling supportive legislation, funding, and institutional backing.

The G20 Global Land Initiative (GLI) supports this approach. At their September 2020 meeting, the G20 Environment Ministers committed to strengthening the evidence base to guide collective action and policy development in tackling the global challenge of land degradation. The Global Initiative on Reducing Land Degradation and Enhancing Conservation of Terrestrial Habitats was launched by G20 Leaders in November 2020, during the G20 Saudi Presidency, at the Riyadh Heads of State Summit. Its aim is to support existing efforts to prevent, halt, and reverse land degradation and habitat loss and promote land restoration globally. The initiative seeks to support the G20 Leaders ambition to reduce land degradation by 50 percent by 2040 through the sharing of knowledge and best practices, capacity building, and coordination among G20 and other countries. It focuses on documenting and disseminating successful practices, fostering collaboration, and supporting sustainable land management to ensure food security, biodiversity conservation, and climate resilience.

The G20 GLI, in collaboration with its partners, is developing user-friendly and comprehensive web portals on ecosystem restoration including a Global Restoration Information Hub (https://grih.info/). This hub aims to improve access to and dissemination of documents, case studies, and capacity-building tools.

This review, supported by the G20 GLI, has been compiled in support of the mission to disseminate good practice and lessons learned from large restoration projects.

3 THE VALUE OF LARGE-SCALE RESTORATION

There are enormous social and ecological benefits of scaling up restoration projects. Large areas may better protect rare species, restricted habitats, and key ecological processes, and they will often provide sufficient space to support multiple land-uses and their associated ecosystem services.

Rare species typically inhabit a landscape as a metapopulation, or several spatially separated subpopulations that interact through migration and dispersal. If a subpopulation goes extinct, its habitat patch may be recolonized by dispersal from other patches. Larger areas contain more and larger habitat patches and this is likely to increase the number of subpopulations, which enhances the overall metapopulation stability. As a result, large, restored areas provide significantly greater resilience for the species that inhabit them.

Natural disturbances such as fires, floods, storms, or predation, play a crucial role in shaping ecosystems. They help maintain nutrient cycles, regulate species competition, and create habitat heterogeneity that supports biodiversity. In small or fragmented areas, disturbances can quickly affect the entire project or come into conflict with nearby land uses (e.g., agriculture or infrastructure). Key ecological processes, particularly disturbance processes, often require a minimum viable area to permit them to operate at their normal magnitude and frequency. After a disturbance, recovery often depends on recolonization from nearby undisturbed patches. In large areas, these source populations are more likely to be present, allowing natural regeneration and ecological succession to occur without the need for human restoration.

An iconic example of the need for large, restored areas, is the experimental re-establishment of tallgrass prairie in an abandoned field, begun in 1936 at the UW–Madison Arboretum. The experiment was one of the first to study the factors influencing the recovery of degraded land and how deliberate interventions could accelerate recovery. One of its most important conclusions was the great value in attempting restoration over large areas. It demonstrated the importance of occasional bison grazing in balancing the competition between forbs and the dominant grasses (Edwards, 1976) and the need for a large enough area to support an itinerant herd of bison.

High levels of genetic diversity within populations are generally desirable, as they help ensure long-term genetic sustainability. Since adaptability is closely linked to genetic diversity, maintaining and re-establishing this diversity should be a key focus of restoration efforts, especially in the face of environmental change (Allendorf *et al.*, 2022). Because genetic diversity tends to increase with population size, restoration strategies should aim to protect, nurture, and reconnect as many existing natural populations as possible to re-establish large, diverse, adaptable populations.

Scale enables diversity, not just ecologically, but in stakeholder objectives. If managed strategically. large restoration projects can encompass sufficient spatial heterogeneity to

support multiple land uses and ecosystem services simultaneously. This approach helps minimize conflicts among stakeholders with different priorities. It can enable different land-uses such as conservation, agriculture, tourism, or forestry to be accommodated by zoning, integrating, or sequencing uses, based on ecological suitability and stakeholder needs.

Integrated landscape management (ILM) approaches involve stakeholder collaboration to coordinate multiple land uses across a landscape in a way that supports both ecological integrity and human development. ILM assists the multiple stakeholders that use a particular landscape to understand the interconnections between their various uses of the land, identify opportunities for business development and manage potential conflicts. The rapid transformation of rangelands in Ethiopia (Aman *et al.*, 2024) showcases what can be achieved by combining innovative techniques, collaborative effort and community engagement.

4 GOVERNANCE

Good project governance is essential for all projects and becomes even more critical as their scale and complexity grow. It is essential for ensuring accountability and hence the on-going support of project sponsors. One of the main challenges in large restoration projects is sustaining funder confidence and support over the long timelines required for successful implementation.

Successful projects have well-defined decision-making structures in which roles, responsibilities, and authority levels are clearly articulated. It can take a lot of time, prior to the start of a project, to understand and build on existing governance structures, and project timescale rarely permit this to be done thoroughly (Chazdon *et al.*, 2021). In a survey of 27 large projects in the UK, Adams *et al.* (2016), found that partnerships took significant time to create and those that were successful, required resilience in the face of different organizational practices, staff turnover, and short-term funding. Experience suggests that local institutions may lack the mandate or experience to manage large restoration projects, necessitating new governance structures or partnerships. Progress with implementing the ambitious vision of the African Union's Great Green Wall Initiative varies significantly between countries, largely due to differences in governance, capacity, and institutional frameworks (UNCCD, 2020). Countries like Ethiopia and Senegal, which, at the start of the initiative, established clear national GGW agencies and action plans, saw greater implementation success. An obvious lesson-learned is the importance of creating or empowering local governance institutions that have the mandate and capacity to manage a complex project and are properly accountable for doing so.

Large projects are complex because they frequently involve multiple stakeholders, often several land-owners and sometimes several administrative jurisdictions and therefore require the reconciling of different aspirations and the agreeing of trade-offs over objectives (Holl and Brancalion, 2020). Stakeholders may have contrasting views on what constitutes

successful restoration (e.g., economic benefit versus biodiversity). Achieving consensus or cooperative action among stakeholders with different cultural, or economic backgrounds requires extensive negotiation and trust-building, which is time-consuming and resource-intensive.

Large projects may span multiple administrative boundaries, requiring coordination across municipalities, states, or even countries (i.e., Trans Frontier Conservation Areas TFCAs). This can result in differences in the legislative and policy context and variation in funding or other incentives available (Rusinga and Mapira, 2012). Approaches to resolving such difficulties will often be jurisdiction specific, but it is important to be aware of this common pitfall.

Despite the importance of good governance to restoration project success, its quality is rarely assessed as part of project monitoring and assessment (Chazdon *et al.*, 2021). An important lesson learned is that regular reviews of the effectiveness of project governance should be a standard part of project monitoring.

5 GAPS IN TECHNICAL EXPERTISE

Gastauer *et al.* (2020) examined barriers to large-scale forest restoration in the Amazon and highlighted significant knowledge gaps as being a key hurdle to scaling-up restoration. A similar barrier has been identified as constraining restoration projects in Europe (Ockendon *et al.*, 2018) and the African Union's Great Green Wall Initiative (Chevallier and Chesterman, 2022). Detailed ecological knowledge, of species' habitat requirements and barriers to their re-establishment, is invaluable in developing robust management prescriptions.

Global knowledge banks, like the GLI Global Restoration Information Hub (G20 Global Land Initiative, 2024), and libraries of good practice, such as the China–WBG Global Center for Ecological Systems and Transitions (World Bank Group, 2025), are vital for scaling land restoration. They consolidate data, case studies, and technical guidance, enabling evidence-based planning and monitoring. By sharing proven approaches, financing models, and policy frameworks, they accelerate learning across regions and reduce costly trial-and-error. These platforms foster international collaboration, align restoration efforts with global goals, and empower governments, NGOs, and communities to design context-specific, effective, and sustainable solutions for restoring degraded ecosystems at scale.

An important lesson that many technical experts have been slow to learn, is that, although not based on scientific research, many indigenous soil and water management and conservation strategies are highly effective. For example, smallholder farmers in semi-arid Kenya adopt remarkably diverse practices, explained by their naturally diverse and difficult environment and varying resource endowments of land, labour, livestock, and capital. Decades of accumulated experience and experimentation, including tried-and-tested strategies to cope with rare extreme events, demonstrate that there is considerable scope for building on indigenous resource management practices to attain sustainable livelihoods, food security, and land restoration (Tengberg and Stocking, 2019). Nevertheless, in a survey

of 75 restoration projects in Mexico, Méndez-Toribio *et al.* (2021) found that only 38% of the projects relied on collective learning from traditional management as a source of knowledge to generate techniques.

At a landscape scale, ecosystems become more heterogeneous, spanning multiple habitats, land uses, and ecological processes. Different parts of the landscape may require different restoration techniques and goals depending on the type of habitat, the level and history of degradation, and stakeholder objectives. The choice of a suitable restoration strategy requires expert ecological knowledge, and social insight (Ambrose-Oji *et al.*, 2025). A skilled project team will make the right decisions and these and can have a profound impact on the costs of the projects and its likelihood of success.

Skilled project officers play a critical role in the successful implementation of landscape-scale restoration initiatives. They can provide specialised ecological knowledge that may not be readily available to generalist land management advisors, thereby supporting more effective interventions. They can develop long-term, collaborative relationships with landowners, contractors, volunteers, partner organisations, and local communities. The trust that they can build is crucial to project success (Metcalf *et al.*, 2015). Additionally, by delivering training to, contractors, volunteers and local stakeholders and fostering local ecological knowledge, project officers significantly improve the potential for long-term restoration outcomes that extend beyond the duration of the initial project. Despite their pivotal role, experience indicates that securing funding for project officers to support scheme uptake remains considerably more challenging than obtaining resources for direct habitat management.

6 COMMUNITY ENGAGEMENT IS CRITICAL TO SUSTAINABILITY

Most restoration project failures result not from technical breakdowns, but from a lack of community involvement, appropriate governance structures, and proper negotiation of restoration objectives with local stakeholders (Ellison et al., 2020). When local communities are meaningfully involved, they are more likely to take ownership of restoration efforts. This ownership encourages long-term care and protection of restored landscapes, even after external funding or project staff leave. Communities hold rich, place-based knowledge about land use, ecology, and traditional practices that can help ensure restoration strategies are locally appropriate, culturally sensitive, and practical.

Land restoration can provide important socio-economic benefits through the creation of jobs or improving livelihoods. Engaged communities are more likely to see and share in the benefits, which strengthens support and continuation. A detailed review of 97 recent restoration projects in in Latin America and the Caribbean by Coppus *et al.* (2019) found that many land restoration projects follow a top-down approach, often overlooking the interests of local communities. Few projects, except for some of those funded by international donors, focussed on creating local jobs or improving livelihoods. Community members were

rarely involved in the planning stages and were typically engaged only during implementation.

Community engagement can help avert conflict and may enhance social cohesion. Restoration may involve changes in land use, access, or livelihood systems. If not managed inclusively, these changes can lead to conflict over resources. Engagement builds trust, transparency, and consensus, reducing the risk of disputes. Aman *et al.* (2024) described the key lessons learned from the successful Mansa Participatory Rangeland Management Cooperative project in Ethiopia. The project showed that interventions designed around community needs, coupled with active participation and representation, resulted in lasting impact. Resolving land-resource based conflicts through co-management approaches not only promoted environmental rehabilitation but also fostered peace and socio-economic wellbeing.

7 SUSTAINABLE FUNDING

One of the biggest weaknesses in large restoration projects globally, has been the underestimation of the true cost of sustaining a project over timescales sufficient to achieve success. Many projects have focussed on their establishment costs, particularly those of tree planting, and failed to make plans for long-term care and maintenance (Van Winkle *et al.*, 2025). There is often under-investment in the infrastructure and institutions that are necessary to support a major project, including the important preliminary work that must be done to build a consensus on restoration objectives. Scaling-up requires a substantial increase in financial investment, human resources and technical capacity, and these demands can be on-going after the establishment phase of the project. In a major review of forest restoration projects in Latin America, Cole *et al.* (2024) failed to find clear evidence of efficiencies of scale, and practitioners reported that substantial additional investment was needed to maintain projects over a ten-year period. Nearly all projects indicated that significant labour was involved in site preparation and maintenance.

Lack of long-term funding is one of the main reasons why so few large projects have sustained adequate monitoring and evaluation, and consequently, why there are relatively few thorough accounts of lessons learned.

Coppus et al (2019), in an analysis of 97 restoration projects in Latin American and the Caribbean, found that the funding for most large projects came from international donors. These donors typically have demanding accounting and reporting requirements and a number of major projects have lost support because they have been unable to meet these standards. The main challenge in the implementation of the Great Green Wall at the required scale and pace has been accessing funding, especially for financing projects on the ground, but also for the institutional framework required to support the GGW as well the initiatives that improve the effectiveness of finance use and allocation (UNCCD, 2020). Implementation has been constrained by fragmented financing and reliance on short-term,

project-based funding. Long-term investment and results-based finance are recommended for scale-up.

An expansion of projects on the scale necessary to meet global restoration targets will, almost certainly, far out-strip available donor funding. Scaling up of this magnitude will therefore require inputs from the private sector and is most likely to include payments for ecosystem services such as carbon sequestration, biodiversity gain and other ecosystem services (Van Winkle *et al.*, 2025). Companies increasingly understand that land degradation, biodiversity loss, and climate change pose direct risks to supply chains, especially in agriculture, forestry, and infrastructure. Restoring land is now seen not just as a moral imperative, but as a strategic investment to protect long-term business interests. The private sector, if appropriately regulated, can bring innovation, efficiency, and the ability to scale through technology, business models, and global networks. These features will be essential for implementing restoration at the speed and scale required.

8 RESTORATION STRATEGIES

A common response to the call-to-arms of the Bonn Challenge (IUCN, 2014) among governments and international non-profit organisations, has been to announce ever more ambitious tree planting targets e.g. the WEF One Trillion Trees campaign (World Economic Forum, 2020). Martin *et al.* (2021) found that the number of organizations dedicated to tree-planting has increased by 288% in the past 30 years, especially for-profit organizations. Trees are often perceived to be a panacea to land degradation problems, but not all land is suitable for trees (Holl and Brancalion, 2020, Xu, 2011, Cao *et al.*, 2011), and planting trees in naturally treeless environments can harm ecosystems by excluding native species, depleting water resources, making wildfires worse, and even exacerbating global warming (Parr *et al.*, 2024, Hasler *et al.*, 2024).

Whilst well-planned and carefully designed tree planting campaigns could play an important role in land restoration, a one-size-fits-all approach does not work in heterogeneous ecological and socio-economic contexts. Restoring land is not simply a matter of planting trees. It is a long-term process of rebuilding self-sustaining ecosystems, strengthening landscape and community resilience, and creating sustainable livelihoods.

Adaptive management of restoration projects is a very successful approach in this context (Ellison *et al.*, 2020). Management actions are treated as experiments, and outcomes are monitored to learn about the system. Plans are adjusted over time based on new knowledge or changing conditions. Long-term environmental trends, like those linked to climate change, and short-term events, such as hurricanes, can significantly affect the outcome of restoration efforts. As environmental conditions now show greater variability than in the recent past, restoration methods that once worked may no longer be reliable (Greening et al., 2023). In a highly unpredictable world, adaptive management is essential to facilitate nimble responses to change.

Adaptive management may require close monitoring of restoration success, experimental testing of novel practices, but also the implementation of knowledge gained from similar projects elsewhere. In this way, the Great Green Wall Initiative has evolved from an ecologically and socially problematic wall of trees toward a mosaic of landscapes that provide multiple benefits. Use of locally adapted and diverse restoration strategies has encouraged a more integrative development approach that aims to transform the lives of those living in the Sahel by creating a mosaic of green and productive landscapes.

Adaptive management is more challenging where for-profit restoration businesses are contracted to carry out work (Mohr and Metcalf, 2018). Businesses will usually prefer to meet contractual requirements rather than to work flexibly with unpredictable outcomes.

In addition to the dangerous hegemony of trees in restoration projects, there has been an unhelpful obsession with planting. Planting is popular because it is a very visible management action that can be easily quantified, for funding, and reported as a measure of success. Furthermore, it is easy to link the funding paid to contractors, and the incentives offered to local people, to the number of trees that they plant.

However, it is evident that planting is an expensive method of restoration, and the outcomes can be very variable. In an analysis of planting success at 176 sites across Asia, Bain *et al*. (2023) found mean mortality of planted trees was 18% one year after planting, increasing to 44% after five years. Site conditions had a big effect on survival. Mean mortality rates were 20% higher in open, degraded land than in forest sites. Relatively few restoration projects record or report long-term survival data.

Planting has often led to the creation of large, genetically uniform populations. The most commonly planted trees in a pantropical survey of 174 tree planting organizations by Martin *et al*. (2021) were a small number of commercially useful species. Many large projects struggle to source sufficient planting material (Merritt and Dixon, 2011) and utilise large quantities of genetically uniform planting stock.

Natural regeneration can, in certain environments, be more effective at achieving restoration objectives. Degraded land can retain many relics of former vegetation, including cut stumps, roots, seed banks and important soil micro-organisms, that can kick-start the restoration process. Natural regeneration is typically the most cost-effective intervention for large-scale restoration (Chazdon and Guariguata, 2016). For example, in Niger widespread use has been made of Farmer Managed Natural Regeneration (FMNR), the deliberate nurturing of trees and shrubs from tree stumps and roots. This technique has helped restore over 5 million hectares of land in Niger at low cost. Several international sponsors of large restoration projects are now alert to the value of low or minimal intervention restoration strategies and there has been a shift towards identifying the most effective strategies for each element in a landscape mosaic. One of the main discoveries from the Sow-A-Seed project in Sabah, Malaysia, (Axelsson *et al.*, 2024) is that the choice of restoration techniques and the need to plant depends on the level of degradation. Where the biological legacy of former vegetation is

poor, natural regeneration may require limited augmentation. Choi *et al.* (2024) found that the presence of invasive exotic species in a degraded US prairie caused spontaneous natural regeneration to stall, due to a potentially strong inhibitory priority effect of invasive plants.

The selection of restoration strategies should also take account of their acceptability to different landowners. In a survey of around 100 land managers in the UK, Ambrose-Oji *et al.* (2025) found that they assess risks and opportunities related to resilience, carbon sequestration, biodiversity, and land restoration differently, which influences their acceptance of various restoration approaches. Most land managers favour a hybrid strategy which combines active planting with some natural colonisation because it reduces risks and provides more predictable outcomes. It is essential to understand farmers' goals and the constraints they face in production. Subsidies and other incentives offered by restoration projects may encourage adoption of certain technologies, but if these technologies do not align with farmers' needs and priorities, their use is unlikely to be sustained.

9 MONITORING AND EVALUATION

There are two key reasons why monitoring and evaluation should be a necessary part of all large restoration projects. First, monitoring enables restoration progress to be measured against specific criteria. This is an essential component of an adaptive management system, enabling strategies to be tweaked and experiments evaluated. It is also critical to a process of collective learning; lessons can only be learned if clear records are made of successes and failures. Second, monitoring and evaluation is a vital part of providing funders with reassurance that the project is well-managed and good value for money. As the private sector becomes increasingly involved in large projects, it will be important to establish key performance indicators to ensure that restoration actions have been carried out appropriately.

The criteria of restoration success should be agreed by all stakeholders at the outset of a project. That agreement must include who is responsible for data collection, over what period and how collection is to be resourced. Larger projects often need more time to produce observable results, complicating monitoring and adaptive management. The lack of adequate undisturbed natural baselines is often given as a significant problem facing those who wish to measure restoration progress. This is only a genuine problem where the success criterion is the recreation of a near-natural community.

New technologies are transforming the monitoring and evaluation of landscape-scale restoration projects by enabling faster, more accurate, and scalable data collection and analysis (de Almeida *et al.*, 2020). These innovations, including remote sensing from drones and satellites, allow restoration efforts to be assessed over vast areas and long timeframes, overcoming many limitations of traditional field-based methods. Drones equipped with lidar, and hyperspectral sensors can capture detailed data on vegetation structure and land surface changes. This is particularly valuable for linking field data with broader satellite

observations. Machine learning has enabled the integration of large datasets, allowing predictive modelling of ecosystem services and restoration outcomes.

These technologies provide restoration practitioners with powerful tools to track progress, evaluate effectiveness, and adaptively manage large-scale restoration initiatives. However, they require expert operation, can be fragile in hostile field conditions, and the data can be expensive to collect and analyse. Monitoring programs that depend on advanced technology are vulnerable to failing funding. Consistent collection over long time periods, of data that are simple and cheap to record will often be of greater value in understanding change, than elaborate schemes that are swiftly dropped when found to be too expensive or demanding. There is a greater chance that project teams will collect long-term datasets if they have ownership of the process and feel that there is value in the analysis (Van Winkle *et al.*, 2025). It is important not to over-burden local communities with complex reporting requirements. In this regard, it will be critical that governments, civil society, and supporting organizations provide technical, financial, and institutional support to ensure that any monitoring and evaluation processes are appropriate, accessible, and equitable.

Socio-economic results of land restoration require different approaches, typically involving ground-based data collection, participatory methods, and sometimes integrated modelling with biophysical data. Whilst there are several well-established and widely used biophysical measures of recovery, there is still strong debate about what variables should be monitored to demonstrate improvements in livelihoods, wellbeing, and economic development. There would be considerable value in agreeing a standard set of socio-economic metrics that could be used by large restoration projects, to increase the comparability of data and to facilitate learning.

A systematic review of restoration monitoring (Wortley *et al.*, 2013) found that published research is still heavily skewed toward United States and Australia and that there was a dearth of papers that included any measure of socio-economic change. They found that 94% of the articles reported on ecological recovery, whilst only 3.5% reviewed socio-economic factors. Similarly, in a review of 75 Mexican restoration projects, Méndez-Toribio *et al.* (2021) found only 2% recorded data on social change. This is a critical omission, because it is important to understand if a project has been successful in addressing the drivers of degradation.

10 G20 CONSIDERATIONS AND RECOMMENDATIONS

10.1 Key Issues Identified

- **Governance gaps**: Many countries lack institutions with the mandate and capacity to manage large-scale, multi-stakeholder restoration.
- **Underestimated long-term costs**: Most projects underfund post-implementation phases, including monitoring and maintenance.

- **Over-reliance on afforestation**: Tree planting is often applied inappropriately in ecosystems where it may harm biodiversity and hydrology.
- **Inadequate community engagement**: Many projects are still top-down, limiting long-term success and local support.
- **Fragmented and short-term financing**: Restoration requires long-term investment, but funding remains sporadic and donor dependent.

10.2 Recommendations

10.2.1 Strengthen Governance and Institutional Capacity

Insight: Empower subnational institutions to lead, with technical support from central authorities.

Potential Policy Options:

- Create or enhance national restoration agencies.
- Support regional restoration planning platforms.
- Facilitate cross-border governance for Transboundary Conservation Areas.

10.2.2 Diversify Restoration Finance

Insight: Long-term funding is more critical than initial capital injections.

Potential Policy Options:

- Explore payments for ecosystem services (PES).
- Leverage green bonds and results-based finance.
- Foster public-private partnerships with restoration-linked incentives.

10.2.3 Embed Community-Centred Approaches

Insight: Community buy-in improves sustainability, reduces conflict, and unlocks local innovation.

Potential Policy Options:

- Require participatory planning frameworks.
- Fund capacity-building for community governance bodies.
- Recognize customary land rights in restoration agreements.

10.2.4 Reform Restoration Metrics

Insight: Too great a focus on tree counts; too little on biodiversity, livelihoods, or resilience.

Potential Policy Options:

- Develop a toolbox of restoration metrics that draws on international best practices while remaining adaptable to national and local contexts. This toolbox would include a range of biophysical and socio-economic indicators that countries can select and tailor according to their specific ecological, social, and economic circumstances.
- Promote long-term monitoring and evaluation protocols that are appropriate, accessible, sustainable and equitable.
- Co-invest in open-access data systems (e.g., GRIH).

10.2.5 Promote Innovation and Knowledge Exchange

Insight: Existing knowledge is underutilized; new technology can help but needs grounding in local contexts.

Potential Policy Options:

- Co-fund regional knowledge hubs on restoration.
- Support restoration "twinnings" among G20 and partner nations.
- Incentivize integration of indigenous and scientific knowledge in restoration curricula.

10.2.6 Encourage Context-Specific Restoration Strategies

Insight: No single approach suits all ecologies or social systems.

Potential Policy Options:

- Encourage adaptive management as a best practice.
- Promote farmer-managed natural regeneration (FMNR) where appropriate.
- Discourage "plant and abandon" tree planting models.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Land Degradation, Desertification and Drought

Achieving resilience: The need for transformative action

Dr. Daniel Tsegai, Programme Officer, UNCCD, Bonn
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This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

"The first is to halt and, when possible, reverse the degradation of the environment, including destabilization of the planet's climate. The second is to reduce the inequalities of wealth and power that threaten to tear societies apart. I believe that it is both possible and necessary to tackle these challenges together. These two historic tasks can and must go hand-in-hand."

James K. Boyce
(University of Massachusetts Amherst)
is an economist and the author of seminal work on the relationship between social inequality and environmental degradation, and has made a major contribution to structuring the field of environmental political economy.

EXECUTIVE SUMMARY

Land degradation, desertification and drought are intimately linked. These are three major global concerns that are worsening over time, putting ecosystems and livelihoods at the brink of collapse, and beyond. In extreme cases, they trigger famine, further amplifying already existing risks. Despite its far-reaching negative impacts, global policy discussions often underestimated the socio-ecological costs and underprioritize the need for proactive policy actions.

Further amplified by the climate crisis, no country remains immune to these calamities. As highlighted in the recent Global Drought Outlook (OECD, 2025), no country is immune to climate change-induced drought risk. However, it is especially the most vulnerable states and the most vulnerable people that face the greatest risk in an increasingly dire situation. People who make a living directly off the land – farmers, foresters and herders – are most often hit the hardest. The negative impacts then spiral into a broad range of other societal sectors.

Transformative action is needed, throughout nations and through global policy frameworks that address the root causes, to build a robust mechanism for resilience. In 2020, in line with this urgent need, the G20 launched the Global Initiative on Reducing Land Degradation and Enhancing the Conservation of Terrestrial Habitats (in short, Global Land Initiative), which aims to reduce degrading impacts by 50 percent by 2040. This ambitious initiative compliments a prior UNCCD one called Land Degradation Neutrality (LDN) as part of the Conventions Strategic Framework, which was joined by 196 countries that have pledged to halt land degradation by 2030. This includes a national voluntary target-setting process with more than 100 countries participating as part of the Initiative.

To avoid catastrophic outcomes from drought, degradation and desertification, it is most critical to enhance the cooperation of G20 States to proactively and in solidarity ramp up efforts that include early warning systems for all, enhanced investment schemes in sustainable land management and large-scale ecosystem restoration across all terrestrial systems. It is crucial to mainstream drought resilience policies across all relevant social, environmental and economic sectors as water and land management alone will not be enough to limit future drought-induced impacts on society, economies and ecosystems.

1 INTRODUCTION

Conventional wisdom holds that soil is underneath our feet and that drought is a natural reoccurring phenomenon. But as the global population passed 8 billion people (2022) and the 1.5-degree mark (2024), land is being degraded at an unprecedented rate, the earth's thin fertile crust is rapidly disappearing, deserts are advancing, and the increase in the intensity, frequency, duration and spatial extent of drought increasing, and its impacts exacerbated by unsustainable human activities related to land and water resources management.

The problems are particularly aggravated in the driest parts of the world and for the most vulnerable members of society. Dryland areas cover approximately 40 percent of the world's land surface and support two billion people. The vast majority of people who depend on drylands live in developing countries, where women and children are most vulnerable (GEF, 2025; Freedman et al., 2025). For humanity, drought has been the deadliest of all hazards in the last 50 years, and it affects the greatest number of people globally (IFRC, 2020).

While famines caused by a lack of rainfall (meteorological famines) have been superseded by political famines – famines as a result of state failure and war, drought often remains a severe aggravating factor when it comes to the loss of human lives. At the turn of the millennia signs looked favorable, as famines were receding into history. However, 25 years on, we face new and harsh realities (de Waal, 2017, 2025). We have witnessed a resurgence in extreme levels of hunger as a consequence of land degradation and drought (Oxfam, 2021; Ahmed et al., 2025). Acute hunger is on the rise again, affecting 343 million people in 74 countries where the World Food Programme (WFP) and other relief programs works and data are available (WFP, 2025). At the same time, land degradation exacerbates global warming, hindering positive development and attainment of the Sustainable Development Goals (Bai et al., 2025).

While droughts have often been known as slow onset phenomena, extreme heat as a result of a changing climate is also resulting in the increasing occurrence of what are called flash droughts, that is droughts that occur rapidly in the space of days or weeks. While the cascading and compounding impacts are also becoming more prominent, for example the impacts of droughts combined with heat waves have greater impacts on crops and animals, or may result in hazards such as wildfires among others.

The following illustrative watershed gives a comprehensive overview of human activities that altered terrestrial systems, each contributing to increasing land degradation, desertification, drought and all associated risks.

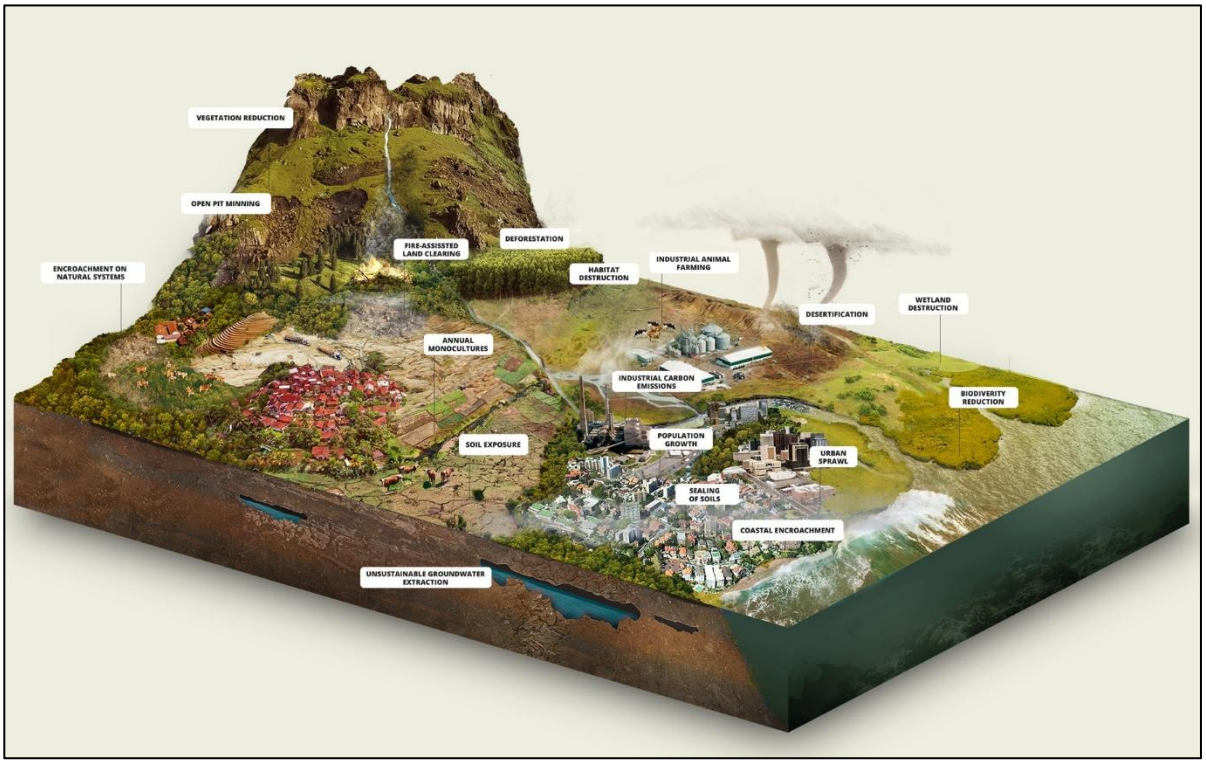


***Figure 1**: Human impacts on earth's systems that are increasing land degradation, desertification and drought.*

The science of what causes land degradation, desertification and drought is well established, and it paints an unambiguous picture (Afroze, 2025; Tintchev & Jaramillo, 2024). Over extraction and exploitation, for example by cultivating water-intensive crops for economic win, undermines long-term resilience and could easily be tackled through targeted policies and incentive structures. Other key anthropogenic drivers are the expansion of agrarian activities into marginal land, especially for harmful meat production (Cheng et al., 2022; Choma et al., 2023). Wetlands continue to be drained in too many nation states, making way for monocultures or urban sprawl (Huang et al., 2024). Despite all written and verbal commitments, the sum of global actions has been insufficient: emissions continue to rise unabated, forests continue to be illegally logged, and Indigenous Peoples and local communities' voices remain largely unheard.

All these trends urgently need to be reversed to avoid catastrophic outcomes (IPCC, 2023), and a more critical examination must be taken on what "growth" and "development" really mean (Schultz & Pies, 2024; Wagner & Hornidge, 2025). There are increasing concerns by many that continued economic growth will not be environmentally sustainable, socially beneficial, or economically achievable (Kallis et al., 2025; Williams, 2025).

Therefore, we find ourselves in unprecedented times – a historic singularity – one that demands a response from humanity as a species towards a conscious transition to a more stable and just world that operates within planetary boundaries.

While some progress has been made regarding this new awareness in the past 25 years, we still lack the political will and momentum to turn the tide. The proposed solutions do not match the size of the problem.

2 CURRENT MULTILATERAL DELIBERATIONS

On a global level, the UNCCD is the sole legally binding convention that addresses issues surrounding desertification, land degradation, and drought. Since the secretariat was established in 1994, the scope has continuously expanded. However, to date, little progress has been made in establishing a global policy instrument for a potential universal drought regime. Despite growing momentum on proactive drought policy matters and two consecutive appointed Intergovernmental Working Groups (2019-2022 and 2022-2024) that elaborated and prepared a set of different global policy options for the Conference of the Parties, no final decision on the shape of a that instrument has been taken, even some preliminary agreements on modalities have been reached, including proactive as well as reactive components. To this end, Parties to the UNCCD decided to continue discussions based on the progress made at COP16 (the launch of the Riyadh Global Drought Resilience Partnership and the International Drought Resilience Observatory (IDRO)) with a view to adopting a decision at the seventeenth session of the Conference of the Parties (COP17) due to be held in Ulaanbaatar, Mongolia in August 2026.

In addition, the UNCCD Strategic Framework (2018-2030) marks the most comprehensive global commitment to achieve Land Degradation Neutrality (LDN) by halting destruction and restoring damage done to socio-ecological systems wherever possible. With 197 Parties working together to achieve these goals, the UNCCD works in close collaboration with the two other Rio Conventions, the United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Convention on Biological Diversity (CBD), on a global level.

Against this backdrop of missing capacities of developing countries, the Parties to the UNCCD established in 2017 the Drought Initiative to support countries in developing and implementing National Drought Management Plans (Dec. 29/COP 13). These include strengthening comprehensive drought monitoring and early warning systems, vulnerability and im- pact assessment, as well as risk mitigation and preparedness measures in line with the principles of integrated drought management[1]. As part of the Drought Initiative, more than 70 countries developed national drought plans based on the principles of risk reduction.

[1] These include strengthening comprehensive drought monitoring and early warning systems, vulnerability and im- pact assessment, as well as risk mitigation and preparedness measures in line with the principles of integrated drought management

A central part of the Drought Initiative is the Drought Toolbox, which countries can use to develop, strengthen and implement their national drought plans. The Toolbox is developed by the UNCCD together with its partners including the Food and Agriculture Organization of the United Nations (FAO), Global Water Partnership (GWP), the World Meteorological Organization (WMO), the Joint Research Centre of the European Union (EC-JRC), the National Drought Mitigation Center (NDMC) of the University of Nebraska, and the United Nations Environment Programme - Danish Hydraulic Institute Group (UNEP-DHI). The toolbox featured a number of context specific technical and policy measures. Another key component of the Drought Initiative is the regional strategic frameworks, which facilitate data sharing, early warning, monitoring, vulnerability and impact mapping as well as drought risk mitigation measures across regions (Drought Atlas, 2024, 156).

In addition, the UNFCCC has established the Programme on Reducing Emissions from Deforestation and Forest Degradation plus (REDD+), National Adaptation Plan as well as the Loss and Damage fund – three mechanisms that deal with land-based climate change impacts or adaptation scenarios, including proactive as well as reactive components.

Additionally, during the UNFCCC COP29 held in Baku on 2024, the Declaration on Water for Climate Action was endorsed by Parties and non-state actors and promoted the Baku Dialogue on Water for Climate Action – a multi-stakeholder platform that brings together 73 states and dozens of stakeholders to foster continuity and coherence on water-related climate action as well as the Global Landscape Forum.

Further progress has also been made through complementary initiatives. The International Drought Resilience Alliance, spearheaded by Spain and Senegal, was formally launched at UNFCCC COP27 in November 2022 in Sharm El-Sheikh, Egypt. Subsequently, in December 2024, the Riyadh Global Drought Resilience Partnership (RGDRP) was established during COP16 of the UNCCD in Riyadh, under the Saudi Presidency. The RGDRP represents a global effort to transition from reactive, crisis-driven responses to drought toward proactive, resilience-oriented approaches.

Finally, a set of other United Nations agencies work with global mandates on topics related to drought risk management (DRM) and land degradation risk management. The five most prominent ones, all without non-binding legal mechanisms, are the FAO, the WMO, the UNEP, the United Nations Office for Disaster Risk Reduction Global Assessment Report (UNDRR), the United Nations Development Programme (UNDP), and the WFP. These institutions, however, do not have any legal mechanisms, be these binding or non-binding. Primary funding agencies are the GEF, G7 countries plus the EU and the World Bank.

Regarding monitoring drought globally, NOAA's Global Drought Information System along with the SPEI Global Drought Monitor, hosted in Spain, provide biophysical parameter measurements with resolution of up to 0.5° in real-time environment. In 2013, the GWP and the WMO jointly launched the Integrated Drought Management Programme (IDMP). The initiative was designed to assist countries and regions in developing proactive national

drought policies and enhancing prediction capabilities by strengthening drought monitoring, prevention, and efforts to address desertification and land degradation worldwide. Also launched at the HMNDP was a UN-Water collaborative initiative to support countries develop National Drought Management Policies (NDMP) spearheaded by WMO, UNCCD, FAO, the Convention on Biological Diversity (CBD) and the UN-Water Decade Programme on Capacity Development (UNW-DPC). In 2024, the Drought Resilience +10 conference was held to discuss the urgent need for improvements in assessing and quantifying drought risks, in developing and implementing transformative solutions, and in boosting policy actions and investments. It was organized by several IDMP partner organizations. This 2024 conference made several recommendations on how to build a sustainable and drought-resilient future.

The graphic below gives a comprehensive, non-exhaustive, overview of multilateral engagements over a thirty-year period (1992-2025):

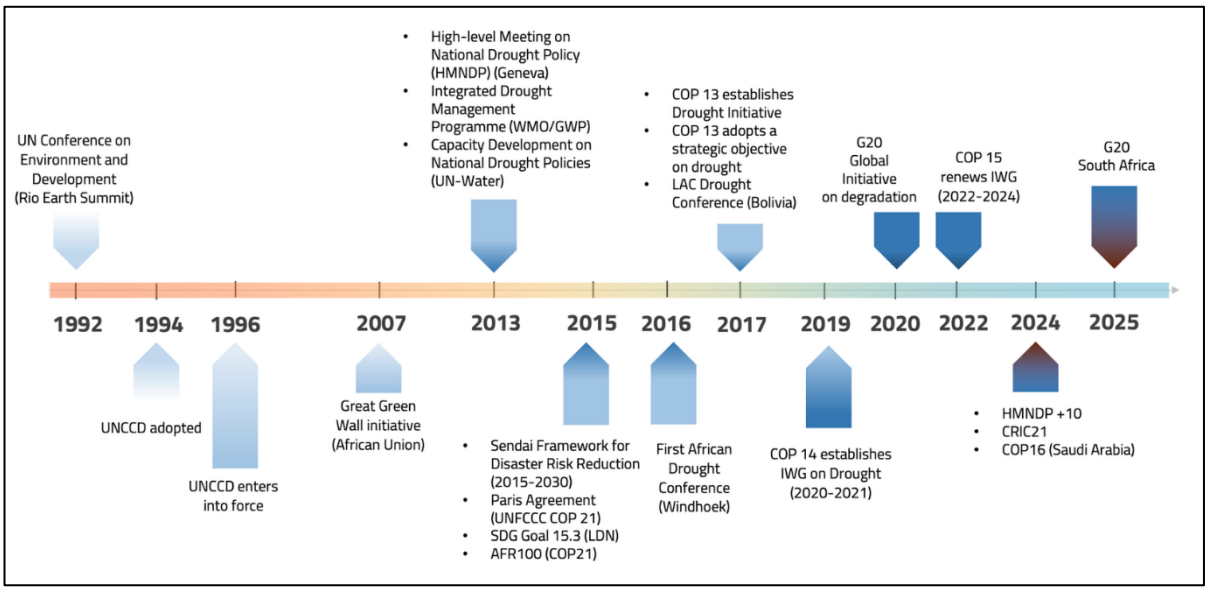


***Figure 2**: Timeline of major global initiatives and frameworks related to drought, desertification and land degradation*

2.1 The G20 Forum and Initiatives

Until now there is no specific working group on land degradation, desertification and drought as part of the G20 Sherpa Track, which is composed of leaders of each country who take the discussions and agreements to the final summit with Heads of State and Government. This is a profound oversight for the G20 designed to address one of the world's most pressing economic and environmental challenges. The topic is featured within the environment and climate sustainability track, however it also impacted multiple other sections in a cross-sectorial manner, such as disaster risk reduction, agriculture, development, health, employment, tourism as well as research and innovation.

Land degradation, desertification and drought only became a topic at the G20 summit of 2020 (Riyadh, Saudi Arabia), during the official launch of the Global Initiative on Reducing Land Degradation. Its set goal is to reduce land degradation by 50% by 2040.

The subsequent summit reiterated this ambition, adding in the 2022 at the Indonesian Summit – for the first time – the word "*drought*" to a final statement. "*We will scale up efforts to combat, biodiversity loss, deforestation, desertification, land degradation and drought, as well as restoring degraded land to achieve land degradation neutrality by 2030, and in support of the G20's ambition to reduce land degradation by 50% by 2040 on a voluntary basis.*" The subsequent Presidencies from India and Brazil continued emphasizing addressing land degradation, desertification and drought – without which sustainable development for all cannot be achieved.

2.2 Other Multilateral Forums

During the 78th session of the United Nations General Assembly in 2021 under resolution A/RES/78/154, titled "Implementation of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification", the UN recognized the G20 initiative above. One year later in 2022, the initiatives coordination office was established under the United Nations Convention to Combat Desertification Secretariat, an online information hub that opened with over ten other international UN-agencies, universities and non-governmental institutions. It joined forces with other existing multilateral forums and initiatives, such as the Decade of Ecosystem Restoration Initiative, the Global Peatland Initiative, the Global Mangrove Alliance and the Partnership for Ecosystem and Disaster Risk Reduction, as well as the Global Landscape Forum.

Following the Nairobi Summit of 2011, the Heads of State and Government resolved to embark on the Drought Disaster Resilience and Sustainability Initiative for Africa, led by the Inter-Governmental Authority on Development (IGAD). Subsequently, the African Risk Capacity Network was founded as a Specialized Agency of the African Union and was "*established to help African governments improve their capacities to better plan, prepare, and respond to extreme weather events and natural disasters*" (ARC, 2021). This African-led initiative was also co-created together with the WFP, the so called AfricaRiskView, a regional satellite-based weather forecast and surveillance program. The first African Drought Conference, held in Windhoek, Namibia in August 2016, brought together African Member States and Parties to the UNCCD, Ministers, Heads of Delegation, and experts to discuss ways to enhance drought resilience in Africa. The two major outcomes of the Conference were the Windhoek Declaration and the White Paper on Drought Resilience and Prepared Africa (DRAPA) as developed by the African Union Commission (AUC) (Duguma et al., 2017). The establishment of an Advisory Board on Drought was requested by the AUC and adopted by a following AU Summit.

2.3 Regional Initiatives

With proactive drought management and land degradation neutrality being a dynamic field of stakeholders, the following listing of initiatives is not intended to be exhaustive, but rather an attempt to highlight key aspects of various regions in a concise manner. Therefore, the omission of certain initiatives is not intentional.

In Latin America, there is the Regional Climate Center for Southern America (Centro del Clima Regional del Sur) which is working to strengthen climate resilience in the region, particularly in the face of drought. Further, there is an EU-financed drought preparedness program encompassing 18 countries called EUROCLIMA+, which functions off the synergistic work of seven agencies: the Spanish Agency for International Development Cooperation (AECID), the French Development Agency (AFD), the Economic Commission for Latin America and the Caribbean (ECLAC), Expertise France (EF), the International and Ibero-American Foundation for Public Administration and Policy (FIIAPP), the German Society for International Cooperation (GIZ) and UN Environment. In the Caribbean region, the Caribbean Disaster Emergency Management Agency (CDEMA) and Caribbean Institute of Meteorology and Hydrology (CIMH) together developed into hubs of knowledge and early warning. The CAPRA initiative was created in partnership with the Center for Coordination of Natural Disaster Prevention in Central America (CEPREDENAC), the United Nations International Strategy for Disaster Reduction (UN ISDR), the Inter-American Development Bank (IADB) and the World Bank.

In North America, there is the National Drought Information System, a national integrated drought early warning information system that aims to create a higher level of drought resilience in the U.S. Close regional collaboration exists with the Canadian Drought Monitor (CDM). Both institutions, along with their Mexican counterpart, are also closely linked through the North American Drought Monitor, hosted at the National Drought Mitigation Center at the University of Nebraska-Lincoln. They all share real-time data and analysis capacities.

Several regional drought monitoring and assessment centres also established themselves as collaborative bodies in Asia, such as The South Asia Drought Monitor (SADM) in 2014, the APEC Climate Center (APCC) in 2005, and the Asia-Pacific Regional Drought Mechanism as part of the ESCAP's Regional Drought Mechanism in support of UN-Spider or the Regional Drought Monitoring and Outlook System (RDMOS) for South Asia.

As for Europe, a European Drought Observatory (EDO) was inaugurated through joint effort of the EU Joint Research Centre, the United Nations Economic Commission for Europe (UNECE), and the European Drought Centre. It is a purely virtual platform serving as a knowledge center with the aim "*to coordinate drought related activities in Europe to better mitigate the environmental, social and economic impact of droughts.*" It involves more than 40 organizations from nine CEE countries (Bokal, 2014; Erven et al., 2025).

Finally, Africa has several transcontinental collaborations, like the Regional Integrated Multi-Hazard Early Warning System for Africa, also including Asia partners (RIMES) and MISLAND to monitor land degradation and desertification in accordance with the SDG requirements. The African Risk Capacity Network in a multilateral framework, as highlighted in the prior section, takes a central role along with the Climate Prediction and Application Center (ICPAC), the Sahara and Sahel Observatory (OSS) and The Permanent Interstate Committee for Drought Control in the Sahel (CLISS). Furthermore, the Southern African Development Community (SADC) together with the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), other UN agencies and humanitarian partners have been coordinating drought response, developing appeals, advocacy and mobilizing resources. Through efforts and synergies along with the invaluable support of local organizations, millions of people received support, especially to mitigate the severe impact of food insecurity because of land degradation and drought. However, so far, this program could not be rolled out at the scale needed. Finally, and arguably the current the largest regional restoration initiative, called the Great Green Wall, stretches across 22 Sub-Saharan States and aims to reverse negative land management trends by actively restoring 100 million hectares of currently degraded land, sequestering 250 million tons of carbon and creating 10 million sustainable jobs by 2030. In 2024 the AU Summit of Heads of State and Government endorsed the AU Great Green Wall Initiative Strategy and Ten-Year Implementation Framework (2024-2034). This new strategy promotes a more integrated and holistic approach to land rehabilitation and has the overall objective of enhancing the resilience of communities, ecosystems and economies in the African Drylands.

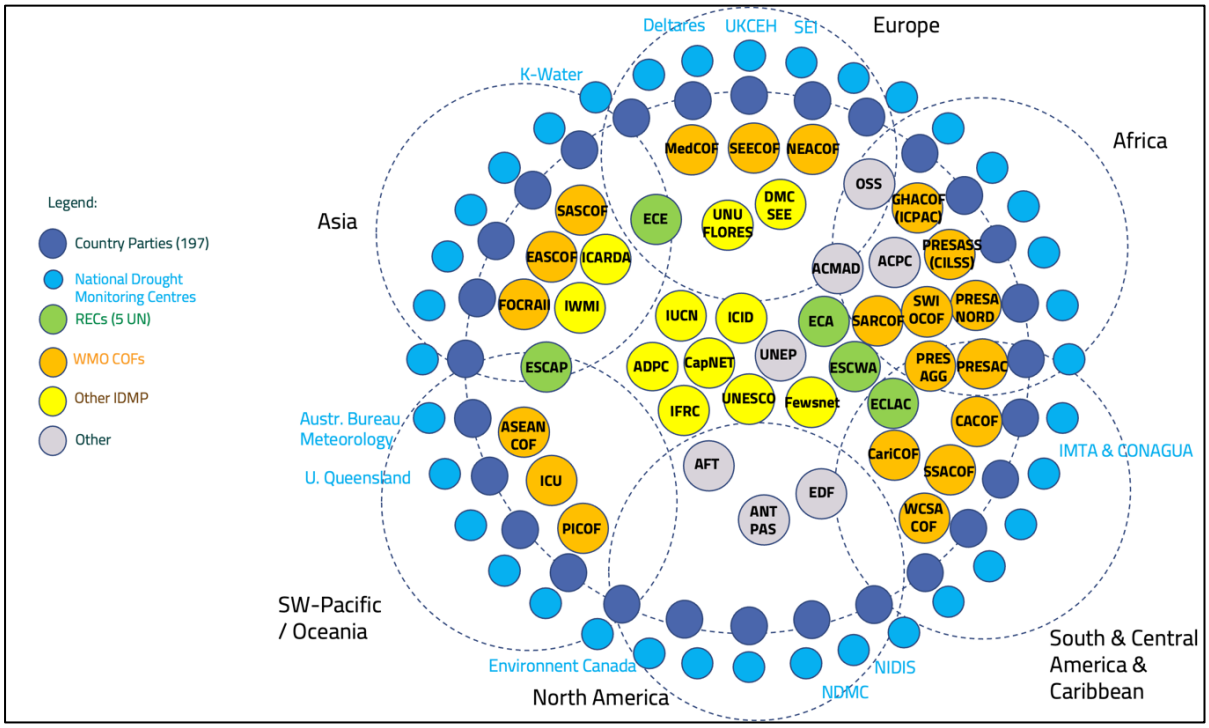


***Figure 3**: Mapping existing initiatives on drought, desertification and land degradation.*

2.4 Monitoring and Reporting Schemes

Policymakers depend on reliable data. However, there is no one-size-fits-all for determining countries' land degradation, desertification and drought status. Despite the provision of standardized global data sets, countries face challenges related to the availability of robust, reliable and nationally applicable measures for each of these data sets, without which the levels of confidence in the overall estimation of dysfunction may be compromised.

Each country works on using the best available information, local expertise and knowledge to modify and improve on the standardized global data sets provided in its most holistic form by the UNCCD reporting platform. This can raise the level of confidence in the outputs and estimates generated.

In accordance with Article 26 and the decisions of its Conference of the Parties (COP), Parties to the UNCCD are required to submit their documentation in a four-year reporting frequency on actions taken to implement the Convention. The so called Performance Review and Assessment of Implementation System (PRAIS) which helps nation states to streamline the process towards five strategic objectives: (a) covering ecosystems affected by land degradation, populations affected, drought hazard, exposure and vulnerability, global environmental benefits, and resource mobilization; (b) Data on the SDG indicator 15.3.1, "*proportion of land that is degraded over total land area;* (c) Implementation Framework, (d) Financial and non-financial resources, (e) Policy and planning, (f) Actions on the ground. During the first one, nation states submitted baseline data for the period 2000-2015, reporting on trends in land degradation, drought, desertification and other key indicators. The third reporting cycle will be in 2026 (UNCCD, 2024).

SDG indicator 15.3.1 (Proportion of degraded land over total area) is the sole indicator used to track progress towards SDG target 15.3. This indicator has reached the highest tier in the SDG indicator framework since 2019, indicating its maturity in terms of methodological approach and data availability. It is calculated using the three sub-indicators previously described, namely trends in land cover, land productivity and carbon stocks. (UNCCD, 2024). Despite its robustness, the discussion of further simplifying the monitoring systems continues, especially with regards to data availability and robustness that can lead to informed policy decisions (Herrick, 2025).

3 CURRENT INITIATIVES AND DEBATES

To address the risks associated to drought, land degradation and desertification national and regional plans and policies are required. However, many countries – especially developing countries – lack these policy instruments and the means to implement them. This has been acknowledged by UN organizations, including UNCCD and UNFCCC, which have made considerable efforts to support developing countries. It is a debate that must address equity and environmental justice, specifically how to account for historical greenhouse gas

emissions from developed countries with large-scale landscape restoration taking a center stage.

In an age of accelerated and simultaneous destruction and restoration of the earth's ecosystems, global conventions and funding mechanisms must take on a crucial role. The six major policy initiatives with a global reach are listed below.

Initiative	Since	Scope	Reach	Obstacles
UNCCD (LDN/NDMP/DI)	1994 (2015/2018)	Global	LDN in 193 countries NDMP are developed by 73 countries	no binding legal frameworks until now / smallest Rio Convention Secretariat
UNFCCC / (NAP/LDF)	1994 (2010/2022)	Global	NAP in 58 countries LDF (250 mill.)	insufficient financial commitments
Paris Agreement (incl. NDCs)	2015	Global	194 countries	Collective ambition gap / lack of strong enforcement mechanism
IDMP	2013	Global	joint initiative by intl' organisations	limited financial resources of 35M annually
Riyadh Global Drought Resilience Partnership	2024	Global	74 vulnerable countries	not being evaluated yet for effectiveness
G20	2020	Global	19 countries, AU & EU	diverse interest of members

While losses of our ecological systems on a global scale still exceed gains through active restoration interventions (Steffen et al., 2015; Chapman et al., 2025), much of what is restored also does not match the structure (Lockwood & Pimm, 1999), function (Zedler & Callaway, 1999) or stability (Shackelford et al., 2013) of similar systems prior to disturbance and yet, with the restoration of ecological functions, we might have the strongest tool at hand to tackle advancing deserts, degrading land and drought simultaneously. Examples of on-going interventions of unprecedented scale include: the Everglades (US, 1985–), the Danube (Europe, 1998–), the Loess Plateau (China, 1994–) and across the Sahel with the Great Green Wall Initiative (Sahel 2007–). "Restoration ecology is a relatively new science (…) but in its short life it has assumed a major role in sustainable development efforts worldwide" (Roberts et al., 2009).

Conventions like the UNCCD, the UNFCCC and the Paris Agreement recognize landscape restoration as an essential mechanism to mitigate the worst effects climate change and degradation. With millions of hectares pledged by nations, especially from the Global South, (Bonn Challenge, 2021; IUCN, 2015) and increasing financial resources available to modify and transform landscapes substantially, questions of global environmental justice, corporate control, land grabbing, as well as the replication of neo-colonial mechanisms in a network of multinationals, gain momentum (Light et al., 1996, 2000; World Inequality Database, 2024).

Going beyond food security, estimates of the overall economic losses should be interpreted with care. This is because, on the one hand, the non-monetizable dimensions of social and environmental losses from economic performance are often not accounted for (so called *"*externalities*"*); and on the other hand, there is usually a significant gap between reported and actual impacts. *"Droughts and their associated social and economic impacts are occurring with increasing frequency and magnitude across most parts of the world. Their costs are underestimated, particularly in the developing countries where assessment capacities and drought management systems are the weakest and drought hazards interact with other threats to global, national and local security*" (UNCCD, 2019). According to UNDRR, the past 20 years have seen at least 1.5 billion people affected by drought, leading to economic losses of at least USD 124 billion across the world. However, these are most likely partial accounts and are grossly underestimated. Cost estimates based on case studies suggest that impacts differentiate much further than these estimates and therefore result in multiplying costs (UNDRR, 2021). It is estimated that changes in productivity due to transitions from high to low value ecological systems account for about 1/4th of the total cost of inaction, equivalent to USD 302 billion per year, plus another USD 159 billion due to losses in direct agricultural productivity caused by erosion and loss of soil fertility (UNCCD Global Mechanism, 2024).

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

Land degradation, desertification and drought raise fundamental questions about the capacities of our societies to adequately prepare for imminent global risks and what hinders us to address the root causes effectively and in solidarity.

Newly emerging considerations are: What are the benefits of action and the costs of inaction? Are there scalable business-driven restoration cases that have proven profitable for ecological functions, social equality and financial returns? How do we divert business-as-usual finance streams into an emerging restoration and resilience economies? How do we best boost communities of learning and practice for effective DRM? Which political factors, including corruption and accountability, enable unsustainable land use practices?

It is important to create and develop a shared vision of a world – a socio-ecological system – where the goal of minimized risk and lasting resilience is clearly articulated. We live in a world where these combined hazards result in major economic impacts, highlighting the need to reassess some development pathways. Long-term sustainability cannot be achieved if mitigation measures are underfinanced anywhere in the world.

Economic analysis estimated how much is needed to meet global restoration pledges and it concluded that it is financially feasible: *"median restoration costs vary from $185 to $3012 per ha (…) current global land restoration commitments cost 0.04%–0.27% of annual global GDP to implement"* In concrete terms, even ambitious targets (~1 billion ha) would require

only a fraction of world GDP. Since many targets lie in developing countries, international cost-sharing and climate finance will be essential to move from pledges to action.

Investing in land restoration and drought resilience comes with a multiple dividend; not only for ecological systems but for all human societies that depend on functional planetary systems. Prioritization must be given to vulnerable groups, including women, youth, and Indigenous Peoples, in drought and land degradation policies, emphasizing that these groups must not only be beneficiaries but also actively involved in decision-making processes to ensure their perspectives, needs, and that traditional knowledge meaningfully shape effective and equitable solutions. At the same time, data-driven decision-making based on freely available and robust data is crucial to effectively combat land degradation and support sustainable land management (e.g., Group on Earth Observations Land Degradation Neutrality – GEO-LDN Initiative).

While the G20 can lead a transformative trajectory on drought resilience by embedding *drought* across key global agreements, they can also strengthen drought risk governance and early warning tools, harness data and science, protect ecosystems and reinforce nature-based solutions and fostering cooperation.

The G20 must align its ambitions with the outcomes of major multilateral environmental agreements, including the UNCCD COP 16 and the implementation of UNEA resolution 6/14 on "Strengthening international efforts to combat desertification and land degradation, restore degraded land, promote land conservation and sustainable land management, contribute to land degradation neutrality and enhance drought resilience".

The recent launch of several high-impact initiatives, such as the Riyadh Global Drought Resilience Partnership, the International Drought Resilience Observatory (IDRO), the Business4Land initiative, and the Middle East Green Initiative, provides a new foundation of tools, data, and financial mechanisms that the G20 can leverage and scale to accelerate progress.

The South African Presidency therefore brings forth the following recommendations for the consideration of all participating nations:

- Strengthen Governance & Early Warning Systems[2]
    - Prioritize drought policies that uplift vulnerable groups including women, youth, Indigenous Peoples, and rural communities
    - Enhance drought monitoring, forecasting, and impact assessment, including data on flash droughts and cascading risks
    - Facilitate access to open data, remote sensing, and local scientific expertise to underpin resilient planning

[2] Please note there is one parallel track G20 track with focus on Risk Reduction and Early Warning

  - The integration of the International Drought Resilience Observatory (IDRO) into national and regional early warning systems to provide accessible, real-time data for proactive decision-making
  - Actively promote and scale up proven initiatives like the Middle East Green Initiative to demonstrate large-scale, cross-border ecological restoration and its socio-economic benefits
  - Develop an internal legally binding instrument on drought under the UNCCD
- Restore economies at scale through nature-based solutions and ecosystem protection
  - Promote ecosystem-based disaster risk reduction (Eco-DRR), including wetland restoration, groundwater recharge, and nature-based infrastructure world
  - Enhance water retention and productivity under drought stress world
  - Bankable landscape rehabilitation projects at scale
- Sustainable land and water management
  - Advance risk governance by mainstreaming land-use planning and sustainable water management in national policies
  - G20 support for investment plans through technical and financial assistance towards attaining LDN
  - Enhanced water retention, groundwater recharge, and sustainable integrated water resource management for improved drought resilience
  - Capacity building for state and non-state actors for effective land management
  - Recognition of First Nation and Indigenous land rights provides a strong foundation for drought resilience
  - Strengthened collaboration among states, private sector actors and civil society
- Finance
  - Promote access to finance specific to drought resilience, including risk-transfer tools (e.g. insurance)
  - Raise the profile of financing proactive drought management
  - Financial commitments from G20 members, especially developed countries
  - Assist countries to develop context specific drought finance strategies
  - Financial commitments with specific focus on advancing sustainable land management, large-scale ecosystem restoration, and the development of effective early warning systems
  - Urgently capitalize on and contribute to the Riyadh Global Drought Resilience Partnership to mobilize and direct substantial financial resources to the most vulnerable countries
- Research and cooperation
  - Strengthen institutions and alliances like the International Drought Resilience Alliance (IDRA); Integrated Drought Management Programme (IDMP) and knowledge platforms like the Communities of Learning and Practice (CLP)

- Support further research on the economics of proactive drought management and strengthen methodologies for cost-benefit analysis
- Review of lessons learnt from large-scale restoration initiatives: the Great Green Wall, AFR100 Initiative, Brazil's 73-million-trees initiative, amongst others
- Evaluate the effectiveness of rehabilitation funding mechanisms to support landowners, communities and restoration entities
- Identify and address the intersections between human mobility and climate-induced stressors
- Formalize cooperation with the UNCCD and align G20 national drought plans with UNCCD outcomes to ensure global coherence and ambition.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Sustainable Chemicals Management

From Commitments to Implementation: A G20 Agenda on Chemicals and Waste

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EXECUTIVE SUMMARY

Chemicals are essential to modern economies, but their mismanagement is fuelling disease, environmental degradation, and economic loss. The triple planetary crisis of climate change, biodiversity loss and pollution cannot be solved without urgent progress on chemicals and waste. The G20, representing the largest economies with the most global production and consumption, can shape a safer future by advancing finance, transparency, innovation and enforcement. Sustainable chemicals management is also an Sustainable Development Goal (SDG) accelerator—reducing disease burdens (SDG 3), protecting water and sanitation (SDG 6), enabling decent work and safer industry (SDG 8 & 9), advancing non-toxic circularity and responsible production (SDG 12), improving ocean and terrestrial health (SDG 14 & 15), and reinforcing climate action (SDG 13).

This technical paper provides a consolidated assessment of the global landscape on chemicals and waste, including recent multilateral deliberations, current initiatives and challenges, and sectoral pathways. It is designed to inform G20 decision-makers on where leadership can have the greatest impact in accelerating implementation and achieving the 2030 Agenda.

Four priority actions and recommendations are identified for G20 members:

1. Reduce the finance shortfall – mainstream chemicals management into national budgets, expand predictable grant funding, and unlock private capital through all financing mechanisms.
2. Reinforce global frameworks – renew commitment to effective implementation of the Basel, Rotterdam, Stockholm and Minamata Conventions, the Global Framework on Chemicals, operationalise the Intergovernmental Science–Policy Panel and deliver a life-cycle plastics treaty.
3. Make transparency the norm – establish global systems for traceability and safer substitution across value chains, phase out high-risk chemicals, and strengthen enforcement against illegal trade.
4. Accelerate action in high-impact value chains - Prioritise action in sectors with the largest health, environment and economic impacts – including electronics, textiles, construction, healthcare, agri-food, mining and cosmetics.

With coordinated G20 leadership, safer chemistry, non-toxic circularity, and resilient economies are achievable by 2030.

1 INTRODUCTION

The triple planetary crisis of climate change, biodiversity loss and pollution, including pollution from chemicals and waste, threatens human health, ecosystems and economies. Chemicals are indispensable for modern life, but unsound management creates high health and environmental costs, with disproportionate impacts on people in vulnerable situations.

Sustainable chemicals management throughout their lifecycle is therefore central to achieving the 2030 Agenda. It supports progress across multiple SDGs, including health, water, work, cities, production, oceans and land, while reinforcing climate and biodiversity goals. The benefits of prevention, safer alternatives and non-toxic circularity outweigh the costs of inaction.

A solid foundation for chemicals and waste management exists through the Basel, Rotterdam, Stockholm (BRS) and Minamata Conventions, the Global Framework on Chemicals (GFC), and the new Intergovernmental Science–Policy Panel on Chemicals, Waste and Pollution (ISP-CWP). Yet implementation gaps, limited transparency and traceability of chemicals in products and supply chains, and emerging issues such as PFAS, endocrine-disrupting chemicals and antimicrobial resistance remain. The G20, as the largest group of economies, can lead by accelerating implementation, scaling finance, and strengthening collaboration to advance sustainable chemicals management.

2 CURRENT MULTILATERAL DELIBERATIONS

There has been considerable and concerted international effort over the years to promote the environmentally sound management of chemicals and wastes to address the adverse effects of pollution on human health and the environment. This section commences by a summary of the actions taken within the G20 and then lists the primary Multilateral Environmental Agreements (MEAs) and other international initiatives and forums to address sustainable chemicals management, bearing in mind they all cooperate with one another.

2.1 G20 Actions on Waste Management and Circular Economy

Important contributions of past G20 presidencies include the creation of the G20 Resource Efficiency Dialogue by Germany's Presidency (2017); efforts by Japan's Presidency (2019) to promote resource efficiency, circular economy and waste management as pathways to tackle pollution; discussions under Italy's Presidency (2021) on how the circular economy can address climate change, biodiversity loss, land degradation and pollution and serve as an important lever for achieving the SDGs; and significant contributions from India's Presidency (2022) in recognising waste management as a global challenge and proposing a worldwide circular economy approach to address both pollution and climate change. The Brazilian G20 Presidency in 2024, included:

- **Science-Policy Panel**: In the agreed ECSWG Ministerial Declaration, G20 members highlighted the process of establishing a new Intergovernmental Science-Policy Panel to contribute further to the sound management of chemicals and waste and to prevent

pollution, informing policies and actions based on best available science, agreeing to engage constructively in its ongoing negotiations[2].

- **Health protection**: In its non-negotiated Waste and Circular Economy (W&CE) Technical Paper, when outlining proposed concepts and principles for an inclusive circular economy, Brazil Presidency highlighted that Circular Economy practices should not harm peoples' health, including addressing workers' occupational health concerns and the presence of hazardous or toxic chemicals in product compositions, which may persist or even be concentrated during recovery cycles[3].
- **Incorporating waste pickers into Multilateral Environmental Agreements**: In its non-negotiated W&CE Technical Paper, when proposing actions for raising ambition in an inclusive circular economy, Brazil's Presidency invited G20 members to consider, among other things, and according to their national needs, circumstances and priorities, to empower informal waste sector workers. The technical paper outlined how waste pickers can play an important role at the national level in the implementation of different MEAs, not only in waste management (e.g. the Basel Convention), but also in chemicals (e.g. Rotterdam Convention, Stockholm Convention and GFC) and others (e.g. the UNFCCC, CBD and the future legally binding instrument on plastic pollution). The paper recommended addressing waste pickers issues in national and local action plans at different MEAs, as well as at innovative financial mechanisms to support developing countries to integrate waste pickers into their systems.

2.2 The Basel, Rotterdam and Stockholm Conventions

The Stockholm Convention on Persistent Organic Pollutants (POPs) seeks to protect human health and the environment from these highly hazardous chemicals by requiring Parties to take measures to eliminate or restrict their production and use, as well as reduce their emissions into the environment. The Convention also encourages the avoidance of potential future POPs or other concerning chemicals by promoting safer alternatives and addresses the environmentally sound management and disposal of POPs wastes to prevent their release into the environment. The Global Environment Facility (GEF) serves as the Stockholm Convention's interim financial mechanism. As of June 2025, 37 POPs (industrial chemicals and pesticides) are listed under the Convention. Some of the listed POPs are PFAS, commonly referred to as "forever chemicals" 4. To date, four groups of PFAS have been listed under the Convention (PFOS, PFOA, PFHxS and LC-PFCAs) comprising of more than 870 related compounds covered by these listings. As part of the effectiveness evaluation of the Convention, the Global Monitoring Plan (GMP) showed that levels of the initial POPs (such as PCBs and DDT) are decreasing in humans and the environment. The trend of newer POPs,

[2] Available at https://www.gov.br/g20/pt-br/trilhas/trilha-de-sherpas/sustentabilidade_climatica_e_ambiental/ecswg_ministerial_declaration_20241003.pdf/@@download/file

[3] Waste and Circular Economy (W&CE) Technical Paper, available at: https://www.gov.br/g20/en/documents/sherpa-track

[4] Stockholm Convention, *List of all POPs and their applications*, available at: https://chm.pops.int/TheConvention/ThePOPs/AllPOPs/tabid/2509/Default.aspx

such as PFOS and PBDEs, has not been as evident and underscores the need for continued and expanded monitoring. The Convention, by removing hazardous chemicals from material cycles and products, contributes to circularity in value chains and, in this context, contributes to a higher level of company competitiveness and more resilient economies.

The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade supports countries in making informed decisions about importing hazardous chemicals that pose risks to human health and the environment. By promoting the exchange of information on the characteristics of a broad range of hazardous chemicals and their associated risks, it promotes their responsible use. As of September 2025, 57 chemicals (38 pesticides – including 4 SHPFs – 18 industrial chemicals, and 1 chemical in both the pesticide and the industrial chemical categories) are listed under the Convention.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal controls the transboundary movements of hazardous wastes and other wastes requiring special consideration, and promotes the prevention and minimization of their generation, as well as their environmentally sound management. The Convention advances the waste hierarchy and collective actions to address priority waste streams (plastic wastes, e-wastes, POPs wastes, mercury wastes, and battery wastes). It has helped eliminate some of the most harmful practices of toxic-waste dumping and protects countries from unwanted imports by subjecting waste movements to the prior informed consent (PIC) procedure, thereby contributing to sustainable global trade and circularity approaches across value chains. Recent developments under the Convention include the plastic waste amendments and the e-waste amendments, which clarify and enlarge the scope of waste controlled by the Convention, thereby increasing transparency and traceability in the global waste trade. In 2025, a new area of work was launched on used textiles and textile waste.

The BRS Conventions have a long-standing practice of working closely together, through what is known as the "synergies process", to enhance their effective implementation, promote coherent policy guidance, and enhance efficiency in the provision of support to Parties.

2.3 The Minamata Convention on Mercury

This global treaty seeks to protect human health and the environment from the adverse effects of mercury. In support of this objective, the Convention contains provisions covering the entire life cycle of mercury, including a ban on new mercury mines, the phase-out of existing ones, and the phase-out and phase-down of mercury use in various products and processes, control measures on emissions to air, and releases to land and water, and regulates the informal sector of artisanal and small-scale gold mining. The Convention also

addresses interim storage of mercury and its disposal once it becomes waste, sites contaminated by mercury, as well as related health issues.

2.4 The Global Framework on Chemicals

The GFC - For a Planet Free of Harm from Chemicals and Waste, a multi-sectoral, multi-stakeholder initiative, adopted in September 2023 during the fifth session of the International Conference on Chemicals Management (ICCM-5). The GFC sets out a comprehensive plan with five strategic objectives and 28 targets to guide countries and stakeholders to jointly address the lifecycle of chemicals, including products and waste (to reduce harmful chemical impacts, promote safer alternatives, and protect human and environmental health across industries and supply chains). ICCM-5 adopted multiple resolutions, including: resolution V/11 which endorses the formation of a Global Alliance on Highly Hazardous Pesticides (HHPs) to achieve the GFCs[5] targets; resolution V/5 whereby all emerging policy issues and issues of concern fall under the GFC until their allocation under the Framework is determined at the first International Conference of the GFC; and resolution V/8 on implementation arrangements and the development of implementation programmes.

A key step for advancing GFC work took place during the first session of the Open-ended Working Group (OEWG-1) of the GFC, on 24-27 June 2025. OEWG-1 operated as a preparatory body for the first International Conference of the GFC, and accordingly, it focused on taking stock of progress in the framework's implementation and the exchanging of ideas and views on ways to ensure effective implementation of the GFC. The OEWG examined implementation arrangements, including Implementation Programmes, operationalization of the Global Alliance on HHPs, financing arrangements through the new GFC Fund, proposals for a gender action plan, emerging policy issues, international cooperation, measurability indicators, health surveillance systems, and capacity-building strategies. A multi-stakeholder day was organised in the context of the implementation programmes to encourage further engagement from all the stakeholders. More specifically, regarding the Global Alliance, OEWG-1 received an update from the Food and Agriculture Organization of the UN (FAO) on the task force formed in 2023 to advance the operationalisation of the Alliance. Under emerging issues and issues of concern, among others, OEWG-1 was updated on the actions taken to manage per- and polyfluorinated alkyl substances (PFAS, see also Box 1) and the transition to safer alternatives, highlighting PFAS as a priority in many regions and

[5] The target states: "By 2035, stakeholders have taken effective measures to phase out highly hazardous pesticides in agriculture where the risks had not been managed and where safer and affordable alternatives were available, and to promote transition to and make available those alternatives".

emphasizing the need for holistic action, including the use of all types of activities, such as collaboration through the OECD.

The outcomes of OEWG-1 will inform preparations for the first International Conference of the GFC, scheduled for the end of 2026.

2.5 The Intergovernmental Science-Policy Panel on Chemicals, Waste, and Pollution

Established on the 20th of June 2025, under the mandate of UNEA resolution 5/8, the ISP-CWP, a new, intergovernmental body, will provide policymakers with robust, policy-relevant scientific advice to contribute to the sound management of chemicals and waste, and pollution prevention.

The ISP-CWP is expected to conduct global assessments, identify knowledge gaps, communicate complex science in policy-friendly formats, and integrate capacity for national decision-making in relation to the Panel's functions. It will also support horizon scanning to anticipate emerging threats and guide timely responses. The ISP-CWP will develop its own programme of work, based on submissions received.

The ISP-CWP is anticipated to promote cooperation and coordination with relevant chemicals and waste MEAs, other relevant international instruments and intergovernmental bodies (e.g., participating organization of the Inter-Organisation Programme for the Sound Management of Chemicals (IOMC)), and work alongside the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), to help ensure that all three pillars of the triple planetary crisis—climate change, biodiversity and nature loss, and pollution—are supported by strong global science-policy interfaces.

The Panel's foundational document was developed and agreed through an intergovernmental process from 2022 to 2025. The Secretariat of the Panel is hosted by UNEP. Its first plenary session is expected to take place in 2026.

2.6 Intergovernmental Negotiating Committee on Plastic Pollution

The resumed fifth session of the UN Environment Assembly (UNEA-5.2) in March 2022, adopted resolution 5/14 to develop an international legally binding instrument on plastic pollution, including in the marine environment, based on a comprehensive approach that addresses the full life cycle of plastic. Plastics are made of chemicals, and a 2023 technical report on chemicals in plastic published by UNEP and the BRS Secretariat emphasised the urgent need for global action on chemicals in plastic as part of the broader effort to address plastic pollution. Five sessions of the INC on plastic pollution were held to date. The second part of the fifth session took place in August 2025.

2.7 Antimicrobial Resistance - United Nations General Assembly Political Declaration and the 4th Global High-Level Ministerial Conference

Antimicrobial resistance (AMR) ranks among the leading causes of mortality. A recent study estimates that if left unchecked AMR will kill 39 million people between 2025-2050, which equates to three deaths every minute, and also contribute to 169 million deaths6. This would have devastating economic consequences, escalate healthcare expenditures and lead to large productivity losses.

The environment plays a key role in the rise and spread of AMR. Overuse and misuse of antimicrobials and exposure to pollution create favourable conditions for microorganisms to develop resistance. The environmental dimensions of AMR include pollution from hospital and community wastewater, effluent from pharmaceutical production, run-off originating from plant and animal agriculture and other forms of waste and releases.[7] Strengthening chemical and waste management is therefore a critical lever in global efforts to tackle AMR.

In September 2024, the UN General Assembly adopted the Political Declaration of the High-Level Meeting on AMR, recognizing that it is one of the most urgent global threats, and demanding immediate action to safeguard the ability to treat diseases, enhance food security, protect the environment, and advance the 2030 Agenda for Sustainable Development. Global leaders committed to a clear set of targets and actions, including reducing the estimated 4.95 million human deaths associated with bacterial AMR annually by 10% by 2030. The Declaration also calls for sustainable national financing and US$100 million in funding to help achieve a target of at least 60% of countries having funded national action plans on AMR by 2030. Moreover, the Declaration mandated FAO, UNEP, WHO and the World Organisation for Animal Health (WOAH) to establish an independent panel on evidence for action against AMR (IPEA) and update the Global Action Plan on AMR, with broad, transparent, and inclusive consultations with Member States.

Countries underscored the need for efforts at all levels to address AMR through a One Health approach, which recognizes that the health of people, animals, plants and the wider environment, including ecosystems, are closely linked and interdependent. The Declaration recognises the need for a multisectoral response combined with human, agricultural, animal, and environmental sector-specific interventions, and underscores the need to prevent and address the discharge of antimicrobials into the environment. This includes increased research and knowledge on the environmental dimensions of AMR to catalyse actions to address key sources of antimicrobial pollution. The 4th

[6] Report *Bracing for Superbugs: Strengthening environmental action in the One Health response to antimicrobial resistance* (UNEP, 2023).
[7] Report *Bracing for Superbugs: Strengthening environmental action in the One Health response to antimicrobial resistance* (UNEP, 2023).

Global Ministerial Conference on AMR held on 15 and 16 November 2024, emphasised the need to implement the Political Declaration and provided elements to foster action to tackle AMR in a multisectoral manner. The Conference resulted in the "Jeddah Commitments on AMR".[8]

2.8 Intergovernmental Consultations on the Environmental Aspects of Minerals and Metals Management

At UNEA-5.2, the UN Environment Assembly, in its resolution 5/12, requested the Executive Director of UNEP to convene intergovernmental regional consultations and a global consultation to develop non-prescriptive proposals to enhance the environmental sustainability of minerals and metals along their full life cycle, in line with the 2030 Agenda for Sustainable Development. Twenty-four such proposals were put forward and considered by UNEA-6 in March 2024 which adopted resolution 6/5, on environmental aspects of minerals and metals. In response to that resolution, a Digital Knowledge Hub is under development to compile existing good practices relevant to the environmental aspects of minerals and metals; as well as capacity building and partnerships are being strengthened, as mandated. Further actions on the environmental aspects of metals and minerals may be considered by UNEA-7.

2.9 Non-Communicable Diseases

The UN Inter-Agency Task Force on the Prevention and Control of Non- Communicable Diseases (NCDs) provides a platform for cooperation among UN system agencies and intergovernmental organisations to support governments in addressing NCDs and mental health conditions. Its actions help to advance the commitments made in the Political Declaration of the 2011 High-level Meeting of the General Assembly on the Prevention and Control of NCDs, and further elaborated in the WHO Global Action Plan for the Prevention and Control of NCDs 2013-2020, now extended to 2030.

The 2018 Political Declaration of the High-level Meeting included air pollution as a fifth shared risk factor.[9] Growing scientific evidence also highlights the role of exposure to hazardous chemicals, including endocrine-disrupting chemicals (EDCs) in the development of NDCs such as hypertension and diabetes mellitus, among others.

UNEP contributes to the work of the Task Force by addressing air pollution and other environmental risk factors. The fourth high-level meeting on NCDs is scheduled for 25 September 2025 during the 80th United Nations General Assembly in New York.

[8] https://amrconference2024.com/documents/16_11_THE_JEDDAH_COMMITMENTS.pdf
[9] The other four being tobacco use, unhealthy diet, physical inactivity and harmful use of alcohol.

2.10 Africa Regional Strategy (2025–2035)

The African Union Strategy for Building a Safer and Greener Africa's Future and Action Plan for Environmentally Sound Management of Chemicals and Wastes (2025 – 2035)[10] was endorsed by AMCEN in July 2025. The strategy provides a unified framework to strengthen laws and institutions, build laboratory and monitoring capacity, scale Pollutant Release and Transfer Registers (PRTRs) and digital tracking, operationalise EPR, revitalise the Bamako Convention, and mobilise finance in alignment with Agenda 2063 and the Global Framework on Chemicals. It emphasises Regional Economic Communities (REC)-level harmonisation, data systems, and anti-illegal waste trafficking measures, with measurable key performance indicators (KPIs) to 2030/2035.

3 CURRENT INITIATIVES, DEBATES AND ONGOING CHALLENGES

3.1 Issues of Concern

In 2020, UNEP prepared the report "An Assessment Report on Issues of Concern: Chemicals and Waste Issues Posing Risks to Human Health and the Environment" to provide UNEA-5 and other international fora with a comprehensive overview of current chemical and waste-related challenges. The report focuses on eight priority issues identified under the Strategic Approach to International Chemicals Management, now succeeded by the GFC: chemicals in products, endocrine-disrupting chemicals, environmentally persistent pharmaceutical pollutants, hazardous substances in electrical and electronic product life cycles, HHPs, lead in paint, nanomaterials, and PFASs (see Box 1). It draws on findings from the Global Chemicals Outlook II (GCO-II) in identifying key challenges and opportunities for progress. The report also examined 11 substances such as arsenic, bisphenol A, glyphosate, microplastics, and phthalates, with emerging evidence on exposure data

Box 1

Per- and Polyfluorinated Alkyl Substances (PFAS)

PFAS are a very large and diverse group of chemicals with unique properties used widely in applications and products. Because of their unique characteristics such as high persistence in the environment and accumulation in humans, these chemicals are raising global concerns. There is growing interest by regulators across countries to address legacy and novel PFAS.

Given the large number of existing PFAS, a group approach is needed when assessing their risks and deciding on the appropriate risk reduction measures. While a number of PFAS are regulated at an international level (through the Stockholm Convention, see above), regulators are struggling to decide on risk reduction measures for other PFAS due to lack of (eco)toxicity data or challenges in balancing industrial uses against health and environmental risks.

[10] Building a Safer and Greener Africa's Future: African Strategy and Action Plan for Environmentally Sound Management of Chemicals and Wastes, 2025 - 2035

and associated health and environmental risks highlighted by GCO-II. The report concluded "ambitious international action is urgently required to ensure the global goal of sound chemicals and waste management in ways that lead to minimised adverse effects on human health, and the environment is reached in the foreseeable future."

In February 2022, UNEA-5 recognised the need to take further action to reduce or eliminate the risks associated with the chemicals and waste issues discussed in the report. In response to resolution 5/7, UNEP conducted a consultation process. Stakeholders emphasized the urgent need for international action to address the 19 identified issues of concern related to hazardous chemicals and waste, highlighted the serious health and environmental impacts, especially on vulnerable populations such as women, children, the elderly, and informal workers. Principles such as the precautionary approach, polluter pays, and extended producer responsibility were cited as essential for guiding future action and stressed the importance of recognizing the interconnectedness of human and ecosystem health. In March 2024, UNEA-6, in resolution 6/9, welcomed the summary analysis of stakeholders' views and requested the Executive Director to prepare a report building on existing measures and initiatives to address lead, cadmium, arsenic and organotins, while continuing to support Member States in their actions, for consideration by UNEA-7.

As highlighted earlier, in accordance with ICCM resolution V/5, all emerging policy issues and issues of concern were transitioned on an interim basis as part of the GFC, until the first International Conference of the GFC, at which time their path under the Framework will be determined.

3.2 Sectoral Approach for Chemicals Management

As previously noted, the GFC addresses the entire life cycle of chemicals. It is multi-stakeholder and multi-sectoral in nature and encompasses the involvement of all relevant sectors. In preparation of the first International Conference of the GFC, stakeholders are developing Implementation Programmes to tackle key challenges, such as incorporating chemicals and waste management best practices into various sectors.

Progress on the following issues would contribute meaningfully to the implementation of the GFC and the achievement of its objectives and targets, and other chemicals and waste MEAs:

3.2.1 Cross-cutting issues.

- **Transparency and traceability** of chemicals in products along their full life cycle in complex global supply chains, including textiles, electronics, cosmetics, food contact materials or toys. This would improve access to information to all actors across the value chain regarding the chemical content and their associated risks, enabling safer choices and regulatory compliance. In sectors such as pharmaceuticals and agri-food,

this also links directly to broader public health concerns such as AMR and the use of HHPs.

- **Adequate and accessible financial resources** are essential to support innovation, capacity-building, and implementation, especially in developing countries and small enterprises, creating a foundation for cross-sectoral collaboration and sustainable chemical management aligned with global health and environmental goals. Currently, the GFC Fund has limited resources, and other mechanisms, such as the GEF, could play a greater role in supporting GFC implementation.
- **Green and sustainable chemistry** allows for the identification of non-chemical and chemical alternatives to hazardous chemicals through the redesign of processes and consideration of impact along entire value chains.
- **Adequate legal and institutional frameworks**, and enforcement capacity are crucial for effectively managing hazardous chemicals, waste and pollution. National legislation should be backed by rigorous enforcement, clear and accessible reporting mechanisms, and comprehensive training programmes.
- **Leveraging and streamlining control measures** under MEAs across all sectors helps ensure that the environment and human health are comprehensively protected from the impact of pollution.

3.2.2 Sector-specific issues.

- **Electronics:** A priority is to reduce hazardous substances across the product lifecycle. This includes promoting safer product design, enhancing e-waste management by reducing e-waste generation, increasing circularity and resource recovery, and implementing extended producer responsibility schemes.
- **Textiles**: Eliminate toxic chemicals in dyeing and POPs chemicals in some finishing processes, adoption of safer alternatives, and full traceability of chemicals in products.
- **Construction**: Promote the use of safer, sustainable alternatives, including integrating chemical safety into green building codes and procurement policies, as well as creating non-toxic material cycles.
- **Healthcare and Pharmaceuticals**: An important priority is to prevent and address environmental releases of active pharmaceutical ingredients that may be persistent, bioaccumulative or toxic as well as other hazardous chemicals from manufacturing processes, while ensuring access to important human and veterinary medicinal products. Some of these compounds present AMR risks, and cause endocrine disruption once emitted into the environment, especially since most wastewater processing plants are not equipped to eliminate such chemicals from wastewater.
- **Mining**: Minimize the use of hazardous chemicals and pollution along the full life cycle of minerals and metals value chains, including extraction, on and off-site processing, refining, management of mining waste and tailings, rehabilitation of sites and closed or

abandoned mines, manufacturing and recycling. Hazardous chemicals minimisation includes mercury and cyanide through safer technologies and best practice.

- **Cosmetics**: Identify and eliminate harmful ingredients such as mercury used for skin lightening, improve product labelling, and promote innovation in safer formulations.
- **Agri-Food**: Institute effective measures to phase out HHPs in agriculture where the risks have not been managed; where safer and affordable alternatives are available; and to promote the transition to and availability those alternatives. The transition towards safer alternatives should consider the three dimensions of sustainable development, i.e., environmental, social and economic. In particular, the incremental costs associated with substitution, the frequent patent protection and higher costs of newer molecules, and the need to ensure a just transition for farmers and producers, especially in developing countries. The sector also needs to address AMR through integrated pest management and safer chemical and non-chemical alternatives. Enhancing traceability and regulatory oversight in food production systems contributes to GFC objectives on ecosystem health, food safety, and sustainable agriculture.

3.3 The Basel, Rotterdam and Stockholm Conventions

Collectively, the Basel, Rotterdam and Stockholm conventions protect human health and the environment by comprehensively addressing hazardous chemicals and wastes across their life cycles and in all relevant sectors. Looking ahead, the areas of focus under the conventions include the following:

Under the Basel Convention, efforts are ongoing to identify further options to improve the functioning of the prior informed consent procedure; to strengthen compliance; to review the hazardous wastes it regulates; to explore the challenges faced by Parties in relation to used textiles and textile wastes; to monitor, prevent and punish illegal waste trafficking; and protect human health and the environment from priority waste streams, such as plastic wastes, e-wastes, POPs wastes, used and waste tyres, waste batteries and mercury waste. With the adoption of the strategic framework for the implementation of the Convention for the period 2025-2031, the Conference of the Parties has also put in place a process to monitor progress in achieving the Basel Convention's objectives.

Building on the progress made under the Stockholm Convention to eliminate POPs, efforts are focusing on accelerating the elimination of listed POPs and the disposal of their wastes to achieve the Convention's goals. The PCB 2025 and 2028 deadlines are particularly critical. COP-12 welcomed the report assessing the funding needs of developing country Parties and Parties with economies in transition for the implementation of the Convention over the period 2026–2030. The assessment estimated that over USD 18 billion will be required to support the implementation of the Convention during that period, which will require innovative scale- up of finance. The 2025 BRS COPs requested the preparation of a resource mobilization strategy from non-state actors for the Africa and GRULAC regions. A most

recent need is to enable Parties to conduct national inventories of newly listed POPs and develop their associated national implementation plans, to transition to safer alternatives, and handle POP wastes to prevent them from entering recycling streams. In addition, scientific work under the Convention continues to identify new POPs to be targeted for elimination, while the newly established compliance committee will initiate its work to improve implementation and compliance with the Convention. Finally, the third evaluation of the effectiveness of the Convention has been launched, which will allow a comprehensive review of progress achieved by the Convention towards achieving its objective.

Under the Rotterdam Convention, strengthening implementation and compliance, as well as enhancing the effectiveness of the Convention remain the priority areas of work. In addition, building on the recent successful listing of two additional chemicals (Annex III to the Convention), to make them subject to the Convention's prior informed consent procedure. Work continues on a range of pesticides and industrial chemicals, subject to final regulatory action adopted by respective Parties to ban or severely restrict their use, and to identify chemicals that meet the relevant threshold to be controlled under the Convention.

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

As the world's largest economies, G20 members should lead by example in advancing sustainable chemicals and waste management, championing finance, innovation and enforcement, and knowledge sharing, capacity building and partnerships to accelerate delivery of the 2030 Agenda. Four priority areas are identified:

4.1 Finance: Commit to reducing shortfalls by unlocking new and additional sources of funding.

- Commit to strengthening financing for chemicals and waste management by fully applying the Integrated Approach to Financing (ensuring mainstreaming of sound chemicals and waste management into national budgets and development plans, securing industry involvement through cost-sharing measures, such as EPR; and mobilizing dedicated external financing from multilateral and bilateral resources)
- Support the mobilization of increased and predictable financial resources under MEAs and international frameworks (e.g., scaling up allocations for chemicals and wastes under the GEF and other funds).
- Encourage innovative financing partnerships and schemes (to mobilize additional resources from non-state actors by embedding pollution-related risk assessments into investment and financing framework, scaling up blended finance such as pollution bonds, applying de-risking strategies to attract private capital, and integrating chemicals financing across the climate, biodiversity and health agendas)

4.2 Existing MEAs: Reaffirm and strengthen global frameworks to deliver results.

- Reiterate continued commitment to the effective implementation of the Basel, Rotterdam, Stockholm, and Minamata Conventions, the GFC, and the new ISP-CWP.
- Invite countries to strengthen coordination, collaboration and synergies at the national level to enhance implementation of their respective obligations and commitments under MEAs, while respecting their individual mandates, recognizing the potential co-benefits that those synergies and cooperation may provide.
- Resource and operationalize the ISP-CWP to enable the swift convening of the Panel's first Plenary session and the adoption of its initial work programme, thereby allowing the Panel to effectively deliver on its functions.
- Accelerate and support negotiations towards the adoption of a legally binding instrument to end plastic pollution, including in the marine environment, based on a comprehensive approach that addresses the full life cycle of plastics in line with the mandate of UNEA resolution 5/14.

4.3 Cross cutting enablers: To advance transparency, safer substitution and enforcement.

- Strengthen labelling and promote global action on transparency and traceability of chemicals in products and supply chains (including interoperability with emerging digital product passport systems, harmonised reporting formats, and sector pilots in textiles, electronics and construction) to enable safer substitution, innovation in sustainable chemistry, and informed consumer choice.
- Encourage countries and companies to invest in robust data systems, digital trade permits, safety data sheets and traceability platforms to ensure that chemicals are used appropriately along the value chain of products. These tools should link waste producers, handlers and recyclers, supporting transparency, circular economy exchanges and compliance with MEAs
- Promote the production of safe and sustainable chemicals by design, and encourage the substitution of hazardous substances with safer alternatives, thereby enabling clean material flows that support reuse and recycling. This may include phasing out chemicals listed under relevant MEAs; applying a group approach for risk assessment for chemicals of concern such as PFAS; supporting sustainable chemistry innovation; and aligning with circular economy strategies to avoid regrettable substitution.
- Support the development and strengthening of chemical monitoring systems to generate data on emissions and releases of chemicals into the air, water and soil, as well as contamination levels in key environmental media and biota, as well as on human exposure through biomonitoring. Such data are essential for informed decision-

making, early warning of emerging risks, effective implementation of relevant MEAs, and progress tracking towards global targets.

- Align green public procurement, building codes, food safety standards, and healthcare regulations with chemical safety and sustainability criteria to drive safer markets and protect workers, consumers, and communities.
- Enhance enforcement against illegal traffic and trade of hazardous chemicals and wastes, including through implementation of trade control procedures under relevant MEAs, and promote capacity-building and knowledge-sharing to support countries, particularly in developing countries, in their enforcement efforts.

4.4 Accelerate action: Prioritise high impact value chains on chemicals of concern.

- Advance action across high-impact value chains by reducing the use of hazardous substances, improving product design, scaling EPR schemes, and phasing out HHPs in agriculture by 2035. G20's support for African priorities — such as those outlined in the AU Chemicals and Waste Strategy (2025–2035) — could help build capacity, scale circular economy solutions, and reduce risks from plastics, e-waste, lead, mercury, and hazardous pesticides.
- Promote the environmentally sustainable management of minerals and metals along their full life cycle, in line with UNEA resolution 6/5, including through the new Digital Knowledge Hub and partnerships to scale best practices
- Address AMR by reducing environmental releases of pharmaceuticals, pesticides, and biocides through a One Health approach, linking actions across agriculture, food systems, and healthcare.
- Create enabling environments and promote market incentives for cleaner, circular, low-pollution solutions, while strengthening capacities for the sound management of chemicals and waste in high-impact value chains. Acknowledge the growing and persistent risks posed by PFAS to human health and ecosystems, and the need for holistic, coordinated action, and commit to enhancing information exchange and cooperation among G20 members to accelerate efforts on PFAS, with a focus on transitioning to safer alternatives.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Circular Economy and Extended Producer Responsibility (EPR)

How G20 countries are embedding circular economy in policy frameworks and implementing Extended Producer Responsibility (EPR)

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EXECUTIVE SUMMARY

The circular economy offers an opportunity to decouple economic growth from resource consumption by designing out waste and pollution, circulating products and materials, and regenerating nature. In doing so, the circular economy addresses interconnected global challenges, from climate change and biodiversity loss to material insecurity and pollution. Under South Africa's 2025 G20 Presidency, the ECSWG is well-positioned to advance this transition through coordinated action, knowledge exchange, and policy alignment.

Circular economy policy in G20 national policy frameworks is fragmented. While examples of circular policy innovation and best practices can be found across the G20, challenges remain around limited linkages to upstream design policies, underutilised fiscal and market levers, limited cross-ministerial coordination, and underdeveloped data and measurement systems. Addressing these barriers will require a comprehensive and coherent policy approach.

The paper recommends that G20 members:

- *Strengthen international coherence by aligning circular economy frameworks through multilateral platforms and shared implementation pathways*
- *Target high-impact sectors with tailored policy packages combining design standards, market incentives, measurement and monitoring systems, and infrastructure investment*
- *Embed circularity in innovation and industrial strategies by advancing enabling technologies and public–private partnerships*
- *Align fiscal and financial systems through subsidy reform and instruments like circular public procurement and blended finance*
- *Support inclusive capacity-building and governance by investing in skills and multi-level mechanisms that foster cross-sector collaboration*

EPR is one of a suite of policy instruments available to support the broader circular economy transition. It shifts the financial and operational responsibility of end-of-life products to producers and can incentivise producers to design products for a longer lifespan.

To maximise its potential, the paper recommends that G20 members:

- *Design EPR schemes around shared principles: mandatory, fee-based structures; eco-modulated fees; measurable performance targets; and transparent, multi-stakeholder governance*

- *Promote inclusive implementation by recognising informal sector contributions*
- *Strengthen global material traceability and enhance transboundary cooperation*

EPR is just one example of the policy instruments needed to drive systemic change within a broader circular economy policy mix. As stewards of over 80% of global GDP, G20 members have both the responsibility and opportunity to lead. By advancing aligned, inclusive, and ambitious policy action, the G20 can help shape a just, circular, and climate-resilient global economy that protects biodiversity and regenerates natural ecosystems.

1 INTRODUCTION

1.1 Scope and Objectives

This technical paper has been written by the Ellen MacArthur Foundation at the request of South Africa's Presidency of the Group of Twenty (G20). It serves as a reference document for the subcommittee discussion on circular economy[2] and Extended Producer Responsibility (EPR) implementation under the Chemicals and Waste Management priority, and the theme "Solidarity, Equality, Sustainability".

It explores how G20 members are adopting the circular economy and EPR, a key policy instrument to operationalise it. While the circular economy provides a broad solutions framework for sustainable resource use, EPR serves as an example of a key policy mechanism to realise these principles in practice.

The paper begins by outlining current multilateral discussions on circular economy and their coherence[3] with global environmental governance frameworks, followed by evidence-based insights on trends across the G20 and Africa. It identifies priority waste streams and sectors with high potential for transformation before moving on to examine the technology and

[2] Circular economy: A systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. It is based on three principles, driven by design: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature. It is underpinned by a transition to renewable energy and materials. Transitioning to a circular economy entails decoupling economic activity from the consumption of finite resources (Ellen MacArthur Foundation, 2021d).

[3] Policy coherence: The systematic promotion of mutually reinforcing policy commitments across government departments and agencies creating synergies towards achieving the agreed objectives (OECD, 2024a).

innovations; financial mechanisms and fiscal instruments; and the capacity building and knowledge transfer needed to support circular business models. This is followed by a deep dive on EPR. Finally, the paper ends with considerations for the G20 to take forward in policy discourse that strengthen global commitments towards sustainable waste management, circular economy adoption, and climate resilience.

1.2 Introduction and background

South Africa's G20 Presidency occurs amidst multiple global crises, including climate change, socioeconomic inequality, poverty, hunger, unemployment, technological transformation, and geopolitical instability. The UN Sustainable Development Goals (SDGs) Report 2024 revealed that only 17% of SDG targets are currently on track, with nearly half showing minimal or moderate progress, and progress on over one-third has stalled or even regressed (UN, 2024). These figures highlight an urgent need for more effective and accelerated action. The implementation of existing international frameworks, including the 2030 Agenda and its SDGs, is not delivering solutions at the pace and scale required to meet today's complex crises.

Against this backdrop, the ECSWG has a crucial opportunity and responsibility to drive impact. Central to its mission is strengthening the environmental dimension of the 2030 Agenda through ambitious priorities and targeted deliverables. Among these, scaling up circular economy and EPR approaches has emerged as a powerful, actionable pathway to both advance the G20's sustainable development objectives and serve as an economic pathway to better growth (G20 South Africa, 2024).

The **circular economy** provides a framework for economic renewal, driving innovation and industrial transformation. Crucially, it goes beyond waste management and recycling. By redesigning production and consumption systems, it fosters new forms of value creation that strengthen the relationship between the economy, people, and the environment, supporting more resilient growth (Ellen MacArthur Foundation, 2021e). As a design-led approach, the circular economy addresses pressing global challenges — such as the triple planetary crises of waste and pollution, climate change, and biodiversity loss — by eliminating waste, keeping materials in use, and regenerating natural systems.

Momentum is building, with the concept increasingly reflected in the G20 agenda, particularly through the G20 Resource Efficiency Dialogue (RED), a key platform for circular economy cooperation since 2017 (G20 Germany, 2017).

EPR, traditionally used as a waste management policy, has significant potential to evolve into a driver of circular economy outcomes. It is a policy approach that extends a producer's responsibility to a product's after-use stage, requiring companies introducing products to a

market to finance their collection and treatment at the end of life (OECD, 2016; Ellen MacArthur Foundation, 2024c).[4] This can deliver the dedicated, ongoing, and sufficient funding needed to establish collection systems at scale and to cover the net cost of managing all discarded products (Ellen MacArthur Foundation, 2024c). EPR has featured in G20 dialogues since 2020, including through the T20's[5] work on plastic products and packaging material (Bakshi, Bhattacharjya and Meidl, 2020), and was recognised as a promising circular economy instrument under India's 2023 G20 Presidency (G20 India, 2023).

2 CURRENT MULTILATERAL DISCUSSIONS

2.1 Circular economy in the G20

Over recent years, the G20 has progressively embedded circular economy principles and EPR into its sustainability agenda. Beginning with Germany's 2017 Presidency, which introduced the G20 RED, successive presidencies, including Japan (2019), Italy (2021), Indonesia (2022), India (2023), and Brazil (2024), have expanded their focus from marine plastic litter and food waste to more systemic circular economy strategies (G20 Brazil, 2024). India's G20 Presidency (2023) notably advanced the global conversation on EPR as a critical enabler of circularity, compiling a comprehensive technical document that outlines EPR models, implementation frameworks, and case studies across G20 members. During Brazil's 2024 Presidency, a vision for an inclusive circular economy was introduced, urging action on involving informal waste workers in formal systems and promoting EPR schemes as a tool for social equity and sustainable development (G20 Brazil, 2024).

Under South Africa's 2025 Presidency, the ECSWG continues this trajectory by aiming to strengthen G20 commitment and collaboration on the circular economy with EPR as a key policy instrument. In particular, this includes the development of action plans and legislation, capacity building, support for small enterprises, knowledge exchange, enhanced implementation, compliance, and monitoring across all levels (G20 South Africa, 2024).

[4] The design and implementation of EPR schemes vary across countries. For instance, some countries have adopted a shared responsibility framework for products' life cycles, in which producers, importers, retailers, public authorities, and other actors share obligations for collection and treatment at the products' end of life (e.g. Brazil's National Solid Waste Policy, Law 12,305).

[5] The T20 (Think20) brings together think tanks, G20 research institutes and countries invited by the rotating presidenc, to produce, discuss, consolidate and present ideas on how to face current and emerging challenges that may be addressed by the G20.

2.2 Circular Economy in the Context of Other Multilateral Discussions

Beyond the G20, key international frameworks have recognised the role of the circular economy. This signals a growing international consensus that transitioning to a circular economy is essential, not only for environmental resilience, but also for building inclusive and resilient global economies.

The United Nations Environment Assembly (UNEA) has recognised the value of circularity through a series of landmark resolutions, including UNEA Resolution 4/1 (2019), UNEA Resolution 5/11 (2022), UNEA Resolution 5/14 (2022) and UNEA Resolution 6/1 (2024).[6] The first Global Stocktake, initiated as part of the Paris Agreement to assess collective progress on its long-term goals, recognised the importance of transitioning to sustainable lifestyles and sustainable patterns of consumption and production in efforts to address climate change – including through circular economy approaches – and encouraged efforts in this regard (UNFCCC, 2023). This momentum was reinforced at COP29 through the first Ministerial Meeting on Circular Economy, which spotlighted the role of material efficiency and circular strategies in addressing the drivers of greenhouse gas emissions (UNEP, 2024).

The circular economy has also been recognised for the contribution it can make to the SDGs, especially to SDG 12 (Responsible Consumption and Production) (MacArthur, 2019), but also to the remaining 16 goals (Schröder and Barrie, 2024; UNEP, 2024), by offering a systemic approach to achieving economic prosperity, environmental sustainability, and social well-being.

The Convention on Biological Diversity's (CBD) Kunming-Montreal Global Biodiversity Framework does not explicitly recognise the circular economy as a means to deliver the global biodiversity objectives, but it aligns with circular economy principles, particularly in tackling unsustainable production and consumption. While not yet widely reflected in national biodiversity strategies and action plans, circular approaches and business models

[6] UNEA Resolution 4/1 (2019) promoted resource efficiency and circular practices across sectors (UNEP, 2019b), while UNEA 5/11 (2022) formally acknowledged the circular economy as a critical pathway to address climate change, biodiversity loss, land degradation, and the impact of water stress, pollution and the impact thereof on human health (UNEP, 2022a). UNEA Resolution 5/14 initiated the development of a legally binding instrument to end plastic pollution, recognising that tackling plastic pollution at scale requires systemic circular economy interventions (UNEP, 2022b). Although the negotiations at INC-5.2 were suspended without reaching an agreement, the process continues to underscore the need to eliminate problematic plastics, foster product design to circulate products and materials safely, and innovate away from the linear "take-make-waste" model (Ellen MacArthur Foundation, 2024a). Most recently, UNEA Resolution 6/1 (2024) reinforced the relevance of circular strategies in agro-industrial sectors (UNEP, 2024).

will be essential to transforming economic systems to value, preserve, and regenerate nature.

In line with this global momentum, the Co-Chairs of the International Resource Panel have called for stronger international stewardship of sustainable material use, including through the potential creation of an International Materials Agency to close governance and data gaps (International Resource Panel, 2025), which aligns closely with circular economy principles of keeping products and materials in use at their highest value.

3 TOWARDS A GLOBAL CIRCULAR ECONOMY: CURRENT STATE AND POLICY ENABLERS

3.1 Assessing the Circular Economy Transition in the G20

The G20 RED has established a policy foundation for circular economy cooperation (G20 Germany, 2017). As stewards of over 80% of global GDP (OECD, 2025), G20 members have both the responsibility and opportunity to lead.

As of 2024, 75 national-level circular economy strategies (including roadmaps, operational strategies, and calls to action) had been launched globally (Chatham House and UNIDO, 2024). These frameworks vary widely in scope and coherence, ranging from high-level visions to time-bound, legislatively backed action plans (Chatham House and UNIDO, 2024). At least 12 G20 members have a circular economy strategy or roadmap in place, representing almost 50% of global GDP, and these, combined with the growing uptake of circular policy instruments across other national policy documents, as well as the growing number of city and subnational circular economy strategies, demonstrate how the circular economy is gaining traction across the G20 (OECD, 2021).

Examples of circular policy innovation and best practices can be found across the G20, particularly regarding investments in interdisciplinary research, support of blended financial solutions, and workforce training. G20 members are also taking clear steps to integrate circular economy principles into broader national policy frameworks and data measurement efforts. However, few have established standardised metrics or tracking frameworks, hampering efforts to align national progress with global goals. This measurement gap is mirrored in the lack of harmonised international standards and legal definitions, which poses a major barrier to cross-border cooperation, particularly in secondary materials trade (Ellen MacArthur Foundation, 2025b).

Experiences from G20 members highlight that long-term political commitment, whole-of-government coordination – including alignment with sub-national governments to fully leverage the role of cities in the transition (OECD, 2021), and bringing business voices to the

table to ensure emerging circular economy policies are complementary to existing voluntary business efforts – strong accountability mechanisms, and inclusive stakeholder engagement are key to successful implementation (Ellen MacArthur Foundation, 2025b). Countries assessed with the highest levels of policy coherence have not only adopted holistic strategies but also supported them with legislation and dedicated funding.

More policy innovation and implementation are needed across the board, but particularly on policies that stimulate design, manage resources, and make the economics work for a circular economy. Many G20 members express a clear intention to make policy commitments in both upstream design thinking and circular resource management, yet the implementation of upstream instruments remains limited, underscoring the technical and institutional complexity of operationalising circular principles at scale. Further, while sustainable public procurement policies are relatively well deployed, fiscal levers such as taxation and subsidies remain aspirational or underdeveloped in most G20 members, limiting governments' ability to shift incentives away from linear models (Ellen MacArthur Foundation, 2025b). Finally, the policy landscape remains fragmented, with varying levels of ambition and implementation (UNEP, 2020; Ellen MacArthur Foundation, 2025b). Fragmentation is compounded by unsuitable institutional structures: circular economy governance often resides within environmental ministries with limited cross-ministerial coordination, leading to missed cross-cutting opportunities and undermining integration with climate, biodiversity, and industrial strategies (Ellen MacArthur Foundation, 2025b).

Opportunities for G20 members to consider: Advancing system change requires holistic policy commitments, improved coherence, and coordinated action across five key policy areas:[7] (1) stimulating circular design, (2) enabling effective resource management to preserve material value, (3) making the economics work for circular business models, (4) investing in innovation, infrastructure, and skills, and (5) fostering both multi-level government — including national, regional, and local authorities — and multistakeholder collaboration. Beyond improving national policy coherence, G20 members can strengthen international cooperation by aligning circular economy frameworks through multilateral platforms and shared implementation pathways.

3.2 African Leadership and Innovation in the Circular Economy

South Africa has emerged as a circular economy leader in Africa, helping to found the African Circular Economy Alliance (ACEA) in 2017 together with Rwanda and Nigeria (World

[7] The Ellen MacArthur Foundation has set out five universal circular economy policy goals that provide a framework for national governments, cities and businesses to accelerate the transition (Ellen MacArthur Foundation, 2021e).

Economic Forum, 2020), implementing a comprehensive national waste framework, including EPR (DFFE, Republic of South Africa, 2020), and — led by the African Circular Economy Network (ACEN) — developing Circular South Africa (CSA), a national circular economy stakeholder platform (Circular South Africa, n.d.). Additionally, the Department of Science, Technology and Innovation (DSTI) has developed a Circular Economy Science, Technology and Innovation Strategy, with support from the Council for Scientific and Industrial Research (CSIR), which also has several circular economy research and demonstration projects (CSIR, n.d.). The Department of Forestry, Fisheries and the Environment (DFFE) has tendered for a national circular economy action plan to be developed (DFFE, Republic of South Africa, 2024), further demonstrating its commitment to advancing implementation.

But South Africa is far from alone. Political momentum has accelerated in recent years, catalysed by ACEA, whose membership has grown to 15 countries (World Economic Forum, 2020; ACEA, n.d.). The 2019 Durban Declaration at the 17th African Ministerial Conference on the Environment (AMCEN) marked the first pan-African policy statement on the circular economy, reaffirmed at AMCEN-18 and -19 (UNEP and AMCEN, 2019, 2021, 2022). Building on this, the African Union, at its 37th Assembly, endorsed the Continental Circular Economy Action Plan, published in September 2025, to guide the continent's transition toward a circular, resilient, inclusive, and nature-positive economy (African Union, 2025).

As of 2025, at least 12 African countries have published national circular economy strategies, and many more are integrating circular principles into waste and plastics policy. Bans on single-use plastics are now in force in 36 countries, and 16 have introduced EPR schemes. Countries such as Rwanda, Kenya, and Tunisia are embedding circularity in broader development plans (Attafuah-Wadee and Tilkanen, 2020).

Opportunities for G20 members to consider: Despite challenges in enforcement, capacity, and data, momentum continues to grow, and African countries offer unique insights into circular economy implementation through informal sector models, community-led and decentralised infrastructure solutions, and innovations that often operate with limited resources (Attafuah-Wadee and Tilkanen, 2020; Rademaekers *et al.*, 2020; World Economic Forum, 2021; Okoya *et al.*, 2023). G20 members can actively engage with and learn from these experiences to inform more context-adapted, inclusive, and resilient circular strategies globally.

3.3 Prioritising Waste Streams and High-Circularity Sectors

Although the circular economy transition requires a whole-of-economy, and therefore whole-of-government, approach, global efforts so far have prioritised sectors with the highest potential for circular interventions — those characterised by high material intensity

and waste generation, substantial environmental footprint, opportunities for system-wide redesign, and increasingly, their relevance to economic resilience and material security. This lays important groundwork for the changes required at the macroeconomic level, and also aligns closely with the G20's overarching priorities of strengthening global commitments towards sustainable waste management, circular economy adoption, and climate resilience. The prioritised sectors include packaging and plastics, consumer goods including textiles and electronics, food and agriculture, and the built environment. Organisations like the United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO), United Nations Office for Project Services (UNOPS), World Economic Forum (WEF), Organisation for Economic Co-operation and Development (OECD), ACEA, Global Green Growth Institute (GGGI), ACEN, and the Ellen MacArthur Foundation are focusing on one or more of these areas.

While a sectoral approach is a strong starting point, policies must also address all areas of the economy, including low-value waste streams, through regulation and targeted subsidies for their safe collection and disposal. In parallel, cross-sectoral instruments — such as digital product passports and national roadmaps — can help align efforts across sectors and support systemic change.

3.3.1 Packaging and Plastics

Packaging and plastics typify the linear economy, where virgin resources are extracted, transformed into short-lived products, and ultimately discarded as waste. Plastics have made packaging much more cost-effective for companies, enabling widespread distribution, but their true costs are externalised, shifted to taxpayers via local waste systems, or to nature through pollution and degradation. Waste management systems in many parts of the world are already struggling to cope with current volumes and are not equipped to handle the increasing quantities placed on the market, nor tackle the unsustainable use of plastics. The material complexity and short use phase of packaging exacerbate the problem, driving pollution and resource inefficiency.

With the annual volume of plastics entering the ocean projected to almost triple, from 11 million tonnes in 2016 to 29 million tonnes by 2040 (Ellen MacArthur Foundation, 2022d), plastic packaging presents both a critical challenge and a major opportunity. While voluntary efforts, such as the Global Commitment, have demonstrated real progress uniting leading governments, businesses, and investors, even this initiative only currently represents 20% of the global market (Ellen MacArthur Foundation, 2023c). Changing the plastic packaging industry to create a circular economy will require closing the 80% gap and addressing every stage of its lifecycle — eliminating problematic and unnecessary packaging, innovating to ensure all packaging is reusable, recyclable, or compostable, and circulating all packaging in the economy and out of the environment.

Opportunities for G20 members to consider: As the world's largest economies and major plastic consumers, G20 members have a unique opportunity, and responsibility, to eliminate plastic pollution and waste. They can take immediate action by developing national legislation and programmes aligned with circular economy principles, for instance by implementing and strengthening EPR schemes, and by coordinating across the G20 to deliver the harmonisation and scale needed for investment in innovation, infrastructure, and compliance. While national and G20-level action is foundational, there is an urgent need for coordinated international action. Although negotiations towards a legally binding instrument to end plastic pollution have not yet concluded, G20 members can play a vital role in sustaining momentum, fostering alignment around ambitious circular economy goals, and ensuring progress continues (Ellen MacArthur Foundation, 2024a; OECD, 2024b).

3.3.2 Fashion and Textiles

Today, more than 80% of textiles are incinerated, landfilled, or leak into the environment after being discarded by their user. This is driven on the one hand by linear business models reliant on virgin materials and fast production cycles, economies of scale that incentivise high volumes to reduce unit prices, and marketing strategies that stimulate frequent purchases and short product use phases; and on the other hand by a lack of infrastructure for separate collection, sorting, reuse, and recycling. Poor design for durability and recyclability, combined with underdeveloped systems for separate collection and sorting, makes circularity economically and operationally challenging (Ellen MacArthur Foundation, 2024c).

Yet, this also presents a clear opportunity. A circular economy for fashion, where garments are used more, made to be remade, and produced from safe, recycled, or renewable materials, can strengthen economic resilience while drastically reducing environmental impacts (Ellen MacArthur Foundation, 2023b). Circular business models such as resale, repair, rental, and remaking could account for nearly a quarter of the global fashion market by 2030, unlocking a USD 700 billion opportunity (Ellen MacArthur Foundation, 2021a). EPR is one of the policy frameworks that can unlock this potential (Brown and Börkey, 2024).

Opportunities for G20 members to consider: G20 governments can play a catalytic role by introducing policies that mandate circular product design requirements, support the development of separate textile collection, sorting, and reuse infrastructure via mandatory-fee based EPR schemes, and exploring tax reforms that will incentivise circular business models. Additional measures could include environmental fee modulation based on product impact, regulation of marketing practices driving short product lifespans, and improved transparency on the environmental performance of textile products. Policy design should recognise the different legal and market constraints across countries to be truly effective.

3.3.3 Electronics

Electronics are among the fastest-growing global waste streams, generating over 62 million tonnes of e-waste in 2022, with only 22.3% formally collected and recycled (UNITAR, 2024). This growth is driven by planned obsolescence, complex design, and limited options for repair and upgrades. Yet, the sector holds significant potential for circular transformation through strategies such as designing for durability, modularity, and repairability, and scaling reuse, refurbishment, and responsible recycling.

Early progress is visible in pilot programmes and circular business models, including refurbished offerings and subscription-based services (Ellen MacArthur Foundation, 2018). Public-private collaboration is proving essential with roadmaps like the Circular Electronics Initiative (CEI), the Circular Electronics Partnership (CEP), and the Partnership for Action on Challenges relating to E-waste (PACE II) highlighting the policy, infrastructure, and market shifts needed for scale (PACE, 2021; CEP, 2024; Basel Convention, n.d.). Programmes such as the Sustainable Recycling Industries (SRI), implemented by the Swiss State Secretariat for Economic Affairs (SECO) in Ghana, Egypt, and South Africa, further illustrate this potential by promoting the sustainable integration of small and medium enterprises (SMEs) into the global secondary resource markets (SRI, n.d.).

Enhancing product traceability and transparency is also key to enabling circular flows — tools like digital product passports can support better tracking of material use across value chains. Furthermore, aligning industrial innovation with circular principles can generate jobs, enhance material security, and reduce emissions (Ellen MacArthur Foundation, 2019b; PACE, 2021), as demonstrated by China's circular innovation zones, where coordinated urban and industrial policy drives both competitiveness and environmental outcomes (Ellen MacArthur Foundation, 2019b).

Opportunities for G20 members to consider: G20 members can support these efforts through a policy mix including, but not limited to, mandating design standards and a right to repair for electronics; setting ambitious collection targets and enforcing EPR schemes; investing in reverse logistics, product traceability tools and secondary materials markets; and revising waste shipment and management regulations, alongside realistic measures suited to particular national contexts.

3.3.4 Food and Agriculture

Today’s food system is failing both people and the planet. Industrial agriculture is a major driver of greenhouse gas emissions, biodiversity loss, and pollution, while nearly one-third of food produced is wasted, even as millions go hungry. A circular economy offers a powerful alternative: one that regenerates nature, eliminates food waste, and provides healthy, nutritious food for all. Regenerative agriculture, through practices like agroforestry, crop

diversity, and rotational grazing, can rebuild soil health, improve biodiversity, and make agricultural systems more resilient to climate and market shocks. At the same time, designing out food waste through prevention, redistribution, and valorisation of inedible by-products can close resource loops and reduce environmental burdens. Reducing harmful inputs — such as excessive pesticide use and agricultural plastics — is also essential to minimise pollution and build long-term ecosystem resilience. In this context, circular solutions can also extend to integrated pest management, pesticide reduction, and new business models like chemical leasing for more efficient use of agrochemicals. Better aligning supply and demand is also critical to reducing oversupply and unnecessary waste, helping to ensure that food reaches those who need it while avoiding avoidable losses across the system (Ellen MacArthur Foundation, 2021c).

Opportunities for G20 members to consider: G20 members can influence change by aligning agricultural policies with regenerative outcomes, supporting infrastructure to reduce food loss and waste, and expanding innovations that redirect surplus food to where it's needed most. A key enabler is to create the incentives and standards that spur industry to redesign food products and portfolios, for example, reformulating offerings to use regenerative or by-product ingredients. By shaping policies that encourage circular design, through public procurement, incentives, or labelling standards, governments can accelerate a shift away from waste-intensive models.

3.3.5 Built Environment

The built environment accounts for nearly half of all materials extracted each year and contributes significantly to greenhouse gas emissions. With global construction demand projected to add the equivalent of one city the size of Paris every week until 2060, there is a critical window for the G20 to shape a more resilient, resource-efficient system (UNEP, 2017). Applying circular design principles — including regenerative approaches — offers a major opportunity to reduce emissions, cut material use, generate employment, and activate the economy, while creating more liveable, economically vibrant urban spaces.

In Europe, circular approaches that regenerate nature — such as increasing green and blue cover, expanding tree canopies, redeveloping brownfield sites, employing material-efficient design, and using low-impact materials, including bio-based materials — could unlock over half a trillion euros annually by 2035 (Ellen MacArthur Foundation, 2024b). Achieving this potential requires going beyond waste management, and embedding targets for circular product design, material efficiency, and extended lifespans of building elements. Instruments like sustainable public procurement, targeted taxation, and blended finance models can scale innovation and investment across the sector (Ellen MacArthur Foundation, 2025a). The National Circularity Assessment Framework (NCAF) Toolkit, developed by UNEP, UNOPS, UN-Habitat, and over 50 experts, provides countries with a practical, globally

applicable methodology to develop circularity roadmaps and accelerate national action in the built environment (One Planet Network, 2024).

Opportunities for G20 members to consider: G20 members can lead by integrating circular approaches and nature-based solutions, aligning fiscal and regulatory levers, strengthening circular monitoring systems, and investing in research and development (R&D) to support systemic transformation of the built environment that is both circular and regenerates nature.

3.4 Technology and Innovation for Circular Business Models

Technology and innovation are key drivers of the circular economy transition, enabling new business models and new product design. The G20 recognised the key role of technological innovation in 2024 by establishing the Research and Innovation Working Group (RIWG). New and emerging technologies, such as blockchain, the internet of things (IoT), artificial intelligence (AI) and immersive technologies, support the implementation of circular business models by increasing transparency, improving decision-making, and unlocking new value creation opportunities. However, as these technologies are adopted, their development must align with circular economy principles and all relevant stakeholders. Many rely on scarce and valuable materials, and their infrastructure is often energy- and resource-intensive. To avoid unintended trade-offs, technologies should be designed for durability, reparability, and material recovery. Embedding circularity into the technologies themselves ensures they support, rather than undermine, circular business models.

In particular, blockchain technology facilitates transparent and tamper-proof tracking of materials across supply chains, enabling reuse, remanufacturing, and recycling by providing real-time data on product composition, ownership, and condition. This is illustrated by the use of blockchain to track and trace the work of informal waste collectors in South Africa (Ellen MacArthur Foundation, 2022b), and to improve transparency in milk, palm oil, and coffee supply chains, helping to verify responsible sourcing from farm to factory (Nestlé Global, 2019; Nestlé Nespresso, n.d.). The IoT enhances supply chain visibility, supports predictive maintenance to extend product lifespans, and enables models like product-as-a-service, for example, to optimise the operation of building cooling systems (Ellen MacArthur Foundation, 2021b, 2022c). AI contributes by optimising operations through predictive analytics, automation, and intelligent resource allocation, improving energy use, logistics, and waste sorting (Barteková and Börkey, 2022). Immersive technologies, such as virtual, augmented, and mixed reality, help visualise circular systems and dematerialise experiences, fostering awareness and engagement (Ellen MacArthur Foundation, 2022a). For instance, the EU-funded ‘Farmer’s Intelligence Toolkit’ (FIT) project supports farmers

with real-time analytics through augmented reality, providing a streamlined crop management process (European Commission, 2019).

Opportunities for G20 members to consider: Advanced economies and emerging and developing economies face different challenges related to technological readiness, infrastructure, and investment capacity. The G20 is well-positioned to address these challenges and unlock the full potential of technological innovation in support of circular business models via international cooperation in areas such as technology transfer and collaboration along international supply chains, ensuring that technologies are accessible, affordable, and adapted to local needs.

3.5 Financial Mechanisms (Fiscal and Economic Instruments)

Transitioning to a circular economy requires coordinated public and private financing to scale innovation, infrastructure, and business models.

Development finance institutions such as the World Bank, European Investment Bank (EIB), and African Development Bank (AfDB) play a catalytic role by de-risking early-stage investments through concessional finance, guarantees, and technical assistance. The Circularity Exchange Network (CEN) exemplifies how multinational development banks (MDBs) are incorporating circular economy objectives into their sustainable development strategies (Circle Economy, 2025). Similarly, international platforms such as the UNEP Finance Initiative (UNEP FI), Platform for Accelerating the Circular Economy (PACE), and the World Business Council for Sustainable Development (WBCSD) have developed taxonomies, metrics, indicators, and disclosure tools to steer capital towards circular business models (UNEP FI, 2025; PACE, 2025; WBCSD, n.d.).

Climate finance can further support circular initiatives. The Circular Finance Roadmap offers guidance to embed circular principles into climate-related investment portfolios, strengthening their role in climate mitigation and adaptation strategies (Circle Economy and Dutch Ministry of Infrastructure and Water Management, 2022). Instruments like carbon finance, through Article 6 of the Paris Agreement, and green or sustainability bonds are increasingly supporting circular projects, with GGGI issuing billions of US dollars in green bonds to national governments (Republic of Rwanda, REMA and GGGI, 2024; GGGI, 2025).

Recent years have seen substantial growth in circular investments: between 2019 and 2021, assets in circular equity funds rose from USD 0.3 billion to over USD 8 billion, with over 35 corporate and sovereign bonds issued to support circular activities (Bocconi University, Ellen MacArthur Foundation, and Intesa Sanpaolo, 2021). The EIB has invested more than EUR 5 billion in 153 circular economy projects since 2020 (European Investment Bank, 2025),

while the African Circular Economy Facility (ACEF) aims to build on its current EUR 9 million capitalisation and secure an additional EUR 10 million by 2026 (AfDB, 2025).

Fiscal instruments play a vital role in stimulating demand and reducing risk, including public-private partnerships, sustainable public procurement, and tax reforms, such as shifting burdens from labour to virgin resource extraction, and aligning subsidies with circular economy principles (UNEP FI, 2020; Ellen MacArthur Foundation, 2021e; UNECE, 2022). Blended finance instruments and EPR schemes can unlock additional capital.

Scaling the circular economy requires both regional coordination and better support for informal workers and SMEs that drive repair, reuse, and resource recovery in many G20 economies. The African Continental Free Trade Area (AfCFTA), connecting 54 countries and a USD 3.4 trillion market, offers a platform to grow circular SMEs and cross-border supply chains (AfCFTA, 2024). To unlock investment, de-risking instruments, and tailored financial mechanisms are needed to overcome persistent risk perceptions and integrate these actors into formal financing channels.

Opportunities for G20 members to consider: G20 members are well-positioned to catalyse systemic shifts in how capital flows towards circular economy solutions because of their collective economic influence and their role in shaping global investment forums. By integrating circular economy priorities into global sustainable finance agendas, accelerating financial support to de-risk circular investments, and adopting fiscal instruments aligned with circular principles, G20 members can both stimulate demand for circular innovation and help mobilise financing for circular solutions.

3.6 Capacity building and knowledge transfer

Accelerating the circular economy requires coordinated capacity building and knowledge transfer across institutions, the private sector, and communities.

At the institutional level, education and vocational systems must embed circular principles, such as design for durability, systems thinking, and reverse logistics, into formal curricula. For example, India's Directorate of Education has introduced vocational courses in over 800 schools as part of the Samagra Shiksha scheme, equipping students with hands-on, industry-relevant skills (The Times of India, 2025). Reforming education systems is essential to equip future workers with both technical expertise and cross-sectoral competencies (Circle Economy, 2020; EESC, 2023).

Beyond formal education, knowledge-sharing networks, such as ACEA, ACEN, the European Circular Economy Stakeholder Platform (ECESP) and the Latin America and the Caribbean Circular Economy Coalition, play a key role in spreading best practices and aligning policies.

The ECSWG sub-working group on circular economy and EPR exemplifies international collaboration and leadership in this space.

Transitioning business models to circularity requires cross-cutting skills: systems thinking to understand interdependencies, design thinking for user-centric solutions, strategic leadership to drive change, and communication for stakeholder engagement. Yet, many businesses, especially SMEs, lack the clarity, capacity, or incentives to invest in upskilling (Circle Economy, 2020; EESC, 2023), highlighting the need for government support.

These skills must be embedded in ecosystems that foster supply chain integration and innovation, with support for technology and digital transparency (Ellen MacArthur Foundation, 2019b; Roland Berger, 2023). The World Circular Economy Forum (WCEF) accelerator session on "Developing essential skills for circularity" demonstrates how education providers, industry, and policymakers can co-develop training that addresses market needs and promotes inclusive access to emerging opportunities (World Circular Economy Forum, 2025).

In many G20 and emerging markets, the informal sector is vital for waste collection, repair, and reuse, often at little cost to governments or producers. In Kenya, it represents over 80% of employment and plays a central role in circular practices (Munro *et al.*, 2022). Yet, informal contributions are frequently excluded from policy, training, and certification systems. This marginalisation limits career prospects, particularly for youth and women, who face additional barriers like restricted access to apprenticeships. When supported by inclusive training, accreditation, and infrastructure, circular initiatives can create quality employment, particularly in labour-intensive sectors like repair and remanufacturing (Munro *et al.*, 2022; EESC, 2023; Ellen MacArthur Foundation, 2023a; Sitra, 2023).

Opportunities for G20 members to consider: Ultimately, building circular capacity requires breaking down silos between education, labour, and industrial policy, recognising informal skills, and creating inclusive pathways to decent work. Acknowledging the pivotal role of the informal sector in many economies, the G20 can lead by advancing integrated strategies that both recognise and harness these existing capacities. This includes education reform, public–private training, and inclusive workforce development, ensuring broad participation in the circular economy, and positioning the inclusion of informal workers as a key entry point for circular transitions.

The opportunities of the circular economy are broadly acknowledged, which has translated to the marked policy momentum we see today. To realise these opportunities, a full suite of policy instruments is needed, among them, one of the most established tools is EPR. The following section explains how well-designed EPR can translate circular principles into day-to-day practice, and why it should be established as a cornerstone of the wider policy architecture.

4 DEEP DIVE: DESIGNING EXTENDED PRODUCER RESPONSIBILITY TO SUPPORT A GLOBAL CIRCULAR ECONOMY

EPR holds the potential to deliver circular economy outcomes, shifting the financial and operational responsibility to producers and incentivising better product design. However, most EPR schemes focus on downstream waste management. This deep dive provides an overview of the current state of EPR implementation and explores opportunities to strengthen its role in supporting the circular economy agenda.

4.1 Extended Producer Responsibility in the G20

The 2023 G20 India Presidency technical paper "Knowledge Exchange on EPR for Circular Economy" marked a pivotal shift by formally linking EPR with the circular economy and the SDGs, broadening earlier discussions that focused primarily on plastic packaging waste. The paper offered a toolkit for EPR design, outlining key principles while emphasising the importance of local adaptation (G20 India, 2023).

EPR is increasingly being embraced by G20 members, with some countries adopting it as early as three decades ago. While a few proposed broad frameworks, most have taken a sector-specific approach, targeting packaging, electronics, batteries, tyres, and vehicles. More recently, EPR schemes have begun to expand to additional sectors such as textiles, furniture, and used oil (G20 India, 2023). EPR schemes are implemented in various forms across G20 countries, reflecting differences in regulatory frameworks, market conditions, and national contexts.

4.2 The Benefits of EPR for the Circular Economy

By making producers financially responsible for end-of-life product management, mandatory, eco-modulated, fee-based EPR schemes ensure dedicated, ongoing, and sufficient funding for separate collection and sorting systems to ensure materials are circulated back into use at their highest value. Despite extensive policy guidance (OECD, 2016; PREVENT Waste Alliance, n.d.; Basel Convention, 2019), EPR implementation has largely focused on downstream activities, such as collection, sorting, and often low-grade recycling. Yet, if it is designed with circular principles and implemented alongside complementary instruments, EPR can be a powerful enabler of the circular economy.

When well designed, EPR offers three additional systemic benefits: it attracts capital investment in the infrastructure needed to collect, reuse, and recycle materials at scale; it enables transparency and traceability of material and financial flows, essential for circularity and accountability; and it fosters collective action, aligning producers, regulators, and value

chain actors around common targets for collection, reuse, and recycling (Ellen MacArthur Foundation, 2024c).

By internalising end-of-use costs, EPR has the potential to shift incentives towards circular product design. Mechanisms like eco-modulation[8] encourage producers to prioritise reuse, repair, and recyclability. This also boosts domestic markets for secondary materials and supports job creation across reverse logistics, repair, and material recovery, generating new economic opportunities aligned with circular economy goals (Ellen MacArthur Foundation, 2021c).

While voluntary approaches can serve as entry points for early adopters, they tend to be fragmented, underfunded, and fail to offer a level playing field for businesses offering circular business models. In contrast, mandatory EPR systems provide the regulatory certainty needed to attract private and blended capital, and level the playing field. Without robust frameworks and complementary policies such as design standards, support for secondary materials markets, and resource classifications and definitions in waste, valuable materials will continue to be incinerated, landfilled, or lost to environmental leakage (Ellen MacArthur Foundation, 2024c).

To support change at scale, national EPR policies must align around shared principles. A common design approach for EPR schemes, anchored in circular economy objectives, can foster collective action while allowing local adaptation. Effective national systems require clear targets, standardised metrics, transparent reporting, and inclusive participation from producers, governments, civil society, and the informal sector (Brown, Laubinger and Börkey, 2023; Ellen MacArthur Foundation, 2024c; World Bank, 2024).

4.3 The role of Producer Responsibility Organisations

In most EPR schemes, producers typically transfer their obligations to a Producer Responsibility Organisation (PRO), which acts on their behalf. Producer fees fund the collection, recycling, and data management systems required to meet regulatory goals (World Bank, 2023). These schemes work only when funds are legally dedicated and transparently managed. Without robust regulatory oversight, countries with a single PRO risk becoming unaccountable monopolies, whilst countries with multiple PROs risk both a 'race to the bottom' with PROs lowering EPR fees to remain competitive, as well as challenges in identifying free riders. To function effectively, PROs must operate under clear, performance-based regulation, use transparent cost structures, procure services competitively, undergo

[8] Eco-modulation involves the modification of fees paid by producers in an EPR scheme based on product design criteria that rewards producers going beyond the minimum requirements of regulations (Laubinger *et al.*, 2021).

regular audits, and include multi-stakeholder governance, particularly involving civil society and the informal sector (Brown, Laubinger and Börkey, 2023; Ellen MacArthur Foundation, 2024c; World Bank, 2022; World Bank, 2024).

4.4 Inclusion of the Informal Sector in EPR Policy

Informal waste pickers provide essential environmental and public services by recovering and recycling significant volumes of materials, yet they are often unrecognised and underpaid (Ellen MacArthur Foundation *et al.*, 2025; World Bank, 2023). Their involvement in EPR systems is both a social imperative and a strategic opportunity, as it helps ensure a scheme functions effectively. Without the inclusion of all stakeholders, efforts are likely to be undermined by conflicting interests, for example, informal workers continuing to focus only on specific materials with the highest value, rather than recovering all materials (World Bank, 2022; World Bank, 2024).

Several G20 members have made efforts to formalise the role of the informal sector with mixed outcomes (WIEGO, 2022; G20 India, 2023). Before formal EPR frameworks were introduced, waste pickers in countries like India, Brazil, and South Africa played a critical role in the waste management sector, often achieving recycling rates on par with European countries, with little recognition or support (G20 India, 2023). India's early EPR policies mandated their inclusion, but recent, corporate-led models risk marginalising waste pickers (WIEGO, 2022). In Brazil, efforts to include waste pickers through shared responsibility and cooperative support were undermined by weak enforcement, insufficient funding, and limited municipal involvement (WIEGO, 2022). In South Africa, despite collecting the majority of recyclables, waste pickers remained underpaid until 2021 EPR regulations mandated their registration, compensation, and representation, though progress has been slow amid institutional transitions and evolving PRO priorities (PREVENT Waste Alliance, 2025; WIEGO, 2022; World Bank, 2023).

4.5 Creating a Common Understanding of EPR across Borders

Post-consumer products and materials increasingly cross borders for reuse, refurbishment, or processing. Yet, most EPR regulations end producer responsibility at the point of export, limiting the ability to manage discarded products where they ultimately end up. As global trade in reusable and waste products grows, extending EPR across borders needs to be explored to achieve a global circular economy, helping to track materials across jurisdictions (Brown, Laubinger and Börkey, 2023; GIZ, 2023; Ellen MacArthur Foundation, 2024c). Importantly, such approaches must not be used to justify the transfer of waste management burdens from developed to developing countries, but rather to ensure that responsibility and resources follow material flows. Robust EPR systems require transparent data to monitor

material flows, measure impact, and support enforcement. Digitalisation, through interoperable platforms and reporting protocols, can enable real-time data exchange between producers, regulators, and PROs (Brown, Laubinger and Börkey, 2023; G20 India, 2023).

The Global Action Partnership for Extended Producer Responsibility (GAP for EPR) serves as a valuable example of international cooperation. By fostering a shared understanding of EPR, supporting country-specific approaches, and building a global knowledge community, it demonstrates how platforms formed by multiple agencies can strengthen EPR frameworks and ensure that responsibility follows materials beyond borders (GAP for EPR, 2025).

4.6 Embedding EPR into a Broader Policy Mix to Support the Transition to a Circular Economy

EPR is most effective when embedded within a comprehensive circular economy policy framework. Currently, it sets the foundation for downstream system change, through measures including incentives to increase proper separation and collection, diverting or banning waste from landfill and incineration, and waste management policies that ensure environmentally sound disposal during the transition. However, to fully realise circular economy outcomes, these measures must be paired with upstream measures, such as product design regulations (e.g. reparability and durability), eco-modulated fees to incentivise better design, producer registers that track what products and quantities are placed on the market (essential for allocating EPR fees fairly and preventing freeriding), and market incentives for reuse and refurbishment. Public procurement and innovation funding can further support these shifts.

This policy mix combining both downstream and upstream measures ensures that production and recovery systems reinforce one another, unlocking systemic change (Ellen MacArthur Foundation, 2021e, 2024c).

4.7 Remaining Barriers to EPR

Despite the potential benefits EPR can deliver, implementation of EPR schemes to date has faced persistent barriers, including insufficient enforcement mechanisms, lack of reliable data infrastructure, industry resistance, and low public awareness. Donor-supported programmes, such as the work of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in Small Island Developing States, show that donor support, technical cooperation, and stakeholder capacity building are essential, especially where institutional and financial resources are limited (OECD, 2016; Brown, Laubinger and Börkey, 2023; GIZ, 2023).

Opportunity for the G20 to consider: To deliver circular economy outcomes, EPR must evolve (Laubinger *et al.*, 2021). The G20 has a dual opportunity: first, by supporting the development of EPR schemes that finance critical infrastructure, drawing on lessons from established models, and second, by championing a next-generation EPR approach that promotes upstream measures such as circular product design, extended use through reuse and repair, and reducing pollution. Even when starting with downstream infrastructure, the design of EPR schemes should anticipate and enable upstream action from the outset.

For G20 economies, EPR can be a strategic lever to accelerate the transition to a global circular economy. When implemented as a mandatory, eco-modulated fee-based system, EPR goes beyond managing waste; it channels investment, reducing pressure on public budgets; increases efficiency for waste management systems through increased access to market information, transparency, and data-driven decision making; and aligns collective action across borders and value chains. To maximise these benefits, the G20 can play a pivotal role in establishing a shared understanding of EPR by promoting international harmonisation — particularly around eco-modulation design criteria, product scopes, and classifications such as Harmonised System (HS) subcodes. Additional alignment with frameworks like the Basel Convention can further ensure that export and import flows are consistent with countries' resource management capacities.

The opportunity now lies in designing EPR systems that are equitable, enforceable, and aligned with the broader circular economy agenda. Given the wide range of EPR experience across the G20, particularly regarding product groups and socio-economic contexts, there is strong potential for peer learning, exchange of best practices, and capacity building. In addition, improved alignment across the G20 could strengthen national EPR systems and reduce implementation costs for firms.

5 PROPOSED G20 PRESIDENCY RECOMMENDATIONS AND CONSIDERATIONS

G20 members have a pivotal role to play in advancing the transition to a circular economy. In doing so, they can foster a more innovative, resilient, and resource-efficient economy, one that operates within planetary boundaries, supports climate and biodiversity goals, and delivers benefits for both people and business.

To raise policy ambition, accelerate upstream innovation, and strengthen global coordination, the following recommendations are proposed, recognising that effective action will require aligned efforts at both domestic and international levels: [9]

5.1 Foster Collaborative Action Amongst public and Private Actors for a Global Circular Economy

- **Strengthen international policy coherence and alignment through multilateral platforms**, such as the G20 ECSWG and RED, UN SDGs, UNEA, United Nations Framework Convention on Climate Change (UNFCCC) COP, CBD COP, Basel, Rotterdam and Stockholm Conventions (BRS COP), the Intergovernmental Negotiating Committee (INC) for a global plastics treaty, Global Alliance on Circular Economy and Resource Efficiency (GACERE), ACEA, and the Latin America and the Caribbean Circular Economy Coalition. Continued engagement through these forums is essential to foster greater alignment around circular economy principles and approaches, policy language and commitments, implementation pathways to strengthen the momentum for action, and coordination across schemes.
- **Focus policy action on high-impact waste streams and sectors**, such as packaging and plastics, consumer goods (including fashion and textiles and electronics), food and agriculture, and the built environment, to reduce waste, emissions, and environmental degradation, and catalyse innovation and opportunity. This includes adopting policy packages that include product design requirements, market incentives, and investments in circular business models, measurement and monitoring systems, and innovation and infrastructure. EPR schemes can serve as a key delivery mechanism.
- **Strengthen innovation systems that enable circular solutions** by embedding circularity in national innovation strategies, industrial policy, and digital agendas. G20 members can foster knowledge exchange, public–private partnerships, and investment in circular research, development, and innovation.
- **Align financial systems with circular economy goals** to scale investment and innovation in circular economy opportunities. G20 members could explore fiscal measures that reflect the environmental costs of virgin resource use, alongside tools such as sustainable public procurement and blended finance to de-risk circular investments and strengthen market signals.

[9] These recommendations are intended to inform G20 members and their applicability may vary depending on national contexts, priorities, and capacities.

- **Support inclusive capacity-building and institutional cooperation** to enable a just and inclusive circular transition. G20 members can draw on informal sector expertise, create support programmes for SMEs, and promote skills development programmes to support worker upskilling and transition, especially among disadvantaged and underrepresented groups, including women and youth. A multistakeholder and multi-level government approach — including national, regional, and local authorities — will be essential to strengthen implementation and avoid policy fragmentation.

To catalyse EPR as a key policy enabler within the broader circular economy transition, the following recommendations are proposed:

5.2 Enhance the Role of EPR within a Broader Circular Economy Policy Mix

- **Promote shared design principles for effective EPR systems**, including mandatory fee-based models, eco-modulated fees, clear performance targets, transparent governance structures, in particular that of PROs, and enforcement mechanisms. These principles can support innovation and mobilise private and blended capital needed for circular infrastructure.
- **Embed inclusivity and local context into EPR implementation** to ensure that EPR systems contribute to inclusive outcomes. G20 members can consider mechanisms that recognise the role of informal workers, SMEs, and community actors, and support multi-stakeholder design approaches.
- **Enhance global material traceability and transboundary cooperation,** working together to explore opportunities for improved traceability and transboundary cooperation to ensure the effective management of resources across jurisdictional borders. G20 members can consider investing in digital systems, shared tracking protocols, and data infrastructure to support accountability and improve system performance.

6 CONCLUSION

Accelerating the transition to the circular economy is both urgent and full of opportunities. The G20 can shape global trajectories through ambitious, coordinated policy action to deliver circular economies that help meet climate, biodiversity, and SDG targets.

EPR systems designed to drive upstream circularity, not just downstream waste management and recycling, can be a key enabler, and whilst there may be implementation challenges, these are surmountable with the right mix of fiscal, regulatory, and institutional tools.

A global transition to a circular and resilient economy requires leadership, long-term commitment, and cross-sector partnerships. Best practice examples of circular economy implementation across the world, particularly in developing nations, highlight the need to align approaches with local market systems and realities. This includes acknowledging the role of informal actors, addressing trade and customs enforcement gaps, and prioritising investment where it can be most effective. Governments, businesses, civil society, and international institutions will need to collaborate to harmonise approaches, recognising the need to adapt to local contexts as necessary, scale investment, and ensure inclusive participation.

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8 LIST OF ACRONYMS

ACEA: African Circular Economy Alliance

ACEF: African Circular Economy Facility

ACEN: Circular Economy Africa

AfDB: African Development Bank

AfCFTA: African Continental Free Trade Area

AI: Artificial Intelligence

AMCEN: African Ministerial Conference on the Environment

BRS COP: Basel, Rotterdam and Stockholm Conventions

CBD: Convention on Biological Diversity

CEI: Circular Electronics Initiative

CEN: Circularity Exchange Network

CEP: Circular Electronics Partnership

COP: Conference of the Parties

CSA: Circular South Africa

CSIR: Council for Scientific and Industrial Research

DFFE: Department of Forestry, Fisheries and the Environment

DSTI: Department of Science, Technology and Innovation

ECESP: European Circular Economy Stakeholder Platform

ECSWG: Environment and Climate Sustainability Working Group

EESC: European Economic and Social Committee

EIB: European Investment Bank

EPR: Extended Producer Responsibility

EUR: Euro

FIT: Farmer's Intelligence Toolkit

G20: Group of Twenty

GACERE: Global Alliance on Circular Economy and Resource Efficiency

GAP for EPR: Global Action Partnership for Extended Producer Responsibility

GDP: Gross Domestic Product

GGGI: Global Green Growth Institute

GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit

INC: Intergovernmental Negotiating Committee

IoT: Internet of Things

MDBs: Multinational Development Banks

NCAF: National Circularity Assessment Framework

OECD: Organisation for Economic Co-operation and Development

PACE: Platform for Accelerating the Circular Economy

PACE II: Partnership for Action on Challenges relating to E-waste

PRO: Producer Responsibility Organisation

R&D: Research and Development

RED: Resource Efficiency Dialogue

REMA: Rwanda Environment Management Authority

RIWG: Research and Innovation Working Group

SECO: Swiss State Secretariat for Economic Affairs

SDG: Sustainable Development Goals

SME: Small and Medium Enterprises

SRI: Sustainable Recycling Industries

UNEA: United Nations Environment Assembly

UNECE: United Nations Economic Commission for Europe

UNEP: United Nations Environment Programme

UNEP FI: United Nations Environment Programme Finance Initiative

UNFCCC: United Nations Framework Convention on Climate Change

UNIDO: United Nations Industrial Development Organization

UNOPS: United Nations Office for Project Services

WBCSD: World Business Council for Sustainable Development

WCEF: World Circular Economy Forum

WEF: World Economic Forum

WIEGO: Women in Informal Employment Globalizing & Organizing

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Waste Management and Waste- to-Energy

Waste policy guidance for Climate Change Mitigation and Energy Generation

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EXECUTIVE SUMMARY

The global surge in municipal solid waste (MSW), driven by rapid urbanization and economic growth, poses a severe threat to climate stability, environmental health, and public safety. Mismanaged waste—particularly in developing regions like sub-Saharan Africa—results in pollution, greenhouse gas emissions (GHG), and resource depletion. Traditional and unsustainable disposal methods, such as non-engineered landfilling and open dumping, demand urgent replacement with circular and integrated waste management systems. This technical paper evaluates the global waste management landscape, emphasizing the promise and challenges of waste-to-energy (WtE) technologies as part of the transition toward sustainability, which under the right circumstances is preferable to disposal in the waste hierarchy. WtE offers dual benefits: reducing the volume of waste while generating partly renewable energy. However, technology adoption faces considerable barriers in low-income countries, including high capital costs, inadequate waste collection infrastructure, and policy gaps. Also, broadly, further technology development need to carefully avoid creating lock-in effect of over-capacity. This paper underscores the need for policy coherence, investment in infrastructure, stakeholder collaboration, and inclusive approaches such as integrating informal waste pickers into formal systems. It also advocates for the selection of context appropriate technologies based on local waste composition and economic capacity. Drawing from recent G20 deliberations, the paper aligns waste management reforms with global commitments to the Sustainable Development Goals (SDGs) and the Paris Agreement. It outlines strategic policy recommendations, such as promoting extended producer responsibility (EPR), public-private partnerships (PPP), and digital innovations to modernize waste systems. The role of Africa in leading regional adaptation and circular economy strategies is highlighted, especially within the broader G20 framework. In summary, effective waste management and WtE technologies are essential tools in combating climate change, advancing sustainable development, and ensuring environmental justice. The paper presents a roadmap for action to ensure resilient, inclusive, and sustainable waste systems across developing and developed nations alike.

1 INTRODUCTION

The escalating generation of municipal solid waste (MSW) has become a critical global issue, significantly contributing to climate change, environmental degradation, and biodiversity loss. Rapid urbanization, industrialization, and population growth—across both developed and developing regions—have intensified the challenges associated with effective waste management, making it one of the most urgent sustainability concerns of the 21st century.

If left unaddressed, the unchecked increase in waste volumes will continue to strain ecosystems, compromise public health, and deplete natural resources.

Leading organizations such as the International Solid Waste Association (ISWA) and the United Nations Environment Programme (UNEP) have warned of the profound risks posed by mismanaged waste. Both emphasize that improper disposal practices represent a major global threat to human well-being, ecosystem integrity, and climate stability.

Traditional disposal methods like open dumping and non-engineered landfilling are environmentally unsustainable. These practices contribute to severe pollution through plastic accumulation, methane emissions, and toxic leachate, all of which harm air, soil, and water systems. Given the magnitude of these impacts, there is an urgent need to shift from linear, disposal-centric models to integrated, circular approaches that prioritize waste prevention, material recovery (reuse), recycling and where possible recovery (energy generation).

Among emerging solutions, waste-to-energy (WtE) technologies offer a promising dual benefit: reducing landfill dependency while generating partly renewable energy, but should be carefully developed to avoid creating a lock-in effect of over-capacity. This paper examines the global waste management landscape and advocates for immediate, coordinated action to strengthen national and regional waste strategies.

Key objectives include promoting a life-cycle approach to waste, enhancing national policy frameworks, fostering international collaboration, and investing in circular economy principles. Special emphasis is placed on energy recovery as a transitional strategy. Furthermore, the alignment of waste strategies with broader environmental, sub-regional, and international climate goals is vital to avoid a looming crisis in public health and environmental stability. The paper underscores the critical role of policy coherence, technological innovation, and stakeholder engagement in achieving long-term sustainability in waste management.

2 STATE OF WASTE MANAGEMENT AND WTE TECHNOLOGIES

The Global Waste Management Outlook 2024 (UNEP, 2024) reports that as of 2020, about 38% of global MSW disposal was uncontrolled (dumping and open burning). Regional distribution of MSW disposal paints a starker picture for the African continent with, for example, about 85% of MSW disposal in sub-Saharan Africa is uncontrolled disposal. However, waste collection coverage in African cities range widely and sub-Saharan Africa is forecast to become the dominant region globally in terms of total waste generation if current generation trends persist (UNEP, 2018). The Global report also indicates that a significant portion of uncollected MSW is from low-income countries particularly in Africa and Asia. Besides uncontrolled disposal and uncollected MSW, a significant global challenge with

waste management is transboundary movement. Transboundary waste movement poses major environmental and governance issues, especially for developing countries that frequently receive hazardous and non-recyclable waste from high income nations. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989) provides the global legal framework for regulating transboundary movement of wastes. The Convention, with 191 party countries, emphasizes environmentally sound management and requires prior informed consent of a receiving country before hazardous and certain other wastes are exported. Recent amendments such as the Plastic Waste Amendments (2021) have strengthened controls to curb illegal dumping and ensure greater accountability.

WtE is potentially a viable option in low-income countries facing uncontrolled waste disposal challenges. However, a lack of effective waste collection systems to move household waste out of communities into sustainable waste management systems is often at the core of MSW management challenges. Introducing waste treatment technology on its own, will not address the collection challenge. Furthermore, according to the World Bank (Hoornweg and Bhada-Tata, 2012), the composition of MSW in sub-Saharan Africa is significantly different when compared to global MSW. In sub-Saharan Africa, the organic fraction contributes 57% and plastic 13% of MSW while global MSW contains 46% organic waste and 10% plastic. A high percentage of organic waste in MSW means a high moisture content, which has a direct bearing on the management of the waste. Therefore, the selection of technology solutions must be informed by the composition of the waste stream and a comprehensive feasibility assessment.

WtE technologies refer to any waste treatment process that can produce usable energy in the form of heat or electricity from a range of waste materials. WtE technologies are broadly categorised into thermal (e.g., combustion or incineration, pyrolysis and gasification) and non-thermal or biochemical (e.g., anaerobic digestion, landfill gas recovery, fermentation, composting) treatment processes. WtE as a waste treatment technique sits below recycling in the waste management hierarchy (UNEP, 2019a) and considered to have a lower negative environmental impact compared to other disposal options such as controlled (incineration without energy recovery, landfilling) and uncontrolled disposal (open burning and open dumping). There are also arguments that WtE cushions the detrimental economic effects of an immediate and total transition to renewable energy (Khawaja et al., 2024; Kalyani et al., 2014; Stehlík, 2009). Despite recognition of a variety of WtE technologies, thermal WtE remains the most widely developed WtE technology accounting for about 88% of global WtE market (UNEP, 2019a; Varjani et al., 2022). However, the majority of thermal WtE technologies are in developed countries, led by Japan, France, Germany and the United States (UNEP, 2019a). In Africa, the Reppie plant in Ethiopia remains the only flagship thermal WtE plant. The abundance of organic waste resources in African countries have potential as feedstock for domestic or large-scale biodigesters through anaerobic digestion,

however, only a few advanced and commercial scale biodigesters such as the Bronkhorstspruit biogas plant in South Africa and Gorge Farm Energy Park biogas plant in Kenya are operational in Africa (Adeleke et al., 2021) and landfill gas-to-energy has potential to reduce the global warming potential by 72.2% in urban areas of Africa (Cudjoe and Han, 2021). Electricity recovery from MSW through landfill gas-to-energy technology is economically feasible in most African countries (Cudjoe and Han, 2021).

3 PAST G20 DELIBERATIONS AND COUNTRY POSITIONS

Previous G20 deliberations have culminated in Leaders' Declarations clearly articulating respective country positions. The themes are consistent with the broader commitments to sustainable and inclusive growth, climate resilience, and international cooperation and reflect the urgent need to align economic development with the complexities of emerging geopolitical, socio-economic, and environmental challenges. Despite all efforts, progress toward the Sustainable Development Goals (SDGs) remains inadequate, with many targets either stalled or regressing. Some gains have been reversed by the years of cascading challenges and crisis (G20, 2022; G20, 2023; G20, 2024). In 2024, G20 leaders reaffirmed their dedication to fostering a just world and protecting the planet, emphasizing the need to scale up climate actions in line with the Paris Agreement.

A prominent topic in recent discussions has been waste and secondary resource management. As economies grow, so does waste generation, necessitating responsible management strategies. The G20 has highlighted the critical role of international cooperation in advancing sustainable waste management and transitioning to a circular economy. Leaders have stressed the importance of reducing waste generation, particularly unmanaged and poorly managed waste, through initiatives like zero waste programs. Prioritizing waste prevention, reduction, reuse, and recycling has been identified as vital for combating plastic pollution and promoting environmental sustainability. These efforts align with global initiatives to end plastic pollution through fair, transparent, and legally binding instruments (G20, 2024).

Climate finance has also been a focal point of G20 deliberations. Leaders have emphasized the need to scale up climate finance and investment for developing countries (G20, 2024), ensuring these efforts are transparent, targeted, and aligned with global climate and sustainability goals. Support for both public and private investments in climate and environmental initiatives is crucial for reducing greenhouse gas emissions and advancing sustainable development. The G20 recognizes that such investments must align with the priorities and strategies of individual countries to maximize their impact. Implementing digital transformation opportunities to boost sustainable and inclusive growth is recommended. By addressing systemic inequalities and promoting equitable opportunities, the G20 aims to build resilient economies that benefit all segments of society. Moving

forward, the G20's ability to translate these commitments into tangible outcomes will be critical for achieving a sustainable and equitable future.

4 CURRENT INITIATIVES AND DEBATES

This section presents initiatives and debates on climate change and SDG priorities, waste management, WtE and barriers to the adoption of such technologies.

4.1 Climate Change and SDG Priorities

The SDGs, also known as the Global Goals, were adopted by all United Nations Member States in 2015. They represent a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030. These priorities, commonly referred to as the 5Ps of the SDGs; People, Planet, Prosperity, Peace, and Partnership, form the framework to achieve sustainable development through integrated social, environmental, and economic dimensions.

The Global Waste Management Outlook 2024 highlights how waste management is directly linked to all 17 SDGs (UNEP, 2024). For Africa, key SDG priorities include SDG 13 (Climate Action), SDG 2 (Zero Hunger), and SDG 6 (Clean Water and Sanitation), as these areas are critically impacted by climate change. The adverse effects of climate change, such as prolonged droughts and erratic rainfall, continue to undermine efforts to improve food security, water availability, and health outcomes. According to the UNDP South Africa Climate Change Adaptation Programme, South Africa's economy and livelihoods, for instance, are heavily dependent on climate sensitive sectors such as agriculture, forestry, and tourism (UNDP, 2025). Changes in temperature and precipitation patterns can significantly affect these sectors, leading to widespread social and economic disruptions.

Additionally, SDG 12: Responsible Consumption and Production also plays a crucial role in ensuring sustainable waste management and resource utilization. According to the United Nations, our planet is running out of resources, but populations are continuing to grow. If the global population reaches 9.8 billion by 2050, the equivalent of almost three planets will be required to provide the natural resources needed to sustain current lifestyles. A significant transformation in consumption habits is required, including a shift toward renewable energy sources and more efficient resource use. However, global crises have led to a resurgence of fossil fuel subsidies, which nearly doubled between 2020 and 2021 (IEA, 2022) undermining progress toward sustainable energy transitions.

Effective waste management and the integration of WtE systems are essential to addressing today's interconnected global crises. These solutions play a vital role in advancing multiple SDGs by combating climate change, reducing environmental degradation, and fostering inclusive economic growth. In South Africa, as in many other regions, WtE technologies are

being explored to simultaneously meet energy demands and waste management challenges. While SDG 12 focuses on responsible consumption, SDG 7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all. Waste-to-energy technologies contribute to both goals by converting waste materials into usable energy, reducing dependence on fossil fuels, and minimizing the burden on landfills.

This highlights the urgent need for targeted climate adaptation and mitigation strategies that align with the SDGs. These strategies must be inclusive, integrating local knowledge and traditional practices, promoting sustainable land use, and strengthening the resilience of vulnerable communities. Equally important is the role of government policy, international cooperation, and public-private partnerships in establishing effective pathways toward achieving the SDG targets.

Across the African continent, countries have made meaningful progress in confronting these overlapping challenges. Many have submitted Nationally Determined Contributions (NDCs) under the Paris Agreement, outlining their commitments to reduce greenhouse gas emissions and enhance resilience. These efforts are complemented by a growing policy shift from a linear to a circular economy. According to the Council for Scientific and Industrial Research (Padayachi et al., 2023), circular economy strategies focus on designing out waste and pollution while regenerating ecosystems thereby aligning environmental, economic, and social priorities.

Regional coordination is also gaining momentum. The African Adaptation Initiative (AAI), launched in 2018, supports sustainable agriculture, water management, and disaster risk reduction across the continent. In addition, the SADC Regional Circular Economy Strategy 2023 aims to enhance coordination and unified action among member states. These initiatives underscore Africa's commitment to addressing climate challenges and elevating waste management as a strategic sector. Africa's growing role in the global economy is reflected in the African Union's permanent membership in the G20, and its recognition in global forums such as the G20 Summit 2024 further emphasizes the continent's importance in international decision making.

At the local level, municipalities are increasingly aligning their waste management policies with specific SDGs. For example, reducing landfill use supports SDG 12.5, decreasing methane emissions contributes to SDG 13.1, and ensuring equitable access to sanitation addresses SDG 11.6. Indicator 11.6.1 specifically measures the proportion of urban solid waste that is regularly collected and adequately managed. Many municipalities monitor these efforts through sustainability dashboards or annual environmental performance reports, which provide transparent metrics to assess progress. Additionally, some pursue ISO 14001 certification to formalize their environmental management systems and publicly demonstrate their commitment to sustainability goals.

A comprehensive and inclusive approach to waste management, grounded in solidarity, equity, and sustainability, can drive significant progress across the African continent. By addressing the root causes of pollution, enhancing livelihoods, and building climate resilience, such efforts will contribute meaningfully to the broader global goals of sustainable development and environmental justice. This paper emphasizes the critical importance of prioritizing climate action within the broader SDG framework and offers a roadmap for policymakers and stakeholders working to foster resilience and sustainability in Africa, particularly within the South African context.

4.2 Waste Management

Waste management represents one of the most pressing yet often overlooked challenges in global environmental governance. Municipal solid waste generation has risen in tandem with urbanization, industrialization, and shifting consumption patterns. According to the Global Waste Management Outlook 2024, global MSW generation reached an estimated 2.3 billion tonnes in 2023 and is projected to increase to approximately 3.8 billion tonnes by 2050 under a business-as-usual scenario (UNEP, 2024). This exponential growth is concentrated in rapidly developing regions such as sub-Saharan Africa and South Asia, where waste generation is outpacing the capacity of municipal systems to manage it safely or efficiently.

There are stark inequalities in how waste is generated and managed across the globe. High income countries, despite comprising only 16% of the global population, generate over 30% of the world's waste, much of which is diverted to controlled treatment methods such as recycling, composting, or incineration (Kaza et al., 2018; UNEP, 2024). By contrast, in low- and lower-middle-income countries, waste collection rates can be as low as 40%, with up to 90% of the collected waste disposed of in open dumpsites or through open burning (Wilson et al., 2012; Hoornweg & Bhada-Tata, 2012). This disparity not only reflects economic and institutional capacity gaps but also has major implications for public health and the environment.

Poorly managed waste contributes substantially to global climate change. Organic fractions of waste, particularly food and garden waste, dominate MSW composition in lower-income regions and are the primary source of landfill methane emissions—a GHG with 84 times the global warming potential of carbon dioxide over a 20-year period (Saunois et al., 2020). It is estimated that waste contributes about 3% of total anthropogenic GHG emissions globally, with the bulk of it originating from landfills and open burning (Bogner et al., 2008). Furthermore, black carbon released from waste incineration and open burning has been identified as the second most important climate-forcing agent after CO_2, amplifying the urgency of controlling these practices (Bond et al., 2013; Wiedinmyer et al., 2014). The continued use of non-engineered dumpsites, particularly in regions with inadequate

regulatory oversight, not only accelerates emissions but also contaminates soil and groundwater, endangering terrestrial and aquatic ecosystems (Ferronato & Torretta, 2019).

Health impacts linked to mismanaged waste are significant, particularly in densely populated urban areas. Informal settlements near dumpsites are often exposed to hazardous emissions and vectors of disease, leading to elevated rates of respiratory illness, gastrointestinal disorders, and vector-borne diseases (Giusti, 2009). Epidemiological studies have linked prolonged exposure to landfill leachates and particulate matter from burning waste to chronic conditions including cancer, developmental abnormalities in children, and impaired immune responses (Rushton, 2003; Nweke & Sanders, 2009). The informal waste sector, comprising an estimated 15 million people globally, plays a critical role in resource recovery but operates under hazardous conditions without adequate occupational health protections or social security (Zolnikov et al., 2021).

Despite its risks, the waste sector remains underprioritized in global climate and development strategies. Waste management was historically excluded from the first round of NDCs under the Paris Agreement, though there is growing recognition of its mitigation potential (Pires et al., 2011; UNEP, 2015). Recent advances in WtE and material recovery technologies offer opportunities for integrating waste into circular economy strategies, but uptake is slow in low-income contexts due to high capital costs, inadequate technical expertise, and competing development priorities (Patrício Silva et al., 2020). Moreover, over-reliance on WtE facilities can undermine higher order waste reduction strategies if not properly aligned with upstream waste minimization and recycling initiatives.

A transition toward sustainable waste management systems necessitates a shift from linear, end-of-pipe approaches to integrated resource management. This includes establishing robust legal frameworks, incentivizing waste prevention and product stewardship, and a global policy trend towards ‘waste picker integration’, a term that does not have a commonly agreed definition. According to Samson et al. (2020) most agree that, at the very least, integration means treating waste pickers with respect, recognizing their knowledge and contributions, stopping discrimination against them, including them in decisions about recycling, making sure they can access materials, and helping them earn more and work in safer conditions. Furthermore, waste picker integration is advocated by international financial institutions, donor agencies, governments, non-governmental organisations and waste picker organisations (Samson et al., 2020). Economic instruments such as landfill taxes, pay-as-you-throw systems, and extended producer responsibility (EPR) schemes have proven effective in higher-income countries and are gradually being adopted in emerging economies (Nelles et al., 2016). The recently adopted EPR regulations of South Africa specifically require waste picker integration into EPR schemes including fair compensation for services and savings (South Africa, 2020). At the same time, significant investments are required to modernize waste infrastructure and to build capacity for data

monitoring, reporting, and verification—areas that remain critically underdeveloped in many regions.

A wide array of sustainable waste management practices can play a pivotal role in reducing environmental impacts and advance circular economy goals. *Waste reduction at source* is the most effective strategy, focusing on minimizing waste generation through product redesign, eco-packaging, and sustainable consumption habits. *Reuse and repair* initiatives extend product lifespans and reduce demand for virgin materials. *Recycling* remains a cornerstone of sustainable waste systems, enabling the recovery of valuable materials and reducing the need for resource extraction. *Composting and anaerobic digestion* of organic waste are essential for managing food and agricultural waste, producing nutrient-rich soil amendments and biogas while mitigating methane emissions from landfills. Finally, *EPR* and *pay-as-you-throw* policies incentivize more responsible waste generation and management behaviours across industries and households. Together, these practices support a hierarchy that prioritizes waste prevention and resource efficiency, with WtE serving as a complimentary option for non-recyclable residues.

4.3 WtE Technologies and Barriers to Adoption

As mentioned earlier, WtE technologies are broadly categorised into thermal and nonthermal or biochemical treatment processes. Thermal technologies use heat to convert waste materials into energy and include combustion or incineration, pyrolysis and gasification.

Incineration technologies utilise combustion of waste materials between 750 and 1100^{0}C in the presence of oxygen to produce heat or electricity. Currently, proven technologies for both prepared and unprepared wastes for WtE incineration include fluidised beds combustion and advanced moving grate combustion (ISWA 2022). The fluidised beds technology requires significant upstream waste preparation such as shredding and metal separation, while advanced moving grate is proven to treat unprepared wastes. The combustion process for fluidised beds is mechanically simpler than advanced moving grates but preparation, operation, waste and residue handling is more complex.

Gasification converts wastes, mostly solid waste materials, via partial oxidisation into liquid fuel or synthetic gas (syngas) with a high calorific value (ideally 10 to 18 MJ/Nm3). Syngas is majorly composed of hydrogen and carbon monoxide and can be used as feedstock to produce other chemicals or fuels or generate electricity. Gasification can be staged where low temperature gasification is followed by combustion of syngas (low quality syngas) and then recovery of energy in a single installation. High temperature gasification produces higher quality syngas, which with subsequent cleaning the syngas is supplied to a higher efficiency thermal process (gas turbine or a gas motor) or to produce liquid fuels.

Pyrolysis is the thermochemical decomposition of waste at temperatures between 500 and 800°C in the absence of air. This process produces char (e.g., converting wood into charcoal), pyrolysis oil and syngas. Nonthermal or biochemical technologies use chemical or biological processes to convert waste materials into energy and include processes such as anaerobic digestion, landfill gas recovery, fermentation and composting.

Anaerobic digestion is the breakdown of organic waste such as food, sewage sludge, residues from agriculture, etc. using microorganisms in the absence of oxygen. The biogas produced from this process is primarily made up of methane and carbon dioxide and can be used to generate heat or electricity or as fuel. Digestate remaining from the process can be used as a fertilizer in agriculture.

Landfills produce biogas naturally from the decomposition of organic waste materials. Where equipped, this biogas can then be captured and used to generate electricity or heat.

Fermentation is a biochemical process that can convert organic waste such as biomass into fuels like ethanol.

4.3.1 Benefits of WtE Adoption

Benefits of WtE include: a safe and clean way to treat residual waste; accommodates a variety of unprepared, mixed or degraded waste materials; enables recycling and material recovery by treating hazardous wastes; preventing contamination of the recyclable waste streams; recovery of embedded energy in residual waste, which in turn reduces reliance on fossil fuels for energy supply; recovery of metals and bottom ash for use in construction aggregates; and waste volume reduction for landfilling (ISWA, 2022).

Current developments indicate that maximizing WtE implementation and all its benefits rely on its specific link to local energy demand and consumption needs (industries, heating, cooling, agricultural, public facilities, etc.). It is thus important to define energy needs and applications at the early stages of WtE project implementation to help secure energy waste flows and improve social acceptability. Further discussions regarding the policy positions of the various technologies will focus more on incineration as it is the most widely used in developing or low-income countries (UNEP, 2019a). The key debate about WtE incineration centres on its role in the sustainability agenda. Aspects such as waste prevention, reduction, reuse and recycling are increasingly being prioritised by governments as more cost-effective and environmentally sound waste management approaches (UNEP, 2019b). There are views that WtE incineration goes against circular economy efforts in a variety of ways such as undermining efforts to reduce carbon emissions, disincentivising waste prevention, minimisation, recycling and reuse (European Commission, 2019; UNEP, 2019b). The EU, for example, has seemingly pulled funding for WtE incineration and identified new incineration plants as an example of non-compliance with the ‘do no significant harm’ (DNSH) principle

with legislation and policy focused on non- or less-emitting waste management approaches (European Commission, 2019). As would be discussed below under barriers to WtE adoption, these views and apparent shift in sentiment, however, aligns more with contexts where systems have developed enough to facilitate implementation of the 3Rs (reduce, reuse, recycle) in the waste hierarchy.

4.3.2 Barriers to WtE Adoption

Key barriers to WtE adoption include costs, institutional barriers, feedstock, legislation and national policies, scale and technical know-how, social acceptance (not in my backyard – NIMBY resistance) (Adeleke et al., 2021; Malav et al., 2020; IEA Bioenergy, 2023; ISWA, 2022; Khan et al., 2022; Maisarah et al., 2018; Mutezo et al., 2015; UNEP, 2019a; Williams et al., 2023). According to Adeleke et al. (2021), the main reasons for the limited application of advanced waste treatment technologies in Africa relate to high running costs, high standards involved in its operation and maintenance, lack of technical know-how, the heterogeneous nature of the waste stream and the additional fuel requirement for combustion due to the high moisture content of the waste. Regarding *costs*, large scale WtE implementation requires huge capital investments. Globally, most WtE incineration technologies are in developed countries where technological infrastructure is far more mature, and resources are more readily available. For low-income countries with more dire priorities like poverty, high setup and management costs of WtE plants remain a barrier to widespread adoption. For example, Africa's first WtE plant, the Reppie WtE facility in Addis Ababa was reported to cost $120m and was fully financed by the Ethiopian government. Where national governments do not fund these projects, WtE projects such as these will be too expensive for municipalities and regional government. *Institutional barriers* include aspects such lack of political will and support for WtE adoption, particularly incineration. Developed countries with superior power and influence appear to be leading sustainability efforts, creating fears that they may exert undue influence on developing countries to adopt inappropriate technologies and / or programmes which may be unaffordable and unsustainable. In sub-Saharan Africa and South Asia ineffective waste collection systems, the absence of waste separation at source, and absence of coordination between different governmental institutions are other aspects of institutional barriers affecting WtE adoption (Khan et al., 2022). *Feedstock* is another important barrier. While some WtE technologies such as incineration can treat heterogenous or mixed waste (although with limitations), achieving optimal performance of each WtE technology requires appropriate feedstock (Maisarah et al., 2018). Currently, about 57% of MSW streams generated in developing countries is organic with a moisture content of up to 56% making anaerobic digestion the most appropriate WtE technology solution (Alao et al., 2022). There is, however, a lot of stigma associated with widespread adoption of biogas projects such as anaerobic digestion due to factors such as incompatibility with traditional and religious beliefs (Nevzorova et al., 2019).

Also related to feedstock is the lock-in effect of particularl thermal WtE technologies which require a fixed quantity of feedstock to operate (UNEP, 2019a). Sweden, for example, in 2014 had to import over 1 million tonnes of waste to feed the Sävenäs Plant in Gothenburg. With regards to *scale*, currently, some WtE technologies such as gasification and pyrolysis have either not been proven to do well at scale or can only be implemented in small applications and are more region or country specific. For example, gasification is largely only implemented in Japan. Other examples such as the Schwarze Pumpe in Eastern Germany and pilot facility in Edmonton, Canada have all shut down. Pyrolysis has also not done well with MSW at industrial scale with attempts in Europe finally shut down in 1999 and 2015. Despite efforts by developing countries to transition to circular economy *legislation and national policies* they are either lacking (Malav et al., 2020; Williams et al., 2023), incentives favour other disposal options (such as landfilling), are not clear or are contradictory (IEA, 2023). In some developed countries, legislation and policies now prioritise waste prevention, minimisation, reuse and recycling. These policies such as the EU Emissions Trading System (EU ETS) which focuses on GHG emissions reduction have made WtE adoption progressively more difficult. As more countries improve waste prevention, minimisation, reuse and recycling, demand for WtE will decrease.

5 G20 CONSIDERATIONS AND RECOMMENDATIONS

The following policy recommendations, strategic interventions, future directions and innovations are proposed.

5.1 Future Directions and Innovations

The future of waste management and WtE lies in a cohesive approach that integrates upstream prevention with downstream resource recovery, aligning with global goals on climate mitigation, circular economy, sustainable and inclusive development. This section highlights strategic innovations that can accelerate a just, sustainable, and efficient transition in line with the theme of Solidarity, Equality, and Sustainability.

- **Integrated waste management and circularity:** Effective waste systems prioritize prevention, reuse, recycling, and energy recovery, reducing reliance on landfills, and open dumping. In many G20 countries, this shift is guided by circular economy policies that address the full lifecycle of materials. Policies such as EPR, plastic bans, and eco-design are central to upstream waste reduction (European Commission, 2020; UNEP, 2024). For example, in South Africa, advancing source segregation, improving collection coverage, and modernizing recycling infrastructure are foundational. Integration of informal waste workers through cooperatives and digital platforms is critical for enhancing recovery rates and achieving social equity (UNEP, 2024).

- **Decentralized and climate-responsive infrastructure**: Localized solutions—such as biogas digesters and micro gasifiers—can process organic and mixed waste while supplying clean energy to underserved areas. These technologies reduce transport costs and emissions while enabling off-grid energy access (World Bank, 2018). Container-based sanitation systems co-managed with waste services also help manage organic fractions while improving public health outcomes (UNEP, 2024).
- **Advanced WtE Technologies**: Organic and residual waste streams unsuitable for recycling can be harnessed through advanced WtE technologies, including advanced digestion, moving grate combustion, fluidized beds, and co-combustion. These systems, particularly when combined with material recovery and flue gas treatment, offer a safe and low-emission alternative to landfilling (ISWA, 2022). To further decarbonize the sector, WtE systems can integrate Carbon Capture and Storage (CCS) and process biogenic waste to achieve carbon-negative energy outcomes (IPCC, 2023). South Africa's integration of WtE with material recovery facilities and power grids can enhance resilience and energy security.
- **Digitalization and governance innovation**: Digital tools, such as smart sensors, AI-driven sorters, and blockchain-enabled EPR tracking, improve efficiency, transparency, and emissions monitoring across the waste value chain. These systems also enable evidence-based policy decisions and facilitate the formalization of the informal sector (UNEP, 2024). However, digital technologies are reliant on sustainable internet connectivity and energy supplies which are no longer guaranteed in many countries. Innovation is therefore required to overcome energy and connectivity challenges. Strong governance frameworks, long-term infrastructure planning, and blended finance—via public-private partnerships—are essential to ensure scalability, affordability, and alignment with Nationally Determined Contributions (NDCs) (World Bank, 2018; UNEP, 2024)
- **Policy innovation and financing mechanisms**: Aligning WtE with national energy and climate frameworks enhances regulatory certainty. Tools such as feed-in tariffs, landfill diversion targets, and climate-aligned budgeting improve market readiness (UNEP, 2024; ISWA, 2022). Blended finance, green bonds, and access to funds (e.g., GEF) are vital for infrastructure development in emerging markets.
- **South-South Knowledge Innovation Hubs**: Regional cooperation accelerates adoption of context-specific technologies. South Africa can serve as a regional anchor for demonstration projects, policy exchange, and technology transfer. Innovation hubs housed in universities and industrial parks can catalyse local R&D, technical training, and scale pilot projects across Africa (UNEP, 2022; UNEP, 2024).

5.2 Policy Recommendations and Strategic Interventions

To effectively meet global sustainability goals, it is essential to prioritize inclusive, environmentally sound and resilient waste management strategies. Developing economies and low-income countries are making notable progress in embracing circular economy principles and aligning local actions with global frameworks. The following policy recommendations and strategic interventions, as appropriate, are proposed:

- Strengthen regulatory frameworks
    - Enforce legislation on waste segregation collection, recycling and disposal
    - Legal frameworks should support EPR for manufacturers and importers
    - Establish and harmonize legislation on WtE with strict monitoring for hazardous waste treatment
    - Policymakers should continue aligning strategies across national and municipal levels
    - Strengthen cost recovery mechanisms through full cost accounting
- Promote Circular Economy principles, for example:
    - Encourage design for reuse and recyclability in production
    - Support markets for recycled materials through incentives and public procurement
- Invest in waste infrastructure
    - Expand and adapt waste collection, sorting and treatment systems and facilities (centralised and decentralised) to accommodate waste picker integration
    - Prioritise engineered sanitary landfills and appropriate WtE technologies to deal with residual waste that is not suitable for reuse or recycling
    - Investment in WtE infrastructure, including anaerobic digestion, offering a dual benefit of reducing waste volumes while expanding access to clean energy
    - Set up dedicated WtE infrastructures in the most exposed regions (control mixing of hazardous and non-hazardous waste)
    - Create industrial synergies around WtE infrastructure, for example, linking waste-to-energy centres to industrial parks to optimize energy consumption
- Encourage Public-Private Partnerships (PPPs)
    - Attract investment by de-risking waste management projects
    - Create transparent and accountable frameworks for PPP contracts
    - Adopt the establishment of a G20 level PPP Centre of Excellence for MSW management
- Foster research and innovation

  - Research and innovation into ways to maximise implementation of the waste hierarchy in particularly low-income countries

- Strengthen public awareness participation
  - Launch national awareness campaigns on waste reduction, recycling, and proper waste management
  - Promote community-based waste sorting and composting programs
- Support informal sector integration
  - Create an enabling environment for waste picker integration (refer to the waste picker integration website https://wastepickerintegration.org/
  - Waste picker integration creates an opportunity for the development of innovative waste collection systems in low-income countries
  - Provide access to training, protective gear and fair compensation
- Implement appropriate alternative policy instruments
  - Regulatory instruments (bans, permits, norms and standards)
  - Economic instrument (environmental taxes, fees and user charges, certificate trading, Environmental financing, green public procurement, subsidies)
  - Information instruments (sustainability reporting, eco-labelling, public information/education, consumer advisory services, environmental quality targets and monitoring
  - Cooperation instruments (Voluntary agreements e.g. on Technology Transfer)
- Promote international collaboration and transparent data collection
  - Exchange knowledge and technology voluntarily and on mutually agreed terms, among G20 members
  - Align strategies with global agreements like the SDGs, Basel Convention, etc.
  - Transparent data collection and reporting systems are essential to track progress, identify gaps, and ensure accountability

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SHERPA TRACK

Environment and Climate Sustainability Working Group (ECSWG)

Adaptation for Resilience and Development

Planning, Implementation and Public Financing of Sustainable and Just Climate Adaptation for Resilience of People, Economy and Nature for All

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This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

EXECUTIVE SUMMARY

Adaptation is an urgent priority for billions of people to secure a safe and sustainable future, especially for communities on the frontlines of climate change. Adaptation reduces climate-related losses and damages, as well as delivering a wide range of broader of economic, social, and environmental benefits. Progress has been made by those who have developed National Adaptation Plans (NAPs) with clear goals and targets. However, there is limited evidence of the full integration of climate adaptation into key national development priorities and sectors, notably amongst G20 developing countries. If the current rates of adaptation planning and implementation are not increased, the adaptation gap will continue to grow, and the loss and damage caused by climate change will increase.

The implementation of adaptation measures, particularly in developing countries, is hindered by the limited availability of resources to support adaptation actions, primarily the lack of access to sufficient, predictable, and sustained public finance. This in turn has led to limited capacity for governance and decision-making processes, as well as limited access to essential and appropriate technology for effective implementation. To advance the implementation of adaptation in G20 countries this Technical Paper recommends the following.

1. *Establishment of clear and structured follow-through processes to achieve full integration of adaptation in national and sub-national development planning across sectors, supported by political will.*
2. *Increased public finance for adaptation, including the use of innovative financial instruments. Grants and concessional loans will remain essential for supporting adaptation actions in the most vulnerable communities.*
3. *Utilising public resources to mobilise private sector finance to broaden the sources of finance to meet the huge investment needs for adaptation.*
4. *Increase incentives and investment in adaptation technology development and increase access to appropriate technology for developing countries.*
5. *Promote the capacity building of relevant institutions to accurately estimate adaptation needs in the G20*
6. *Invest in effective and reliable climate information and response services, climate adaptation data collection, evidence synthesis and knowledge sharing between different agencies within and across G20 countries.*

Considering the recommendations 1 – 6 above, the South Africa G20 Presidency recognises the importance of achieving just adaptation[1] in the G20.

[1] In this paper, "just adaptation" is defined and framed as adaptation that prioritizes fairness, equity, and the well-being of vulnerable populations, ensuring that the burdens to adapt are equitably distributed through provision and mobilisation of sustained and sufficient means of implementation, particularly,

1 INTRODUCTION

Evidence of observed changes in extreme weather and climate events, such as heatwaves, heavy precipitation, floods, droughts, and tropical cyclones, and their attribution to human-induced climate change has strengthened (IPCC, 2021). The increase in the frequency and severity of these hazards and events has caused widespread adverse impacts and related losses and damages to nature and people. Without accelerated adaptation action in this decade, losses and damages will continue to increase, disproportionately impacting vulnerable populations, including those in Africa, Asia, Small Island Developing States, and Central and South America (IPCC, 2022).

This places adaptation to climate change as an urgent priority for billions of people to secure a safe and sustainable future[2] (IPCC, 2023), especially for frontline communities, including key infrastructure in both developed and developing regions and ecosystems across the G20 members. This forms the basis on which the South Africa G20 prioritizes a just adaptation for all that delivers economic and social development co-benefits that promote sustainable development.

Just adaptation in this paper is defined as adaptation that prioritize fairness, equity, and the well-being of vulnerable populations, by ensuring that the burden to adapt is equitably distributed through the provision and mobilisation of appropriate and sufficient means of implementation, particularly, finance, capacity building and adaptation technology transfer required for effective implementation of adaptation across society and generations[3].

The synthesis report on Nationally Determined Contributions (NDCs) produced by the United Nations Framework Convention on Climate Change (UNFCCC) in 2024 underlined several synergies between adaptation efforts and Sustainable Development Goals (SDGs)[4]. The scientific assessment of the IPCC Synthesis Report (2023) found with high confidence that adaptation actions have more synergies than trade-offs with SDGs[5].

This technical paper is organized following the common approach in which adaptation is understood and implemented by most G20 members: from (i) integrated planning for adaptation (and development); (ii) implementation of adaptation actions and sustainable financing of adaptation; and (iii) increasing or strengthening climate information and response systems that enhance adaptation implementation.

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finance, capacity building and adaptation technology transfer, which are required for effective implementation of adaptation for all across society and generations. Just adaptation in this paper also seeks to address the inclusion of adaptation in current financial transition plans (see Section 3.7)

[2] Approximately, 3.3 to 3.6 billion people live in contexts highly vulnerable to climate change. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

[3] https://climate.sustainability-directory.com/term/just-adaptation/

[4] UNFCC, 2024: Nationally Determined Contribution under the Paris Agreement; Synthesis report by the secretariat. UNFCCC.

[5] IPCC Synthesis Report; Figure 4.5: https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf

2 CURRENT MULTILATERAL DELIBERATIONS

2.1 Aligning G20 Adaptation Efforts with Global Adaptation Framework

Since the start of the 2020–2030-decade of climate action, global focus has prioritised elevating adaptation in the multilateral space. This has resulted in the adoption of global adaptation frameworks, agreements, and programs, including the UAE Framework for Global Climate Resilience (UAE FGCR). These processes signal coordinated efforts to prioritize and advance the implementation of adaptation, illustrating an understanding of adaptation as a global and shared responsibility. In 2023, as part of operationalization the global goal on adaptation (GGA) in the Paris Agreement, the UNFCCC agreed to adopt the UAE FGCR with global targets, marking a historic moment for adaptation.[6] At the regional level, efforts such as the Africa Adaptation Acceleration Program[7] and the Regional Observatory of Adaptation for Latin America and Caribbean,[8] have been promoted to advance adaptation implementation. As part of aligning G20 adaptation efforts with the global agenda on adaptation, the G20 must assume leadership and raise its ambition for adaptation. This is crucial for the successful implementation of adaptation, and for mobilisation of sufficient, predictable and sustained finance that advances multilateral adaptation efforts.

The UAE GGA, agreed upon in 2023 at the UNFCCC COP 28, adopted 11 global adaptation targets: four focused on the stages of the iterative adaptation cycle, and seven focused on thematic areas. Following the iterative cycle of implementing adaptation, the impacts, vulnerability and risk assessment target in the UAE FGCR states that by 2030, all the Paris Agreement Parties have "conducted up-to-date assessments of climate hazards, climate change impacts and exposure to risks and vulnerabilities and have used the outcomes of these assessments to inform their formulation of national adaptation plans, policy instruments, and planning processes and/or strategies, and by 2027 all Parties have established multi-hazard early warning systems, climate information services for risk reduction and systematic observation to support improved climate-related data, information and services".[9]

The planning target states that by 2030, all the Parties to the Paris Agreement have in "place country-driven, gender-responsive, participatory and fully transparent national adaptation plans, policy instruments, and planning processes and/or strategies, covering, as

[6] https://unfccc.int/documents/637073
[7] https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/africa-adaptation-acceleration-program
[8] https://accionclimatica-alc.org/ora/en/home/
[9] Paragraph 10a of Decision 2/CMA.5 on Global goal on adaptation: https://unfccc.int/documents/637073

appropriate, ecosystems, sectors, people and vulnerable communities, and have mainstreamed adaptation in all relevant strategies and plans".[10]

The adaptation implementation target states that by 2030, all Paris Agreement Parties, have "progressed in implementing their national adaptation plans, policies and strategies and, as a result, have reduced the social and economic impacts of key climate hazards".[11] The Framework also has seven thematic targets that are more outcome-based to advance the implementation of adaptation on: Water, Agriculture and Food, Health, Ecosystems and Biodiversity, Infrastructure and Human Settlement, Poverty Eradication and Livelihoods, and Cultural Heritage.

With the work on GGA implementation advancing, G20 members can build on this momentum to ensure that countries have mainstreamed adaptation in key national economic development priorities to advance adaptation implementation. Thereby, ensuring that economic and social development processes and actions, from planning to implementation, are addressing climate adaptation.

The GGA work on the development and adoption of global indicators is advancing and is set to be concluded at COP 30 in Brazil (November 2025). These indicators will serve as the first global attempt to understand the progress of adaptation implementation. Successful conclusion of this, and future, GGA bodies of work are crucial for informing the understanding of adaptation progress globally, including within the G20, and to inform G20 efforts needed to advance adaptation implementation that protects people, the economy, and ecosystems and biodiversity.

The Cancun Adaptation Framework of the UNFCCC in 2011 established the national adaptation plans (NAP) process' objectives of (i) reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience; (ii) facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.[12] In 2025, the Least Developed Countries Expert Group (LEG) published the revised guidelines for the NAPs process.[13] These new guidelines prioritise the mainstreaming of GGA into adaptation planning and implementation. They also place emphasis on the costing of adaptation in NAPs. Thus, significant progress by G20 members in formulating NAPs or equivalent planning process that comply with these guidelines is crucial to ensure adaptation needs are properly costed.

[10] Paragraph 10b of Decision 2/CMA.5 on Global goal on adaptation: https://unfccc.int/documents/637073
[11] Paragraph 10c of Decision 2/CMA.5 on Global goal on adaptation: https://unfccc.int/documents/637073
[12] FCCC/CP/2011/9/Add.1: National adaptation plans
[13] The NAP Technical Guidelines: https://unfccc.int/sites/default/files/resource/250828_UCC_LEG_NAP_NEW_NAP_TG.pdf

The Kunming-Montreal Global Biodiversity Framework (KMGBF), the Convention on Biological Diversity in 2022 set out an ambitious pathway to achieve the global vision of a world living in harmony with nature by 2050.[14] Among the Framework's key elements are four goals for 2050 and 23 targets for 2030.[15] There are significant links between biodiversity goals and the advancing of climate adaptation, because biodiversity (nature) significantly contributes to climate adaptation and resilience of communities to climate change impacts, and yet biodiversity is threatened by climate change. This means that G20 adaptation efforts should ensure the protection of biodiversity and ecosystems to sustain and maximise the multiple benefits from nature. The most relevant ecosystem and biodiversity goals for climate adaptation in G20 are Goal A on "The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050"; Goal B on "Biodiversity is sustainably used and managed and nature's contributions to people, including ecosystem functions and services, are valued, maintained and enhanced, with those currently in decline being restored, supporting the achievement of sustainable development for the benefit of present and future generations by 2050" and Goal D on "Adequate means of implementation, including financial resources, capacity-building, technical and scientific cooperation, and access to and transfer of technology to fully implement the KMGBF are secured and equitably accessible to all Parties, especially developing country Parties, in particular the least developed countries and small island developing states, as well as countries with economies in transition, progressively closing the biodiversity finance gap of $700 billion per year, and aligning financial flows with the KMGBF and the 2050 Vision for biodiversity".[16] Significant progress in the implementation of these goals is crucial for achieving climate resilience of vulnerable communities in the frontlines on the G20.

2.1 Past Adaptation Efforts in G20

Over the past five years, progress has been made to recognise and support the implementation of adaptation in G20 declarations, including noting the importance of predictable and sustainable financing of adaptation in the G20. Notable progress was made in 2024 (Brazil G20) on advancing the financing of climate adaptation, with the G20 declaration underscoring the need to scale up public and private climate finance and investment in developing countries of the G20.[17] In 2023 (India G20), the Chair Summary recognised the significant role of public finance as an important enabler of climate actions, including leveraging private sector finance of adaptation through blended financial instruments, mechanisms and risk-sharing facilities.[18] In Bali 2022 (Indonesia G20), the

[14] https://www.cbd.int/conferences/2021-2022
[15] CBD/COP/DEC/15/4: 19 December 2022
[16] CBD/COP/DEC/15/4: 19 December 2022
[17] G20 Rio de Janeiro Leaders' Declaration: https://g20.org/wp-content/uploads/2024/11/G20-Rio-de-Janeiro-Leaders-Declaration-EN.pdf
[18] G20 New Delhi Leaders' Declaration: https://g20.org/wp-content/uploads/2024/09/G20-2023_India_Declaracao-de-Lideres.pdf

Chair Summary reassured the need to raise adaptation ambition and provision of means of implementation, recalling the Glasgow Climate Pact that urged developed countries to at least double their collective provision of climate finance for adaptation to developing countries, from 2019 levels, by 2025.[19] In Rome, 2021 (Italy G20), the Communique stressed the importance of effective implementation of the global goal on adaptation.[20] It is important to note that this history dates back to 2014 in Brisbane (Australia G20), demonstrating that climate change adaptation and its financing has been a priority in the G20 agenda.

3 CURRENT INITIATIVES AND DEBATES

The discussions in this paper are organized following the common approach in which adaptation is understood and implemented by many G20 members: from (i) integrated planning for adaptation (and development); (ii) implementation of adaptation actions and sustainable financing of adaptation; and (iii) increasing or strengthening climate information and response systems that enhance adaptation implementation. This approach aligns with the GGA, particularly with regard to the iterative adaptation cycle targets.

3.1 Integrated Planning for Adaptation in G20

Many G20 countries have developed or adopted national climate adaptation plans, policies, frameworks or strategies. These policies and planning instruments signal intentions to prioritise adaptation.[21] However, the evidence of full integration of climate adaptation planning (including integration of these instruments) in key national development priorities and sectors is still limited, with these gaps notable in developing countries in the G20.[22]

To ensure a more coordinated effort in the planning and implementation of adaptation actions that promote sustainable development, the integration of adaptation into national development planning processes, achieved through mainstreaming of adaptation in key economic and development policies, strategies, and frameworks is fundamental. Many G20 countries have not yet achieved this and support to attain this is needed.[23] The full alignment and integration of adaptation (and adaptation policies) in the national development discourse is key to promoting development that is climate resilient across the G20 countries.

National scale planning for adaptation and development is a central part of an effective response to climate change in the G20 countries, but success will also depend on implementation at the sectoral and sub-national levels. This paper reiterates that the entry points for integrating adaptation into national development planning are greatest when

[19] G20 Bali Leaders' Declaration: https://g20.org/wp-content/uploads/2024/09/2022-11-16-g20-declaration-data.pdf

[20] G20 Rome Leaders' Declaration: https://g20.org/wp-content/uploads/2024/09/G20-2021_Italia_Declaracao-de-Lideres.pdf

[21] Data from authors' analysing adaptation planning instruments – national adaptation plans, strategies, adaptation action plans, frameworks and policies in G20 countries.

[22] Data from authors' analysis of adaptation planning documents – national adaptation plans, strategies, actions, frameworks and policies in G20 countries.

[23] Adaptation support from the financial, appropriate technology and capacity building required to effectively implement adaptation plans, goals and actions.

countries take a comprehensive perspective to set ambitious national social and economic objectives beyond poverty reduction and economic growth and recognize linkages with sector-level policy objectives and local development and well-being objectives.

3.1.1 Approaches to Achieve Integrated Adaptation Planning

To ensure that adaptation planning is fully and successfully integrated into national development planning within the G20, the following approaches and considerations.

- Multi-sectoral adaptation planning that addresses climate risks that cut across systems and sectors and takes advantage of synergies of adaptation with SDGs.
- Adaptation planning that is inclusive and equity-based to enable *just adaptation for all* that reduces vulnerability and risk and enables resilience of people, economies and ecosystems in the G20.
- Embedding adaptation planning in development planning processes to maximize synergies between adaptation and economic and social development, thus contributing to sustainable development in G20 countries.
- Establishment of a G20 exchange programme and/or platform that focuses on sharing best practices, approaches, frameworks and tools to support the mainstreaming and integration of adaptation in national and sub-national development planning.
- Adaptation planning requires governance coordination mechanisms that ensure coherence across sectors and timeframes, enabling joint management of risks through integrated early warning, preparedness and long-term resilience measures.

The approaches and key considerations above should be implemented in a participatory and inclusive manner to ensure that multiple forms of knowledge, including scientific, local knowledge and indigenous knowledge are included in the process with the full participation of Indigenous Peoples and local communities (IPLC). The IPCC in 6th Assessment reports as with high confidence that equitable partnerships between local and municipal governments, the private sector, IPLC, and civil society can, including through international cooperation, advance climate resilient development by addressing structural inequalities, insufficient financial resources, cross-city risks and the integration of Indigenous knowledge and local knowledge (IPCC, 2022)

3.2 Establish Follow-through Processes to Accelerate Implementation to Close Adaptation Gap.

The IPCC AR6 Working Group II report finds, with high confidence, that political commitment and follow-through across all levels of government accelerate the implementation of adaptation actions (IPCC, 2022).

Thus, this technical paper recommends a clear *follow-through process* that is supported by political commitment to ensure that adaptation planning leads to the mainstreaming of adaptation implementation across key economic and social development sectors.

To ensure that this *follow-through process* is successful, setting clear goals and targets for the adaptation sector is important, as well as tracking progress and benefits. These targets should be supported by robust and measurable indicators to fully understand the progress of integrating adaptation into national development processes across all levels of government (see Box 1).

BOX 1: A demonstration of how to monitor follow-through process to ensure adaptation has been integrated in national development planning and implementation processes.

(1) At adaptation planning level

Example of a national target: Fully integrate national adaptation goals in plans for key economic and social development sectors.

Example indicators:

(i) The percentage of key economic development sectors that have fully integrated adaptation into planning.

(ii) Number of government departments/ sections/ units in key sectors that have included relevant adaptation priorities in development of projects and programs.

(iii) The size of the programs and projects that integrated adaptation data at planning stages, including training programs or technical support of the relevant government officials and stakeholders involved in planning processes of these key sector projects and programs.

(2) At adaptation implementation level:

Example of a national target: Significantly advance the implementation of adaptation plans, goals and actions at sector level at subnational and national.

Example indicators:

(i) The number and size of development projects and programs at implementation level have included sector adaptation actions and priorities listed in national adaptation plans and strategies.

(ii) Valuation of different adaptation benefits – economic, social and environmental – achieved through the implementation of adaptation actions in specific sectors of development (disaggregated by economic sector).

(iii) Amount of public resources mobilised to support the implementation of adaptation actions in priority development sectors.

(iv) Number of programs and initiatives on development, transfer and implementation of technology that advance implementation of adaptation actions.

Evaluation of the indicators at different levels of government can indicate whether follow-through is being achieved.

3.3 Barriers for Accelerating Adaptation Implementation for Just Adaptation for Sustainable Development for All

Globally, evidence of the implementation of adaptation remains very limited and unevenly distributed across countries (IPCC, 2022). Furthermore, most observed adaptation is focused more on planning rather than implementation and is fragmented (IPCC, 2022). The limited evidence of implementation includes a lack of evidence of the implementation of national adaptation plans, goals and strategies (Leiter, 2021), including in the G20. There is a widening adaptation gap and adaptation finance gap[24] that is largest among lower income population groups (IPCC, 2022; UNEP, 2023; 2024). Accelerated adaptation implementation is required in this decade to close the adaptation gap (IPCC, 2022). Thus, the South Africa G20 Presidency is prioritizing the implementation of adaptation that reduces both these gaps, while reducing biodiversity loss.

The sustained implementation of national adaptation plans, strategies and action plans requires large upfront investments of human, financial and technological resources (IPCC, 2022). The progress and effort to close the adaptation gap, especially in developing countries, has been hindered by the following factors:

- **Limited availability of public finance for supporting adaptation implementation.** The global need for adaptation finance far exceeds current public and private flows (both domestic and international), leaving people and assets increasingly vulnerable to the worsening impacts of climate change (IPCC, 2022), including in the G20 countries. Many financing arrangements that support current adaptation are sourced from vulnerable people in developing countries (UNEP, 2024). While this is critical for closing the adaptation finance gap, it is not aligned with the international principles of good practices, such as common but differentiated responsibilities.
- **Limited capacities, effective governance and decision-making processes**, particularly in developing countries (UNEP, 2024; IPCC, 2022).
- **Limited access to the essential and appropriate technology required for adaptation implementation**. Limited access to essential and appropriate technology is a significant challenge for developing countries in implementing climate change adaptation measures (UNEP, 2014; 2022).

3.4 Enhance Implementation of Just Adaptation for Sustainable Development for All that Close the Adaptation Gap

To achieve a just adaptation process for all and break the business-as-usual approach to climate adaptation, the South Africa G20 Presidency is prioritizing adaptation that intersects with and prioritise sustainable development across the G20 countries. The aim is to promote

[24] Adaptation finance gap is defined as the difference between the estimated costs of adaptation for a given adaptation target, versus the amount of finance that is available (UNEP, 2014)

adaptation with economic, social and environmental co-benefits that effectively reduce vulnerabilities and climate change impacts while addressing key societal challenges affecting developing countries in the G20, including poverty eradication, unemployment, hunger, inequality, and environmental degradation.

To prioritise the implementation of such adaptation actions, the South Africa G20 aims to suggest practical ways to unlock innovative funding channels for adaptation, with the view of tripling the current access to adaptation support within G20 countries. This includes leveraging public investments for adaptation from domestic and international sources. This paper also highlights how achieving increased access to public finance for adaptation contributes to a just adaptation process.

To fully understand better approaches for resource mobilisation for adaptation, a clear definition of adaptation needs in G20 countries, particularly developing countries, on public finance, technology and capacity building is critical. This must include data on the adequacy of adaptation support flows, and potential innovative approaches to increase adaptation investments from public resources. This paper outlines the approaches that need to be prioritised to increase adaptation support in G20 countries to close the adaptation gap. This paper emphasises how this can be achieved through public resources in multilateral processes, bilateral cooperation and other sustained channels that leverage public investments to support adaptation. Figure 1 highlights some of the available sources of adaptation finance in multilateral and bilateral channels.

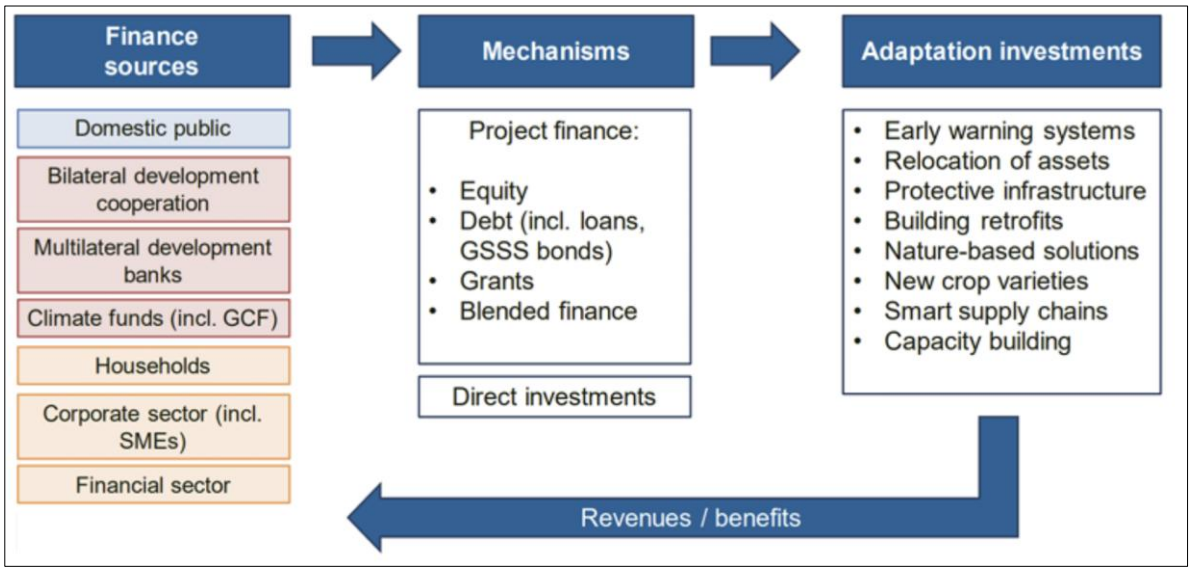


***Figure 1**: Sources of adaptation finance: Illustrative list of finance sources, mechanisms and adaptation investments. Source: OECD (2023a).*

3.4.1 Sufficient and Accessible Public Finance for Adaptation in G20

Public finance is an important enabler of adaptation (IPCC, 2022). Available data show that in 2024, over two-thirds of adaptation needs in developing regions are financed by the public sector (UNEP, 2024). The public sector accounted for up to 92% of total adaptation financing in 2022 (CPI, 2024). This demonstrates the important role of public finance in advancing

adaptation implementation in developing countries. Available data show that the climate adaptation finance gap is growing (UNEP, 2024; IPCC, 2022). This is due to the over reliance on public finance and limited mobilisation of private sector financing in the adaptation sector globally (Tall et al., 2021).

Access to reliable, consistent, predictable, and sufficient public finance is critical for implementing adaptation plans that achieve adaptation and development goals in the G20. The provision and mobilisation of public finance in the G20 and implementation of adaptation should sufficiently address the need to implement adaptation that helps countries achieve the temperature goal of the Paris Agreement. Public finance is important for implementing effective adaptation actions and measures that achieve resilience to climate change impacts while promoting sustainable development. Thus, innovative public investments in the adaptation sector are key to addressing this widening adaptation finance gap. Evidence from selected initiatives in G20 countries illustrates that public resources can be leveraged to implement adaptation, which is crucial for closing the adaptation finance gap.

Case studies: Public investment in the adaptation sector. Four case studies demonstrate how public investments are leveraged to deliver adaptation with multiple benefits, drawn from South African initiatives: "*Water for Water*", "*Working for Fire*" and "*Working for Wetlands; Working for the Oceans*" and "*National Department of Health, Heat Health Action Guideline*". These initiatives are being implemented by the South African government and funded through public investments (see Box 2). Access to international public finance is important for scaling up these initiatives. This is essential for achieving a just adaptation process that effectively addresses the increased climate impacts in the G20, particularly in developing countries.

BOX 2: Case studies demonstrating how public investments have been leveraged to support adaptation with wide range of benefits in South Africa.

"**Working for Water,**" "**Working on Fire,**" and "**Working for Wetlands**" are examples of adaptation initiatives funded through public resources by the Government of South Africa. These initiatives demonstrate the critical role of public investments for adaptation which deliver co-benefits, including reduced losses and damages, economic, social and environmental returns.

Working for Water in South Africa[25] is a government programme launched in 1995 with the dual function of controlling invasive alien species and providing social upliftment. To date, this programme has a budget of over ZAR400 million and is the largest single natural-resource-based poverty relief and public works expenditure in South Africa. The programme provides a wide range of adaptation benefits. These include reduced losses and damages, such as flood attenuation, protection of water bodies and estuary restoration; economic and social benefits such as employment and livelihood creation, and training of communities and skills development (Turpie, Marais et al., 2008); and environmental benefits such as restoration of natural ecosystems, biodiversity conservation. To scale up such initiatives funded by domestic public resources,

[25] https://www.dffe.gov.za/working-water-wfw-programme

accessing international public finance for adaptation is crucial, and ways to unlock this funding are important to continue realising adaptation benefits in G20 countries. International cooperation in G20 can also play a role in mobilising resources to support such initiatives.

Working on Fire[26] is a multi-partner programme with the objectives of implementing integrated fire management, prevention and control of wildfires. The initiative is funded by the South African government and plays a key role in adapting to increased impacts of fire attributed to climate change (Liu, 2023; Kretzmann 2023). The program provides the following adaptation benefits: reduced losses and damages through fire prevention, economic benefits through employment and receiving skills training[27], and environmental benefits.

Working for Wetlands[28] is a joint initiative of the Departments of Forestry Fisheries and the Environment (DFFE), and Water and Sanitation (DWS), funded by the South African government. The program focuses on wetland conservation through rehabilitation and sustainable use. An important point demonstrated by "working for wetlands" is how collaborations between government institutions can promote the idea of planning and implementation of adaptation in a coordinated way (described in Section 3.1). Like the other initiatives above, working for wetlands has all the three categories (economic, social, and environmental) of adaptation benefits. The initiative combines wetland restoration with poverty alleviation by creating jobs and developing skills for vulnerable communities. This government-wide initiative was set up to draw significant numbers of unemployed people into the productive sector of the economy, gain skills while they work and increase their capacity to earn income. The ability to turn wetland rehabilitation into a labour-intensive process unlocked a magnitude of financial resources and political support that was previously inconceivable to cash-strapped government departments responsible for biodiversity conservation and natural resource management.

"National Department of Health, Heat Health Action Guideline." The NDoH prepared a National Heat Health Action Guidelines, which, leveraging public finance resources, has assisted Provincial Departments of Health, District Health Services and Municipalities to reduce the burden of disease from heat exposure.[29] The guidelines support the design and implementation of World Health Organization's Heat Health Action Plans and outline the prevention and management of heat-associated illnesses.

Why public finance for adaptation: Many benefits of adaptation arise as public goods and avoided damages rather than direct revenue streams. In the absence of adaptation yielding direct revenue streams for the private sector, many adaptation interventions in more vulnerable communities can only be funded with highly concessional public finance (New, 2022).

Benefits of public finance for adaptation: There are many benefits of investing in adaptation through public finance. A recent analysis of adaptation and resilience investments in 12 countries (including four G20 countries: China, Brazil, India, and South

[26] https://workingonfire.org/working-on-fire-epwp/
[27] https://kishugu.com/wp-content/uploads/2022/05/Key-facts-WOF.pdf
[28] https://www.dffe.gov.za/WorkingforWetlands
[29] https://www.health.gov.za/wp-content/uploads/2022/06/National-Heat-Health-Action-Guidelines.pdf

Africa) shows that every USD 1 invested in adaptation can yield over USD 10.50 in benefits[30] over a 10-year period, with average returns of 20–27% (Brandon et al., 2025). This provides compelling evidence for scaling adaptation finance, improving data collection and appraisal methods to unlock additional and substantial financial resources required to advance adaptation financing in G20 countries. Box 2 presents examples of investments in public goods and services that provide adaptation benefits to the communities.

Approaches to increase public finance available for adaptation in the G20: Without increased access to sufficient and consistent public finance, it will be difficult to deliver most adaptation priorities and goals in the national adaptation plans of G20 countries, particularly for developing countries. Access to sufficient public finance is important even if innovative approaches to financing adaptation unlock private sector finance for adaptation (OECD, 2024). Sufficient public finance remains crucial in many cases where there has been very little progress to date on significant resources mobilised through private sector financing channels to reduce the adaptation gap for the most vulnerable (New et al., 2022).

To increase the available public finance resources for adaptation (international and domestic finance), this paper makes the following recommendations for consideration by G20 countries.

- **Integrate adaptation into national planning**: Integrating climate adaptation into national and sub-national development and core government functions, supported by a clear follow-through process, has the potential to increase public finance available for supporting climate adaptation in G20 countries.
- **Develop climate adaptation investment plans:** Translate adaptation priorities into a robust financing strategy in G20 countries that are feasible and fundable.
- **Reform fiscal policies by redirecting distorting subsidies and providing financial incentives to build climate resilience.** These are most effective in sectors such as agriculture (OECD, 2025).
- **Increasing the capacity of developing countries to access international public finance for climate adaptation.** Increasing the number of direct access entities in G20 developing countries potentially increases access to international public finance for adaptation. Developing countries in the G20 and globally still have limitations in accessing international public finance, particularly through direct access entities from climate funds. South Africa recently received its first direct access fund for adaptation in 2025. There are developing countries in the G20 that still do not have a single registered project through direct access entities from the UN climate funds – Green Climate Fund, Adaptation Fund, Global Environment Facility. Other G20 developing countries have received GCF funds through at least one direct access entity are Brazil, Mexico, India. Most funds from GCF received by developing countries in G20 through

[30] The analysis assessed, using the triple dividend approach, the three benefits results from adaptation investments: Reduced losses and damages, induced economic benefits, and social and environmental benefits.

direct access entities are readiness programme activities as opposed to implementation of adaptation.

- **Integrating the benefits of climate resilience into budgetary processes and project appraisals.** The implementation of climate budget tagging by G20 countries has the potential to increase public finance allocation towards adaptation through deliberate planning.
- **Implement public procurement policies that account for benefits over the entire investment lifecycle.** Public procurement can steer public expenditure towards activities that support adaptation. Integrating climate resilience can increase upfront costs, while generating benefits over the life of the investment. Therefore, procurement policies that only consider upfront costs discourage the selection of resilient solutions. The use of Life-Cycle Costing can provide a level playing field for resilient investments. Performance standards may also need to be updated to reflect the projected impacts of climate change (OECD 2024).
- **Increase international cooperation as an enabler of bilateral funds for climate adaptation.** Increasing international cooperation within the G20 and between the G20 and other economic groups, such as the G7, has the potential to increase the flow of international public finance for adaptation in developing countries of the G20.

3.4.2 Enabling Conditions for Unlocking Mobilization of Private Sector Financing of Adaptation Through Public Resources

Available data on adaptation financing suggest very limited participation of the private sector (UNEP, 2024; CPI, 2024; OECD, 2023a), notwithstanding the need to broaden the sources of available financial resources for adaptation. Of the USD 100 billion that developed countries committed to mobilise per year by 2020 for climate action in developing countries from a variety of sources, including the private sector, the effectiveness of international public climate finance in mobilising private finance has been limited: of the USD 89.6 billion provided and mobilised in 2021[31], only USD 14.4 billion was mobilised from the private sector (OECD, 2023). The participation of the private sector in adaptation is critical for closing the adaptation finance gap in the G20 and globally.

Major barriers to attracting the substantial volumes of private sector finance needed to advance adaptation implementation in most developing countries fall broadly into four categories: (i) lack of country-level climate risk and vulnerability data and information services that can be used to guide investment decision-making; (ii) limited clarity on the government's capital investment gaps to achieve adaptation goals, and/or on where private investment is needed; (iii) low (perceived or actual) returns on investment (Tall et al., 2021); and (iv) fragmented adaptation finance architecture and complex eligibility requirements to

[31] Only USD 24.6 billion was earmarked for adaptation. OECD, 2023a https://doi.org/10.1787/b0878862-en

access finance (OECD, 2023a). To address these challenges in the G20, the paper discusses the following technical considerations.

Enhance capacity of G20 countries to unlock or mobilize private sector financing for adaptation through public finance. Public finance leverages private sector finance for adaptation by addressing real and perceived regulatory, cost and market barriers (IPCC, 2022). Thus, private sector mobilisation utilising public resources remains the most feasible way to attract private sector participation in adaptation sector. This paper explores measures available to G20 countries to create a conducive environment for private sector financing of adaptation. Public finance is required as a key enabler.

- **Improvements in standardized metrics for project impact in the G20**. Investing in improved adaptation costing in G20 countries allows the private sector to clearly estimate the investment costs required and the risk, which is critical for building an investment case for adaptation projects.
- **Provide adequate climate risk data in the G20**: Providing access to climate data, risk information, localized climate information and ensure its public availability assist the private sector to make informed decisions on adaptation investments, identify risks and opportunities, and foster confidence. Data and knowledge gaps make it difficult to identify, develop, and prepare potential climate adaptation projects for public and private investors (OECD, 2023).
- **Create enabling policies in the G20:** The G20 countries can implement clear and supportive legislation, policies and regulatory frameworks in key adaptation sectors, such as land-use policies, and building codes that mandate or incentivize adaptation, allowing for sufficient incentives for the private sector to invest. High investment risk in developing countries limits the investment attractiveness of private sector participation in adaptation (CPI, 2024). With the establishment of correct and supportive policies, this barrier can be lowered. Setting up effective institutional arrangements for multi-sector adaptation planning, including a better articulation of adaptation and resilience goals and plans at the national level, establishing the policies/ regulations/ standards, including who will do what, where, when, and how—enable private sector participation.
- **Address high upfront costs required for adaptation in the G20**: Offering blended finance, credit enhancement, and other targeted risk reduction or revenue-boosting measures are important for de-risking mechanisms for private sector in G20 countries. This can also be achieved through implementation of financial incentives ideas such as tax breaks and public funds that de-risk adaptation investments. Transaction costs can be high relative to the size of the project, particularly where innovative technologies are being used, or the investment involves multiple beneficiaries (OECD, 2024).
- **Foster public-private partnerships in the G20**: Developing blended finance mechanisms that combine public and private capital and implementing de-risking instruments to reduce investor concerns is crucial. It is also important to co-design

solutions that align with the national climate priorities and leverage public sector support.

- **Foster collaboration**: Creating business sector panels and knowledge-sharing platforms in and among the G20 countries, such as the London Resilience Partnership[32] offers learning opportunities that are required to attract more private sector participation in the adaptation sector.
- **Deploy public and blended finance instruments strategically to mobilise private finance for adaptation.** There is a need for international providers to better understand and link private investors' preferences, notably for secure revenue streams, with specific characteristics of adaptation projects. Options include scaling up approaches such as risk sharing, using intermediaries to overcome address financiers' unfamiliarity with adaptation, and revising mitigation-related bankable projects to increase their contributions to adaptation.

3.5 Adaptation Technology Development and Transfer in G20

The total support provided to developing countries for technology-related adaptation development increased from US$5.7 billion to 12.7 billion between 2018 and 2022 (UNEP, 2024). Despite the increased support for adaptation technology, a substantial technology support gap exists[33] (UNEP, 2022). The limited flow of support for adaptation technology development in developing regions is mainly due to the high upfront investment costs required, difficulties in obtaining loans, and uncertainties surrounding the return on investments (UNEP, 2024).

To unlock barriers for accessing relevant support needed for the development of appropriate or transfer of such technology to developing countries, this paper explores how international cooperation G20 can achieve this. To facilitate international cooperation in the G20 and between the G20 and G7, this paper considers the following approaches.

- **Provision and mobilisation of public finance** (domestic or international) in the G20 targeted at promoting the development and deployment of appropriate technology for adaptation in developing countries, consistent with Paris Agreement Article 10 and 13.
- **Promoting innovative public financing initiatives**, such as public-private partnerships.
- **Foster international collaboration**: Strengthening international cooperation and technology transfer mechanisms to share knowledge and best practices in climate adaptation.

[32] https://www.london.gov.uk/programmes-strategies/fire-and-city-resilience/london-resilience-partnership

[33] Adaptation technology gap can be defined in terms of perceived gaps by countries, based on available technology needs assessments and requests made to technology support mechanisms (UNEP 2014).

- **Integration of adaptation technology needs** in national adaptation plans, innovation strategies and frameworks to prioritize and facilitate the implementation of relevant technologies.
- **Supporting the advancement of science and innovation** across disciplines that influence climate adaptation efforts and inform the technologies developed and deployed to assist with adaptation, including an improved understanding of how climate change impacts human health

The paper recognises the importance of ensuring that adaptation technology transfer is applied through a gender lens to ensure that women and men benefit equally from adaptation technological advancement, and that gender-specific needs and perspectives are adequately considered. The paper notes the importance of the following in ensuring access to the appropriate adaptation technology required to significantly advance adaptation implementation that reduce the adaptation gap.

- **Role of accessible, appropriate adaptation technology – development and or transfer of the technology to developing countries.** Appropriate technology plays a crucial role in enhancing resilience, improving resource management, and facilitating early warning systems, all of which are essential for effective adaptation and achieving national adaptation plans and policies. When access to these technologies is restricted due to factors, such as cost, infrastructure limitations, or lack of knowledge, it can exacerbate existing or create new vulnerabilities. Technological resources enable effective implementation of adaptation, especially when supported by institutions with a strong understanding of adaptation needs and capacity. This involves developing new technologies and ensuring their accessibility, affordability, and suitability to local contexts. Transferring these technologies requires addressing financial, institutional, and capacity-building needs, as well as promoting information sharing and awareness.

In Box 3, we draw lessons from a few selected case studies to demonstrate how international cooperation can facilitate adaptation technology development or transfer and how the G20 can learn from these cases.

BOX 3: Case Studies demonstrating the importance of international cooperation in delivering key technology for adaptation.

The following case studies to demonstrate how international cooperation in the G20 has delivered the technology for adaptation required by countries to address climate change. The case studies also demonstrate how to scale up these activities in the G20 to protect all people, economy and ecosystems.

FLOOD TECHNOLOGY TRANSFER in Semarang, Indonesia. The city, with a population of nearly 1.8 million people, is vulnerable to sea level rise, tidal flooding and inundation. As part of the adaptation solutions to address these climate impacts and hazards, the city implemented a Transboundary Flood Risk Management through Governance and Innovative Information Technology Program (TRANSFORM), helping Semarang tackle flood risks beyond city boundaries. The project was supported by Mercy Corps, the Rockefeller

Foundation-funded Asian Cities Climate Change Resilience Network (ACCCRN), and Zurich Resilience. Since 2017, under the Global Resilience Partnership' Water Window Challenge funded by the Zurich Foundation, Mercy Corps has been able to scale its ACCCRN approach from a city to a river basin level, engaging government, communities, and the private sector upstream and outside of the city's administrative boundaries to tackle the major drivers of downstream flood risk.

TRANSFORM was inspired by Switzerland's Zurich Flood Resilience Measurement Tool (ZFRMT). This demonstrates the role of sharing knowledge, tools and experiences, including the importance of sharing soft technology in advancing adaptation.

How can it be expanded across the G20: Many G20 countries can benefit from the lessons of this case study. This shows that beyond financial support, sharing experience and technical knowledge is critical in achieving progress and impact.

INTERNATIONAL COOPERATION FOR EARLY WARNING TECHNOLOGY TRANSFERS. The development of a reliable early warning system is the backbone of implementing effective, data-informed and responsive climate adaptation. However, the technology and infrastructure required to set up reliable early warning systems, including reliable response systems require significant resources. Here, we demonstrate how this can be achieved through international cooperation and bilateral agreements.

A collaboration between the UN through the Early Warnings for All (EW4All) initiative, and the Caribbean led to the implementation of the Climate Risk and Early Warning (CREWS) project. The initiative leverages AI to enhance forecasting and warnings through collaborations with governments, tech firms, and communities.

How can it be expanded to the G20: The lessons from the CREWS project provide an opportunity for G20 countries to invest in such cooperations among members to advance early warning systems that help protect people, economies and ecosystems.

3.6 Capacity Building of the Frontline Communities and National Institutions to Implement Adaptation in G20

Capacity building is fundamental to accelerate adaptation implementation, especially for vulnerable groups, regions and sectors (IPCC, 2022). Thus, the implementation of adaptation across countries and regions depends on the capacity of people and all government levels, to plan and implement adaptation. Given the importance of capacity building, this paper discusses the broad lenses required to fully understand what is required in G20 countries. These lenses are: (i) capacity building of frontline communities to implement adaptation that increases their resilience to climate impacts, (ii) capacity building of national institutions to plan and implement scalable adaptation actions and (iii) capacity building of countries, particularly developing countries, to develop adaptation technology required to implement adaptation significantly.

3.6.1 Capacity Building of Frontline Vulnerable Communities in G20

To implement adaptation that effectively reduces vulnerability, the following capacity building measures for frontline communities in the G20 are recommended by this paper.

- **Community-Driven Activities**: Includes building resilience through information sharing, preparing for, and recovering from climate impacts.
- **Financial and Policy Support**: Economic and regulatory policies developed, accountability frameworks established, and funding allocated for community-led and locally relevant adaptation actions and investments.
- **Participatory and Equitable Processes**: Ensure vulnerable groups, women, and IPLC actively participate in decision-making processes to build sustained resilience.
- **Integration of Knowledge**: Combine local, traditional knowledge with scientific climate information to inform planning and adaptation actions.
- **Long-term Institutionalization**: Embed climate change adaptation into educational curricula and professional training to build a sustainable supply of skilled professionals for future challenges.
- **Knowledge Transfer**: Facilitate the transfer of expertise and knowledge from more advanced organizations and communities to those that are less resourced.

3.6.2 Capacity Building of National Institutions in G20

The following considerations must be addressed to strengthen the capacity of state institutions to implement adaptation that significantly reduces the existing gaps:

- **Capacity building to increase access to international public finance for implementation of adaptation.** Removing barriers to accessing finance is fundamental to accelerating adaptation, especially for vulnerable populations, regions and sectors (IPCC, 2022). Strengthening the capacity of state institutions to access international public finance is crucial and will unlock the limited access to financial resources.
- **Capacity building of local and national institutions to accurately assess adaptation needs and implement adaptation actions in G20 countries** that directly respond to adaptation needs and national adaptation goals. There is a huge gap in the estimation of adaptation needs (CPI, 2024, Isah et al., 2025). This is mainly due to lack of consistent, established methodologies, and capacity to accurately estimate adaptation needs (CPI, 2024, Isah et al., 2025). In Africa, adaptation needs are likely to be underestimated due to a lack of data and technical expertise to estimate the true cost of adaptation measures, including a lack of data from subnational governments and vulnerable communities (CPI, 2022). Thus, building the capacity of local and national institutions to access financial resources and accurately estimate the needs and implementation of actual actions and options is critical for closing the widening adaptation gap.

3.6.3 Capacity Building of Developing Relevant Adaptation Technology

The following approaches should be considered to strengthen the capacity of developing countries to produce and manage adaptation technology.

- **Promoting local capacity building** through skills education and training programs is essential for developing the knowledge required to design, implement, and maintain adaptation technologies in developing countries.
- **Awareness and knowledge sharing**: Creating awareness of the benefits of adaptation technologies and facilitating knowledge sharing among stakeholders to help overcome potential resistance to change and promote adoption.
- **Localizing technology**: The South Africa G20 prioritise and recognize that technologies adapted to local contexts, considering cultural values and social needs, is crucial for successful implementation.

3.7 Sufficient Support as Solidarity for a Just Adaptation

The provision, mobilisation and access to finance, technology and capacity building for adaptation implementation through public finance, in sufficient quantities and appropriate timing in the G20 is crucial for achieving a “just adaptation” process that protects all people, economy, and ecosystems from the increased climate change impacts.

This paper describes the concept of just adaptation as two-fold. The first component occurs when access to means of implementation is provided, mobilised and delivered to the most vulnerable and frontline communities, including IPLC, prioritising equity and just and equal access to the benefits of adaptation. This is important for protecting all people from increase climate change impacts across the G20.

The second component focuses on long-term solutions to create a resilience society, economies in G20. Achieving this is fundamental in delivering the first component above. This is achieved through the inclusion of adaptation elements in the current financial transition plans.

The current financial transition plans lack full consideration of adaptation and tend to focus on transitions in the mitigation space; hence, a just adaptation would ensure that financial transition plans integrate adaptation as one of their core elements. The current transition finance concept acknowledges that while this could extend to finance substantial contributions to other environmental objectives and goals of the Paris Agreement, such as climate adaptation and resilience, or biodiversity, these other objectives are not the main focal point of the Guidance at this stage (OECD, 2022). Notably, while the Guidance focuses on corporate transition planning to align with the Paris temperature goal by decarbonising, there is also ongoing work by other initiatives (e.g., the Task Force on Climate-related Financial Disclosures and the International Sustainability Standards Board) to help corporates understand, assess, and mitigate their exposure to climate-related risk (both

transition risk and physical risk) (OECD, 2022). This is important for ensuring that there is long term strategy to address climate change impacts through adaptation by the corporate world.

3.8 Climate Information and Response Systems for Enhancing Adaptation

Planning, designing and implementing effective adaptation measures that deliver risk management and development benefits require significant investments in reliable climate information systems (OECD, 2024).[34] Such investments in developing countries are critical for increasing access to international public adaptation finance from climate funds and MDBs. This paper discusses the critical approaches required to build or strengthen climate information and response systems in the G20. This paper also explores how international cooperation is crucial for advancing the process of improving climate information and response systems across the G20. This is one potential way to address the investments required in technology associated with early warning systems required to effectively implement adaptation. This paper makes the following technical submission regarding how to build climate information services and response systems that protect people, the economy and ecosystems in G20.

- **The development of climate information and dissemination of appropriate response actions** for adaptation is key for designing and implementing appropriate and early action adaptation measures. It is also important to formulate adaptation goals and measures in planning policies that address the correct climate problem. The creation of reliable climate information systems with early warning systems, and climate services provides greater benefits. For example, the use of climate information and services for health, which entails the production, translation and application of climate information to inform health decisions, can help authorities anticipate climate-sensitive risks, protect vulnerable communities, and implement timely evidence-based measures to strengthen health system preparedness and resilience. International cooperation among G20 members and with other partners, such as the G7, is critical for delivering climate information and response systems.
- **Support for the development of information and response systems.** Given the critical role of reliable climate information systems in the design and implementation of adaptation and unlocking public climate finance, it is important that countries invest in supporting the development and maintenance of climate information and response systems.
- **Support for technology development for climate information and response systems**. Advancing reliable climate information and response systems requires appropriate technology development or the transfer of such technology from

[34] Climate information systems in this paper includes agrometeorological information systems, early warning systems, disaster risk assessment tools, multi hazard platforms and climate change vulnerability assessments.

developed countries. Adaptation technologies often require more public support than mitigation technologies because market-based approaches are more difficult to develop (UNFCCC TCE, 2023).

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

Given the robust technical discussions presented in this paper, the South Africa G20 considerations and recommendations focus on three priority areas to benefit from adaptation and deliver sustainable development: (i) how to achieve *integrated planning for adaptation*; (ii) how to advance the *implementation of adaptation actions that is sustainably financed to achieve sustainable development for all*; and (iii) how to *strengthen or develop climate information and response systems that enhance adaptation* implementation.

4.1 Integrating Planning for Adaptation in G20

As the entry point to the implementation of effective adaptation that address national development goals and reduce climate risk, the South Africa G20 Presidency recommends the following as key approaches to integrate adaptation planning into national development processes in G20 countries.

4.1.1 Structured follow-through

The establishment of clear and structured follow-through processes is necessary to achieve full integration of adaptation in national and sub-national development planning across sectors, as well as for implementation of adaptation, that is supported by political will. The follow-through process must be supported by political commitment across all levels of government to accelerate adaptation implementation. Follow-through processes will achieve two main objectives: (i) progress in integrating adaptation planning across multiple key development sectors, and (ii) progress in the implementation of adaptation actions across key development sectors. The success of follow-through process ensures that the benefits of integration and implementation of adaptation are realised and utilised for the welfare of people across the G20. This includes the potential effort to increase private sector participation in financing adaptation.

For a successful follow-through process, the provision and mobilisation of public finance and capacity building are required to effectively advance the mainstreaming and integration of climate change adaptation into development planning and implementation processes. This support can be provided or mobilised through various channels, including bilateral cooperation between G20 countries and multilateral institutions, including the UN Climate Funds, the multilateral development banks (MDBs) and institutions. This would be mobilised as additional support to advance the integration of adaptation in national planning and development, for example, as additional support to the current GCF readiness support provided to developing countries in the G20 to formulate national adaptation plans and policies. This includes support for developing successful follow-through systems that help

assess how the process of integrating adaptation at all levels of government planning is advancing and how experience and knowledge is shared between G20 countries.

4.1.2 Technical adaptation planning committees

The establishment or capacitation of technical adaptation planning committees is recommended, such as national adaptation steering committees, that are inclusive and composed of key economic priority sectors, ensuring that adaptation planning and key economic development are integrated at all levels of government. Where these committees are already established, capacity building and sufficient support are crucial, providing them with the necessary skills and training required to develop and implement the recommended follow-through process.

4.2 Implementation of Adaptation Actions and Sustainable Financing of Adaptation for Sustainable Development in G20

These recommendations aim to enhance the implementation of actions and measures to simultaneously close the widening adaptation gap whilst reducing the adaptation support gap.

4.2.1 Increasing public finance for adaptation

Increasing public finance for adaptation, including by increasing the use of innovative financial instruments for public finance[35] Massively increasing grants and concessional loans is essential for supporting many adaptation actions in the most vulnerable communities. Public finance has proven critical for financing adaptation, although the huge investments required for adaptation across the G20 make it urgent to diversify sources of public finance. Therefore, the South Africa Presidency recognises the importance of broadening the available public financial sources for adaptation, including the potential of innovative instruments that can be suitable for the mobilisation of public resources, such as bonds (blue bonds), equity, insurance/risk transfer instruments, and payment for ecosystem services (such as biodiversity credits), to significantly advance the implementation of adaptation. This support can be provided or mobilised through various channels, including through bilateral cooperations between G20 countries and multilateral frameworks, including multilateral development banks (MDBs).

4.2.2 Increasing incentives, investment and access

Increase incentives and investment on adaptation technology development and increase access to appropriate technology for adaptation by developing countries. This is critical for addressing the technology gap facing developing countries. International cooperation, such

[35] Looking beyond traditional sources of finance – grants and high concessional loans to multiple sources of funding - bonds (such as blue bonds), high concessional loans, equity, insurance/risk transfer instrument, and payment for ecosystem services.

as the cooperation between the G7 and G20, is needed to advance adaptation technology sharing and technology development in developing countries.

In the health sector, which is one of the most vulnerable sectors in developing countries, international cooperation can advance the sharing of necessary vaccines required to adapt to increases in climate-sensitive infectious diseases, such as vector-borne diseases, ensuring that vast expertise, technology and other resources required to develop these vaccines are shared between developed and developing countries to achieve just adaptation for all.

The South Africa G20 presidency recommends initiatives that increase investments and innovation in adaptation technology development in the G20, such as promoting initiatives that reduce the cost of licensing patents for relevant technologies that support adaptation in developing regions. Strengthening efforts to reduce the cost of technology development and innovation and supportive policy interventions, such as subsidising patents.

4.2.3 Promoting capacity building

Promote capacity building of relevant institutions to accurately estimate adaptation needs in the G20. Only a minority of G20 countries have clear and well-costed adaptation action plans—whether in national development plans, NDCs, or NAPs. Accurate costing of adaptation plans and goals potentially increases access to international public finance for adaptation implementation. Effective adaptation costing and the availability of climate data are also crucial for attracting private sector participation in the adaptation sector. By investing in improved adaptation costing in G20 countries, the G20 will create enabling conditions for the private sector to invest in adaptation.

This includes building new capacity or strengthening the capacity of national institutions in G20 countries to generate relevant adaptation investment data, including the benefits of key actions and priorities in NDCs and NAPs. The South Africa G20 Presidency is also prioritising the establishment of technical adaptation planning committees, such as national adaptation steering committees, that are inclusive and composed of key economic priority sectors, ensuring that adaptation planning and key economic development are integrated. In cases where these committees exist, building their capacity is crucial for them to be relevant, by supporting them with necessary skills and training.

4.2.4 Just adaptation

The South Africa G20 Presidency is prioritising ‘just adaptation’ in the G20. This can be achieved if adaptation plans and goals are supported by sufficient, predictable, and sustained climate finance; ethical, equitable, and appropriate adaptation technology; and capacity building of key institutions and frontline communities to enhance the implementation of adaptation actions. This requires full political support and commitment to implement a clear, full follow-through process from planning to implementation of adaptation. The timely provision of all these conditions reduces climate-related losses and

damages for billions of people, as well as providing economic, social and environmental benefits that ensure the resilience of people and nature. For just adaptation to be achieved, all these important factors should occur at the appropriate time, scale and speed.

4.3 Strengthening (Development) of Climate Information and Response Systems for Enhancing Adaptation in G20

To promote the strengthening or development of climate information and response systems that are reliable and efficient for planning, designing and implementing appropriate and effective adaptation:

4.3.1 Investing in effective and reliable climate information and response services.

Investing in climate adaptation data collection, as well as evidence synthesis and knowledge sharing on adaptation between different agencies and institutions within and across G20 countries.

With the increased demand for countries to assess global adaptation progress, through multilateral processes, such as the GGA in the 2020 – 2030 decade of action, investing in climate adaptation data collection, synthesis and sharing offer massive benefits to improve reporting, while offering opportunities for sharing experience to improve adaptation implementation.

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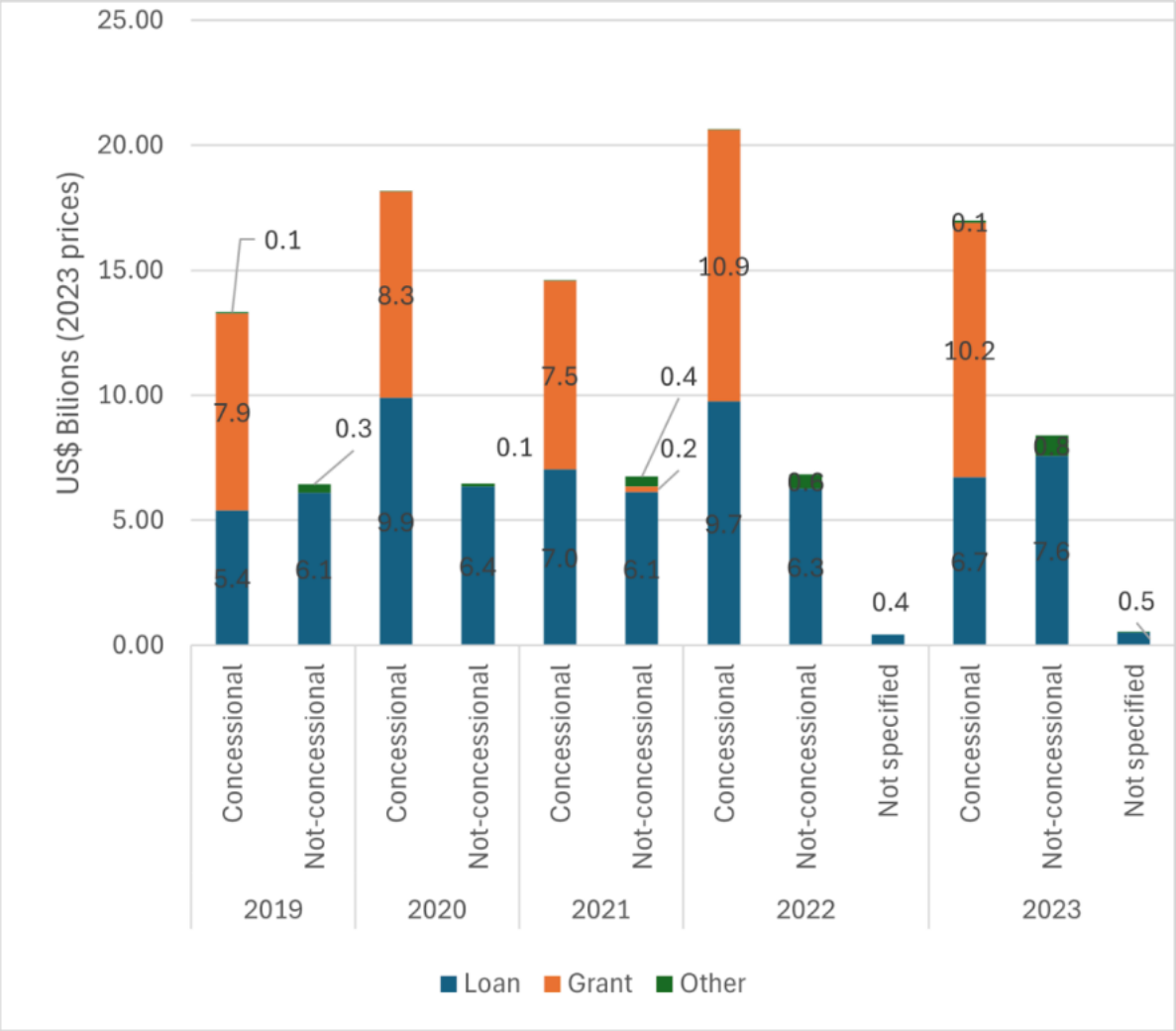
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ANNEX 1: INTERNATION PUBLIC CLIMATE FINANCE – BREAK DOWN BY FINANCIAL INSTRUMENT

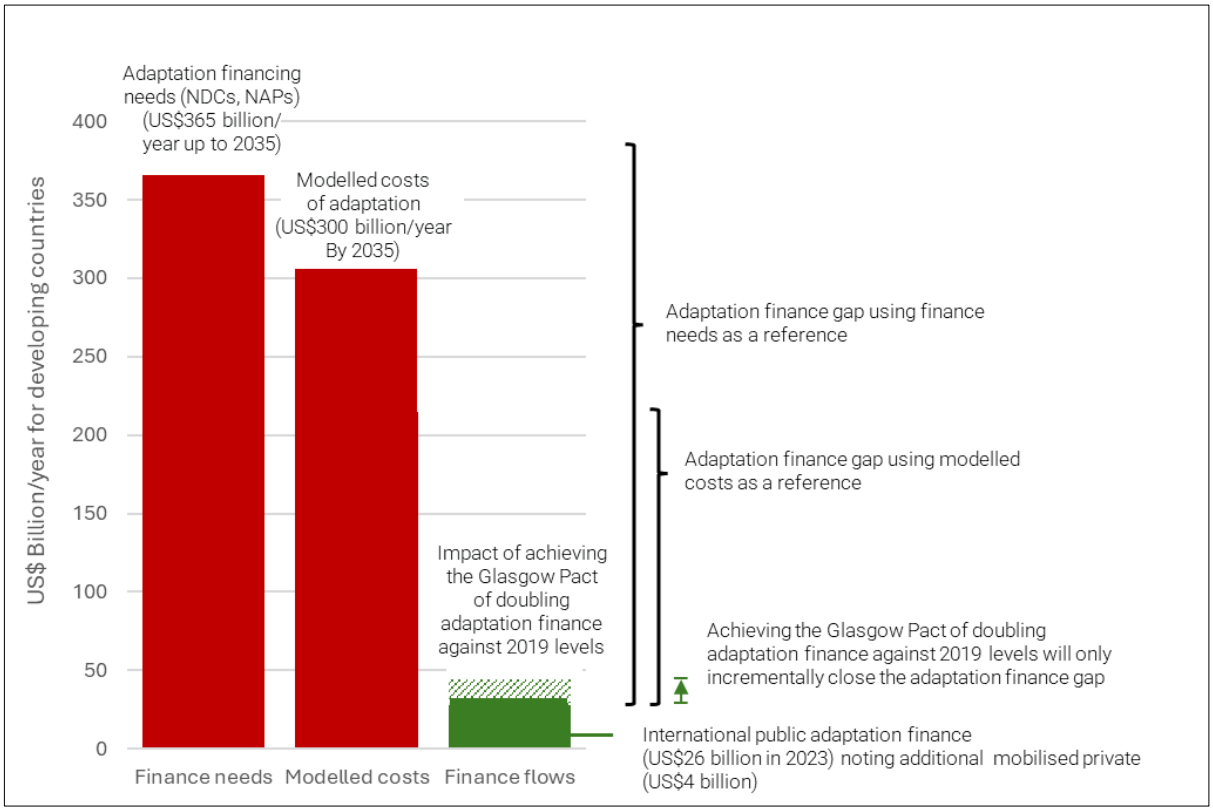
Adaptation finance by concessionality level and financial instrument



Source: Adaptation Gap Report 2025 (forthcoming)

ANNEX 2: ADAPTATION FINANCE GAP

Comparison of adaptation financing needs, modelled costs and international public adaptation finance flows in developing countries (note in current US$2023 prices, not inflation adjusted).



Source: Adaptation Gap Report 2025 (forthcoming)

SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Loss & Damage in a Warmer World

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This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

EXECUTIVE SUMMARY

The year 2024 was the first calendar year to exceed the 1.5 °C level of global warming. At current emission levels the remaining carbon budget that could have kept the level of global warming below 1.5 °C will be burned in the next few years. This implies that the persistent exceedance of the 1.5 °C level of global warming is inevitable within the next five years. This exceedance will be permanent, within the context of several generations of humans, unless strong mitigation of emissions can be achieved and carbon dioxide removal technologies can be developed and applied at scale. A 1.5 °C warmer world is a more dangerous world, in which extreme weather events will be more intense and occur more frequently. Moreover, under current NDCs the level of global warming will be in the order of 3 °C by the end of the 21st century, with the 2 °C level reached as early as the 2040s. Climate change adaptation can thus be expected to become increasingly important. However, at 2 °C of global warming both adaptation and mitigation will not be enough to prevent loss and damage (L&D). Accordingly, towards the end of the century, residual impacts of climate change, L&D, will increasingly cause harm through both slow onset and extreme weather events, particularly in vulnerable regions such as those in Africa. Assessment Report Six of the IPCC found that current responses to address L&D are insufficient. The need for averting and minimizing L&D in developing countries is enormous, however, these harms constitute barriers to sustainable development, cause diminishing of GDP and exacerbate the challenge of debt. Estimating of the economic costs of climate change are making it increasingly clear, that finance for L&D stands the best chance to deliver climate equity at levels of global warming well below 2 °C. Under higher levels of global warming, climate costs to the world economy become so excessive that sufficient L&D associated funding may well be out of reach and will not be achieved. The continuum of mitigation, adaptation and L&D within the UNFCCC framework are thus needed to ensure a sustainable future for all. The methodologies used to estimate the economic costs of climate change, including L&D costs, can still be improved. This in turn will help to obtain better estimates of the quantum of L&D funds needed in the near future, as climate impacts worsen in a 1.5° C world, and beyond. The science of climate change attribution has strengthened considerably and could inform L&D policy and operationalisation for a wide range of extreme event types and related impacts. However, more research is needed to strengthen aspects of extreme event attribution, and there is a need to standardize and operationalize attribution assessments. The G20 countries need to demonstrate leadership in terms of funding L&D, given the recent breakthrough of an operational L&D fund, and noting that differentiated responsibilities exist. The G20 can also commission research to strengthen the estimation of future climate change costs to the global and regional economies. The G20 has a responsibility to strengthen Early Warning Systems and Disaster Risk Reduction worldwide, to lead in mitigation and to fund adaptation, towards minimizing L&D costs.

1 INTRODUCTION

The calendar year 2024 was the first individual year to exceed the 1.5°C level of global warming. A recent and authoritative study has assessed that at the current rate of emissions, the world will burn through the remaining carbon budget to limit global warming to below 1.5°C over the next three to five years (Forster et al., 2025). Already in 2021, the Intergovernmental Panel on Climate Change (IPCC) in its Assessment Report Six (AR6) stated that even under strong mitigation the 1.5°C global warming level is more likely than not to be exceeded, and that the best estimate for that exceedance is the early 2030s (Lee et al., 2021). In the absence of strong mitigation since 2021, however, and given a recent rapid warming of the Earth system, persistent exceedance of the 1.5°C global warming level may well occur as early as the late 2020s (Forster et al., 2025). This exceedance will be permanent, within the context of several generations of humans, unless strong mitigation of emissions can be achieved and new carbon dioxide removal technologies can be invented and applied at scale.

A 1.5°C warmer world is a more dangerous world for humans to live in (Hoegh-Guldberg et al., 2019). This was the stark finding of the IPCC's Special Report on Warming of 1.5°C, an assessment that was reinforced by AR6. Increases in the occurrence of extreme weather events such as heatwaves, wildfires and droughts can already be detected in every inhabited region in the world, and further increases in the intensity and frequencies of these extremes can be expected under 1.5°C of global warming. Moreover, under current emission rates the level of global warming may reach 2 °C as early as the mid-2040s (Lee et al., 2021). The current Nationally Determined Contributions (NDCs) of countries, as submitted to the United Nations Framework Convention on Climate Change (UNFCCC), have in fact been estimated to be equivalent to about 2.6 °C of global warming during the 21st century (UNEP, 2024).

The dawn of the era of 1.5°C of global warming thus calls for an enhanced climate change adaptation. However, there are structural and financial constraints to the speed at which adaptation interventions can be rolled out, especially so in the developing world. There are also biophysical and socio-ecological limits to adaptation. A warmer world, especially at levels of global warming of 1.5°C and higher, therefore also implies that more frequent extreme weather events will translate to more damages incurred by economies (Hoeg-Gulberg et al., 2019). It is also a hard reality that there will be unavoidable increasing climate change impacts on human life and mortality (World Economic Forum and Wyman, 2024).

Loss & Damage (L&D) results from the climate change impacts that occur in the absence of sufficiently strong mitigation, and that could also not be prevented by adaptation, whether that is due to insufficient adaptation or actual limits to adaptation.

It follows that limited mitigation and adaptation translates to more substantial climate change impacts, or L&D, which in turn implies a greater need for L&D financing. Within the concept of 'Loss & Damage', one can distinguish between 'Damage' referring to climate change harms to the economy, environment or directly to people that in principle can be

restored at a certain cost, and 'Loss', which refers to harms from which no full recovery is possible, but for which some form of support may still be possible.

In this paper we will review the current methodologies used to make assessments of costs of L&D incurred, and provide some of the existing estimates to be incurred over the next few decades in a warmer world. The non-economic losses of L&D, including aspects such as loss of life and cultural heritage, are also discussed. The paper places emphasis on the higher vulnerabilities to L&D in the Global South, which partially stems from the lack of adaptive capacity in developing economies.

Against this background the paper then proceeds to comment on existing perspectives of the progress made in terms of securing funding for L&D, within the context of the framework of cooperation and facilitation of the UNFCCC. The paper also discusses the existing legal framework for L&D beyond the UNFCCC, including the recent opinion of the International Court of Justice (ICJ).

The paper reflects on the science of climate change and extreme event attribution, providing evidence that the science is mature for several extreme event types, and could provide the scientific underpinning of L&D. This includes reflecting about the status of and the need to grow attribution capabilities in the Global South. The paper furthermore explains the interlinkages between attribution science and early warning systems, and between attribution science, adaptation and L&D.

The paper concludes with a proposed set of actions by G20 in terms of furthering L&D policy, financing and operationalisation.

2 CONCEPTUALISING LOSS & DAMAGE

It is possible to conceptualise L&D from a physical science perspective, although a formal operational definition of framing L&D within the UNFCCC and Paris Agreement framework remains elusive.

The physical science base is clear that an increase in extreme weather events can already be detected in every region of the world, relative to pre-industrial climate, as a consequence of anthropogenic warming. Further increases can be expected under continued global warming. Adaptation is key to build resilience to the increasing occurrence of extreme weather events, towards alleviating and minimizing impacts. However, there are limits to what adaptation can achieve, particularly under low mitigation scenarios, and adaptation is often expensive and out of reach or not fully achievable within developing economies. Moreover, these countries have relatively small historical responsibility in terms of increasing greenhouse gas concentrations, global warming and associated climate change.

It is against this background that the concept of L&D has arisen. It refers to harmful climate impacts (economic or non-economic) that occur due to a lack of climate mitigation and despite efforts of climate change adaptation. Strictly speaking, however, one also needs to determine whether the extreme weather events that led to the harmful impacts were made

worse or more frequent by climate change. That is, an event that would have occurred anyway, without the influence of climate change, strictly speaking does not qualify as an L&D event. The science of climate change attribution has been developed to explore the role of climate change in harmful climate impacts, including in the extreme weather events that underpin these impacts. Extreme weather and high-impact climate events include fast onset (e.g. landfalling tropical cyclones, heat waves) and slow onset (e.g. sea-level rise, desertification). The L&D caused by harmful climate impacts are defined broadly, including both economic and non-economic impacts.

3 LOSS & DAMAGE FRAMEWORK WITHIN THE UNFCCC

The current policy framework for L&D within the UNFCCC has a rich history of debate and negotiation between the developed and developing nations. Only a brief history is provided here.

The core of the framework was initially formulated as the Warsaw International Mechanism (WIM) at the 19th Conference of the Parties (COP19) in 2013. Its main feature is a commitment of enhanced 'action and support, including finance, technology and capacity-building' within the context of L&D associated with the impacts of climate change on developing countries (Verchick, 2018). Note that the framing is in terms of L&D, that is, in terms of climate change impacts that could not be prevented by mitigation and adaptation. A workplan related to WIM was approved in 2014, which placed strong emphasis on risk reduction to avoid L&D and insurance against risks of L&D (Nishat et al., 2013).

In 2015, the WIM became the foundation of Article 8 of the Paris Agreement on Climate Change. The continuum of mitigation, adaptation and L&D was hereby established to achieve climate action, but without providing any specifications or a basis for liability and compensation in the context of L&D.

In 2019 the COP at its 25th session established Santiago Network under the WIM to provide technical support to developing countries in averting, minimizing, and addressing L&D from climate change. Its core goal is to catalyze demand-driven technical assistance for addressing L&D, drawing on expertise from organizations, networks, and experts to operationalize climate risk management across regional, national, and local levels.

The next important development occurred only in 2022 at the 27th Conference of the Parties (COP27), when the Parties agreed to establish the Fund for Responding to Loss & Damage (FRLD). The purpose of the fund is to assist particularly vulnerable developing countries to address the adverse impacts of climate change. The fund was operationalised at COP28 in 2023, with the World Bank appointed as interim trustee. By April 2025 USD 768 million was pledged to the fund (Climate Funds Update, 2025), which is only a fraction of the estimated costs of L&D (see Section 5). The FRLD is based on solidarity (no commitment) among parties as it urges developed country Parties to provide support and encourage other Parties (developing countries) to also provide support, on a voluntary basis, for activities to address L&D.

The FRLD is now operational and has a Board with representatives from both developing and developed countries. At its fifth meeting, the Board established the Barbados Implementation Modalities (BIM) to respond to L&D consisting of a first set of interventions, for the calendar years of 2025 and 2026, for a total of USD 250 million.

The first Global Stocktake (GST) acknowledged that climate change has already caused and will increasingly cause L&D as temperatures rise. The impacts of weather extremes, as well as slow onset events, will pose an ever-greater social, economic and environmental threat. L&D associated with the adverse impacts of climate change is an outstanding threat to many developing countries, carrying consequences for food security, water resources, health, livelihood, and hinders sustainable development. There is urgency for averting, minimizing and addressing (AMA) both economic and non-economic losses associated with the adverse impacts of climate change.

The elements of scope of work identified by different processes (including the WIM and its expert groups, the first GST, the FRLD) include comprehensive risk management, anticipatory action and planning, recovery, rehabilitation and reconstruction, actions to address the impacts of slow onset events, policymaking and planning for displacement and planned relocation, and mechanisms for channelling funding. In this regard developing country governments need to develop comprehensive policy frameworks on L&D that address national interest and take into consideration advancement of the climate action agenda. They also need to strengthen existing institutional frameworks based on lessons learned in disaster risk reduction. They might need to provide a clear mandate and responsibility for national institutions dealing with L&D and work with regional bodies, initiatives and specialized agencies. Alignment with international agreements such as the Paris Agreement, Sendai Framework and SDGs is also important.

4 NATURE OF FUNDING SUPPORT FOR L&D

Funding support for L&D incurred can be achieved through a range of measures, which may include financial support from dedicated L&D funds, payments from insurance funds, emergency aid and recovery assistance and relocation assistance (Verchick, 2018).

There are limits to what L&D financing can achieve, as there are limits to adaptation. At higher levels of global warming, climate costs may become so substantial that full financial support becomes unachievable (see Section 5). Insurance schemes against climate change impacts may similarly become unsustainable if climate change impacts become unprecedented in scale and frequency (Verchick, 2018). For example, climate costs have been estimated to be high but still substantially lower at 1.5°C global warming compared to 2 °C, or higher levels (see Section 5). This suggests that the extent to which L&D policy can be successfully implemented depends to some extent on the success of climate change mitigation and accompanying adaptation that can reduce or alleviate impacts (Verchick, 2018).

There is of course also the reality of losses for which there is no reasonable financial support, such as lives lost in the increasing occurrence of flash floods or heat waves, or the living space that is irreversibly lost because of sea-level rise.

5 ESTIMATING ECONOMIC LOSS AND DAMAGE

There are certain types of L&D that can be directly monetized, for example, damage to infrastructure and housing during a flood event, or a portion of a crop lost during a drought. However, the methodologies used to monetize climate change impacts are highly heterogeneous. Perhaps the most sophisticated approach, with the potential to provide a standard framework to calculate L&D costs, is Integrated Assessment Modelling. Integrated Assessment Models (IAMs) make use of macroscale economic models to calculate how climate may impact on both the global and country-level economies. These modelling systems have the potential to be very detailed in terms of their calculation of costs related to high-impact events in a changing climate. For example, in terms of climate costs related to losses of and damages to food production, some IAMs incorporate the results of mechanistic crop models that project changes in crop yield in a warming climate, and the IAM then translates what the implications of crop yield losses would be downstream into the economy. Such IAM-based studies that project both global and regional aggregated economic costs are gradually becoming more generally available. An important recent analysis is that of Waren et al. (2021), which estimated that global aggregate damages by 2100 would be 0.29% (90% confidence interval 0.09–0.60%)) of GDP if global warming is limited to 1.5°C, 0.4% for a global warming level of 2°C (range 0.12–0.91%) and 3.67% (range 0.64–10.77%) for a global warming of 4°C.

A variety of other approaches are also used, however, to quantify what can be broadly referred to as climate costs. A recent study of the World Economic Forum, for example, was focussed specifically on the costs of climate change to the health sector, and to the global economy via impacts on human health (World Economic Forum and Wyman, 2024). This study used cost-of-illness models to estimate aspects such as changing treatment costs, costs-of-death and public health system strain in a changing climate. In conjunction with projected changes in productivity due to climate change impacts on human health and mortality, the study arrived at estimates of how climate change impacts on human health translate to economic impacts. Their central estimate is one of an additional 14.5 million deaths and $12.5 trillion in economic losses worldwide, by 2050 under low mitigation scenarios.

Another recent study by the Potsdam Institute for Climate Impact Research (PIK) considered not only health-related L&D but also impacts on infrastructure and agriculture (Kotz et al., 2024). It estimated overall climate costs of $38 trillion per year by 2050 to the global economy relative to a baseline without climate impacts. This translates into a 19 % income reduction (likely range 11% to 29%) over the next 25 years (relative to a baseline without climate impacts). Moreover, Kotz et al. (2024) estimates that Global South countries least responsible greenhouse gas emissions are projected to incur income losses 40% greater

than higher-emission Global North countries, given their generally higher vulnerability to climate change impacts. Specifically, in North America and Europe the median of estimated reductions in income is 11%, but in South Asia, Africa and tropical/subtropical South America, it is in the order of 22 %.

The AfDB's 2022 African Economic Outlook report on the needs of African Countries estimates finance needs for L&D in the period 2022-2030 at between USD 289.2 to USD 440.5 billion. The estimated adaptation finance needs are in a similar order of magnitude. Still, the report highlights a likely underestimation due to data gaps and challenges. One of the most advanced modelling-based assessments on L&D in Africa was the UNECA/ACPC report from 2014. The study generated useful results regarding the linkages between mitigation, adaptation and L&D costs (under different scenarios). It found that in a 4°C world with weak adaptation and weak mitigation L&D is anticipated to cause annual losses of 6% of Africa's GDP. Even with strong regional adaptation in a 4°C world this would still amount to a cost equivalent to 3% of Africa's projected 2080 GDP annually. Even at 2°C warming and with significant adaptation patterns, the models projected more than twice as high L&D costs (in % of GDP) compared to a present-day baseline.

Our understanding of the current and future impacts of climate change on the global and regional economies, including L&D costs in developing countries, is strengthening but remains inadequate. Peer-reviewed literature on the topic remains slim. More research is also needed to explore how well-designed adaptation interventions and improved DRR (which also require investment costs) can reduce climate impacts and consequently L&D costs. There is also not full consistency across different studies in terms of quantifying the role of specifically climate change (as opposed to natural climate variability) in L&D. That is, there is a need for studies estimating the increasing economic costs due to climate change to link to climate change attribution (a science designed to quantify the role of climate change in the frequency and intensity of fast- and slow-onset extreme weather events and their biophysical impacts). Such an extended range of studies undertaken within a common framework will help to provide clarity on the amount of financial support needed from an L&D perspective. Evidence is already very strong, however, that L&D costs under unmitigated global warming will far outweigh mitigation costs to constrain warming to below 2°C (Verchick, 2018; Hoegh-Guldberg et al., 2019, Waren et al., 2021). It is clear that L&D operationalization has its best chance to be affordable if global warming is constrained to below 1.5°C (which now seems unachievable) and can possibly still be achieved under 2°C, but at higher levels of global warming, costs may well spiral out of the reach of what realistically can be sourced from funding support.

6 LOSS & DAMAGE: NON-ECONOMIC LOSSES

There is general consensus in the global discourse around L&D that forms of support should also be provided for non-economic L&D referring to that which cannot simply be replaced via monetary value (Centre for Environmental Rights, 2024). Key examples of such losses include loss of life, loss of territory and identity (e.g. due to sea level rise), loss of access to

services such as healthcare, education and sanitation; physical and mental health impacts, including individual and collective trauma; loss of access to transport and the ability to be economically active; loss of a sense of place, social cohesion and stability; loss of tangible and intangible cultural heritage, loss of biodiversity and environmental harm beyond obvious and quantifiable ecosystem services (Centre for Environmental Rights, 2024).

While economic loss from climate change is well-documented (see Section 5), the non-economic impacts remain poorly understood, particularly in developing countries that have limited capacities. Non-economic loss and damage (NELs) is difficult to quantify but have profound long-term consequences, often exacerbating vulnerabilities and deepening inequalities. The African countries, and more broadly Global South countries, need enormous effort to bridge this knowledge gap (assessment of NELs) to have appropriate responses in place (identification of approaches to address NELs). There is need for dedicating adequate and predictable financial resources (plus other mean of implementation) to assist countries to comprehensively implement approaches to avert minimise and address L&D.

7 WHO MUST PAY?

Within the context of the recently operationalized L&D Fund of the UNFCCC, there are no legal obligations placed on developed country Parties to provide financial resources through the financial mechanism. Rather, contributions depend on voluntary contributions, with developed countries expected to demonstrate leadership in this respect. However, the UNFCCC framework across the continuum of mitigation, adaptation and L&D does recognise the principle that developed countries bear greater historical responsibility for greenhouse gas emissions, as endorsed by the principle of ‘Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC)’ as per Article 2.2 of the Paris Agreement.

An important recent development is the advisory opinion of the International Court of Justice (ICJ) regarding ‘States obligations in the face of climate change’, as delivered in July 2025. The ICJ reached a unanimous opinion that outlined the legal consequences for States whose actions or omissions have caused significant harm to the climate system and other parts of the environment. The Court stated that climate treaties such as the Paris Agreement, the UNFCCC and the Kyoto Protocol, alongside customary international law, establish obligations whose breach can lead to international responsibility. Chief among these is the duty to prevent significant environmental harm. The ruling considered in particular Articles 8 and 15 of the Paris Agreement and Article 14 of the UNFCCC (i.e. in the context of voluntary actions) and pointed out that these do not replace general rules on State responsibility. It affirmed that a State's acts or omissions, including a failure to adequately regulate emission-producing activities, can be attributed to that State under international law. It further noted that the existence of multiple responsible States does not prevent an injured State from invoking the responsibility of one or more of them. Regarding causation, the Court reaffirmed the applicability of the "clear and direct causal link" standard between the wrongful act and

the damage. It found that this standard can be adapted to the climate context through case-by-case assessments grounded in scientific evidence (i.e., climate change attribution).

It may be noted that beyond the realm of the UNFCCC, and before the opinion of the ICJ, L&D related litigation has been underway within several G20 countries. Much of this discussion has been focussed on the so-called top 20 'carbon-majors', the group of companies responsible for 35% of emissions of CO2 and methane from fossil fuel and cement production over the last few decades (Centre for Environmental Rights, 2024). By 2024, more than 60 L&D related cases were filed against the carbon majors (Centre for Environmental Rights, 2024).

8 EARLY WARNINGS, ATTRIBUTION SCIENCE AND L&D

Early Warning Systems (EWSs) are the first line of defence in terms of preventing or at least minimizing L&D. EWSs consist of observational, prediction and dissemination systems and are essential for effective DRR. The United Nations has in 2022 launched the initiative 'Early Warnings for All (EW4All)' with the aim of all regions in the world to be covered by EWSs by the end of 2027. Maintaining and further developing the observational and prediction systems that underpin EWS are expensive and require international cooperation in data and systems sharing, via structures such as the WMO (World Meteorological Organisation) Integrated Processing and Prediction System (WIPPS). However, just as important is the processes towards the uptake of Early Warnings in decision making, weather within formal governance structures or at the community level (Engelbrecht and Vogel, 2021). The World Weather Research Programme (WWRP) initiative progressing EW4All Oriented to Partnerships and Local Engagement (PEOPLE), for example, is entirely dedicated to improving the uptake EWS. It may be noted that in this context, there is a particular need to protect the most vulnerable communities against the increasing impacts of climate hazards. These groups include women and children in the developing world, who given their roles in food production, caregiving, water fetching and informal work are often most exposed to climate hazards, yet due to financial and livelihood constraints have the least opportunity to respond to EWS (Birkman et al., 2022).

EWSs depend first and foremost, within the context of preventing L&D, weather prediction systems that function across the timescales of nowcasting to short-and medium-range weather forecasting, to seasonal forecasting. It is important to realise that the science of climate change attribution that can potentially inform on L&D operationalisation relies heavily on the underpinning technologies of EWSs. There are two main and complementing approaches to extreme weather event attribution, the conditional approach and the probabilistic approach (Engelbrecht et al., 2025). The conditional approach is used to explore how the intensity of a specific weather event that has caused a disaster would have been different in a counterfactual cooler world in which anthropogenic warming has not occurred. This approach directly makes use of numerical weather prediction technologies at the nowcasting to medium-range weather forecasting timescales.

The probabilistic approach explores the frequencies and intensities of weather systems similar to those of a specific event that caused a disaster, for today's anthropogenically-warmed world relative to a counterfactual cooler world. This approach has very close links to the models used in seasonal forecasting and climate change projections. Thus, if operational L&D payments are to be directly informed by attribution science, that science will need to be available operationally. Harnessing the EWS would be key to achieving operational attribution, thereby ensuring that that attribution systems are standardised, transparent and a multi-national collaboration accessible by the Global South. Such a common operational attribution framework can potentially be formally supported and quality-controlled by the WMO.

9 ATTRIBUTION SCIENCE AND ADAPTATION

Attribution science, although originally designed to inform on L&D policy and operationalisation, also has tremendous value to inform on climate change adaptation and building resilience to future extreme events, thereby reducing impacts leading to L&D. Conditional attribution is used to explore how the intensity of an extreme weather event that caused a disaster would have been different in a counterfactual cooler world in which anthropogenic warming has not occurred. This approach can also be applied in a forward-looking way, to explore how the attributes of the weather system would be different in a future warmer world (e.g. Engelbrecht et al., 2025). There is immense value for decision makers, when considering advances in DRR and the development of adaptation options, to be able to link a specific weather system that caused a disaster to climate change. Moreover, understanding how such a weather system may intensify even further in a future warmer world provided further impetus for climate-smart DRR and adaptation actions. The probabilistic approach to attribution also directly informs on changes in both the frequency and intensity of extreme weather events in a future warmer world, once again with direct implications for adaptation actions. Clearly, attribution science does not only inform on L&D considerations, but also on adaptation, which in turn can substantially reduce future L&D costs.

10 PROPOSED ACTIONS BY THE G20

It is clear from the physical science base of climate change that the only hope for the continuum of mitigation, adaptation and L&D to keep global warming well below 2°C, prepare for and manage climate change impacts and achieve sustainable development for all, is for climate change mitigation to be strong in the first half of the 21st century. Under levels of global warming substantially higher than 2°C the levels of economic damage become substantial, and there is the potential for the limits of Planetary Boundaries to be exceeded, leading to irreversible and irreparable losses, such as lost living space/land because of sea-level rise. It is against the background that the following recommendations are made for G20 members in terms of furthering the underpinning science-base and means of implementation (MOI) required to address L&D:

- Addressing L&D in a comprehensive manner and providing climate equity can most realistically be achieved if global warming can be restricted to well below 2°C above pre-industrial levels. Under higher levels of global warming, the climate costs of extreme weather events may spiral out of control and out of the reach of funding support. The G20 needs to demonstrate strong leadership in terms of climate change mitigation in order to achieve the temperature Goal as set by Article 2 of Paris Agreement
- Given that the world is committed to further warming even under strong mitigation in the near-future, climate change adaptation and financing adaptation in the Global South is critical to building resilience to increasing weather and climate extremes. Funding adaptation and mitigation offers a huge saving in terms of preventing L&D costs. The G20 needs to be pro-active towards quantifying and funding the Global Goal on Adaptation, noting that differentiated responsibilities exist in this respect, amongst the G20 countries.
- With increases in the frequency and intensity of extreme weather events, risk reduction is the first line of defence in terms of preventing and minimizing L&D. EWS, including the observation, prediction and dissemination systems they depend on, and their formal uptake (including implementation of diverse responses that avert, minimize and address L&D), need to be maintained, improved and expanded worldwide. The G20 countries can be pro-active in achieving the United Nations vision of Early Warnings for All. This would include strong support for sharing freely the observational and prediction data needed for EWS.
- More broadly, the G20 is recommended to commit in a coordinated way institutional capacity within the member countries to support the Santiago Network, which exists under the WIM and is administer via the UN Office for Disaster Risk Reduction. This can include aspects such as strengthening EWS, climate change risk assessments and disaster risk planning developing countries, with the overall aim being to reduce the L&D being incurred.
- The G20 developed members need to demonstrate leadership in terms of scaling-up adequate and predictable finance, using various financial mechanisms/instruments, alongside the provision of direct budgetary support, to address the urgent needs arising from L&D as well as other climate change impacts. This support should be tailored to specific national contexts, ensuring it effectively addresses the diverse needs of developing countries and aligns with national development priorities.
- G20 members could promote research on an assessment of needs and the calculation of L&D costs in developing countries. The purpose would be to better understand the amounts of funding needed for actions required to address L&D associated with adverse impacts of climate change, when mitigation and adaptation action are not sufficient.
- G20 developed members should similarly support the establishment/strengthening of technical capacity in developing countries for advancing research related to assessing

historical and projected L&D to inform decisions related to management of risks including through identification of approaches/responses to address L&D.

- The G20 developed members need to, in support of L&D in the UNFCCC framework, facilitate and support the development of comprehensive policy frameworks on L&D that address national interest and take into consideration the need to strengthen existing institutional frameworks based on lessons learned in DRR.
- The G20 members, in support of L&D in the UNFCCC framework, should establish operational attribution centres for L&D financing. Such centres need to have the mission to provide equal access to the Global south in terms of attribution science.

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Integrated Approaches for Climate Mitigation and Development Towards Enhanced Implementation

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This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

EXECUTIVE SUMMARY

Climate change threatens progress toward the Sustainable Development Goals (SDGs) through adverse effects on human well-being, biodiversity, labour productivity, and physical infrastructure, with disproportionate impacts on vulnerable communities. Exceeding the 1.5°C temperature limit of the Paris Agreement will exacerbate climate impacts and hinder the achievement of SDG outcomes. Transitioning to low-emission development pathways presents significant opportunities to advance socioeconomic development and social wellbeing, if accompanied by safeguards for equity and justice. Action to combat climate mitigation has been found to have more potential synergies than trade-offs with SDGs across sectors.

The global policy landscape reflects a growing consensus that climate action and socioeconomic development are intrinsically linked, but translating this recognition into integrated approaches has remained a challenge. Recognising the impact of their national policies and actions on global emissions and welfare, past G20 Presidencies have acknowledged the strong interlinkages between sustainable development (SDGs) and climate change mitigation and repeatedly committed to working towards integrated goals. Likewise, integrated approaches feature as an important theme in multilateral forums and initiatives, such as the UNFCCC Conference of the Parties (COP), the Breakthrough Agenda, and the Global Clean Power Alliance.

This technical paper builds on G20 consensus and makes the case for an integrated approach to socioeconomic development and climate mitigation policies to unlock joint opportunities and manage trade-offs. In this context, an integrated approach refers to a framework that pursues climate mitigation and socioeconomic development objectives simultaneously, achieving progress on both through the advancement of the other. Drawing on a literature review and case studies from G20 members, the paper identifies required enablers—policy integration, finance mobilisation, technical capacity and international cooperation. The latter two enablers are cross-cutting, as they underpin and strengthen the former.

***Policy integration** is the alignment of climate mitigation and socioeconomic development policies across sectors and governance levels towards a low-emission national development pathway. Aligning long-term low-emission development strategies (LT-LEDS) with short-, mid-and long-term climate and socioeconomic development objectives creates opportunities for integrated policymaking, efficient resource use, joint financial mobilisation, and integrated monitoring and reporting. Effective policy integration relies on coherence across sectors and levels of government, long-term continuity, local ownership, and equity. However, it can be challenging to reconcile diverse political and societal*

perspectives and coordinate across institutions and governance levels that often operate in silos.

***Mobilising finance** from diverse sources – domestic, international (bilateral and multilateral), public and private – is another key enabler of implementing integrated climate mitigation and socioeconomic development priorities. This requires conducive enabling conditions, including policy continuity, integrated investment frameworks, and well-designed incentives. Persistent challenges include weak or inconsistent policy signals, high perceived and real risk and limited institutional capacity. Fiscal constraints due to high debt burdens and limited access to affordable long-term financing also hinder public financial mobilisation.*

***Technical capacity** and **international cooperation** are essential cross-cutting enablers that help to address these challenges and advance opportunities by enhancing institutional and stakeholder capacity for policy integration, promoting access to finance and markets, facilitating knowledge and technology cooperation, and fostering coordinated global efforts that accelerate low-emission development pathways.*

The G20 plays a key role in advancing action toward increasingly urgent socioeconomic development and climate goals. Three considerations are proposed for G20 action to strengthen cooperation on integrated action.

1. ***Facilitate experience-sharing on integrated approaches at the G20 level** – Harness the G20 platform to share best practices and lessons learned across member countries to promote mutual learning and leapfrogging.*
2. ***Foster international coordination for enhanced implementation at the G20 level** – Utilise the G20 platform to facilitate multi-stakeholder coordination at the international level to advance integrated approaches.*
3. ***Engage in demand-driven partnerships to support country-level implementation** – G20 members can leverage bilateral and multilateral partnerships and roles in multilateral financial institutions, to champion demand-driven holistic partnership models that align finance, technology, and capacity building with national priorities.*

1 INTRODUCTION AND BACKGROUND

The evidence on climate change is clear. Between 2011 and 2022, human activities led to a 1.1°C rise in global surface temperatures above pre-industrial levels, overshooting 1.5°C for the first time in 2024. Current policies are projected to result in global warming of 2.7°C[1] above pre-industrial levels (CAT, 2024). Human-caused global warming is rapidly changing Earth's systems. Extreme weather events, like droughts, floods, and heatwaves, are becoming more frequent, contributing to increased food and water insecurity, human

[1] 2.7°C is the median of the combined low and high ends of current policy projections of the Climate Action Tracker.

mortality and morbidity, displacement, biodiversity losses, and economic and infrastructure damages (IPCC, 2023).

Global warming is caused by greenhouse gas (GHG) emissions from a variety of human activities, including unsustainable energy use, land use, land use change and forestry (LULUCF), and production and consumption patterns. Limiting global warming and avoiding the worst impacts of climate change requires collective and coordinated action on deep, rapid, and sustained GHG emission reductions (IPCC, 2023).Historical and current contributions to GHG emissions growth vary across regions and income groups. 35% of the global population lives in countries emitting more than 9 tonnes of carbon dioxide equivalent (tCO_2-eq) per capita (excluding LULUCF emissions), compared to the global average of 6.9tCO_2-eq. In contrast, 41% of the global population lives in countries that emit less than 3 tCO_2-eq per capita, less than half of the global average (IPCC, 2023).

Communities with the least historical and current contributions to climate change tend to be disproportionately vulnerable to its impacts (IPCC, 2023). A significant proportion of this population lacks access to basic energy services and living standards, let alone the capacity to adapt to climate change impacts. As of 2024, at least 1.1 billion people[2], over half of which are children, lived in acute multidimensional poverty, lacking access to adequate nutrition, drinking water, sanitation, housing, and electricity (UNDP and OPHI, 2024). The World Bank has noted that the Covid-19 pandemic and overlapping global crises have undermined development gains in International Development Association (IDA) countries and led to a reversal in development (Chrimes, et al., 2024).

Global efforts to mitigate climate change and improve socioeconomic development[3] are deeply interconnected and should go hand in hand. Climate change impacts undermine progress towards socioeconomic development through adverse effects on human wellbeing, biodiversity losses, labour productivity, and physical infrastructure (Adom, 2024). At the same time, continuing to pursue emissions-intensive development pathways leads to further GHG emissions and exacerbates these climate impacts, which in turn worsen socioeconomic development outcomes. This effectively traps countries in a vicious cycle globally, where their pursuit of development through emissions-intensive pathways itself poses a risk to collective future development outcomes Lecocq, et al., 2022).

On the other hand, the transition to low-emission development pathways presents significant opportunities to advance the socioeconomic development objectives. In the short-term, enhanced mitigation policies and actions can foster economic growth and social wellbeing through the expansion of low-emission industries, technologies, and sectors, job

[2] From a total of 6.3 billion people in the 112 sample countries (UNDP and OPHI, 2024).

[3] In this paper, *development* refers to the general process historically centred on economic progress (e.g., GDP, productivity). *Socioeconomic development* emphasises improvements in both economic and social dimensions (e.g., income, health, education, equity). *Sustainable development* is used in line with the UN Sustainable Development Goals (SDGs), integrating economic, social, and environmental/climate objectives. *Low-emission development* denotes strategies focused on reducing greenhouse gas emissions while pursuing both economic and social development.

creation, clean energy access, poverty reduction, and improved public health, thereby contributing to several SDGs (OECD, 2025a). In the long term, mitigating climate change delivers welfare gains through avoided economic damages, productivity losses, and adaptation costs (Burke, et al., 2018).

The interconnectedness of climate change mitigation and socioeconomic development demands an accelerated and integrated approach for pursuing them. An integrated approach in this context refers to a framework for pursuing climate mitigation and socioeconomic development objectives simultaneously, and each goal through the other. It implies shifting national development pathways towards low-emission trajectories and designing climate mitigation policies to drive progress towards national development goals, thus capitalising on opportunities to deliver economic and welfare gains while reducing emissions and contributing to the global effort to avoid climate damages that compromise future development. An integrated approach ensures that development plans do not compromise climate objectives and climate plans do not compromise development objectives.

This technical paper aims to inform discussions on climate mitigation in the 2025 G20 Environment, Climate, and Sustainability Working Group (ECSWG), incorporating feedback from G20 members provided during previous meetings. It provides an overview of the multilateral context, at the G20 level and beyond, highlighting the significant work done so far and the potential for continuity on the topic of integrated approaches (**Chapter 2**). It then presents the case for climate mitigation as a driver of socioeconomic development based on literature (**Chapter 3**), followed by a review of the key enablers of integrated approaches (**Chapter 4**). Theoretical research is supplemented with an analysis of G20 case studies to draw out high-level learnings (**Chapter 5**), forming the basis for a set of considerations for G20 action (**Chapter 6**).

2 MULTILATERAL CONTEXT

This chapter provides an overview of the key multilateral mechanisms and initiatives linking climate and development, as well as past and ongoing G20 deliberations and initiatives on this topic. It highlights that significant work has already been done in this area, indicating potential to further build on this foundation.

2.1 Key Multilateral Mechanisms Linking Climate and Development

2.1.1 Global Legal and Policy Foundations

The UN Framework Convention on Climate Change (UNFCCC), adopted in 1992, establishes the global legal and political foundation for climate mitigation. It emphasises that climate policies should consider national development priorities and promote sustainable growth (UNFCCC, n.d.). Under the UNFCCC, the Conference of the Parties (COP) serves as the apex

governing body of the Convention, responsible for reviewing progress and taking decisions to ensure its effective implementation (UNFCCC, 2015).

In 2015, Parties adopted the Paris Agreement, committing to limit future GHG emissions and global warming to "well below 2°C above pre-industrial levels" by the end of the century, and pursue efforts to limit it to 1.5°C above pre-industrial levels (UNFCCC, 2015). As part of the Paris Agreement, all countries submit their respective climate action plans, or Nationally Determined Contributions (NDCs), reflecting their contribution to mitigating GHG emissions, based on equity and the principle of Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC), in the light of different national circumstances.

The Paris Agreement emphasises the "intrinsic relationship that climate change actions, responses and impacts have with equitable access to sustainable development and eradication of poverty" and frames the global response on climate change mitigation "in the context of sustainable development and efforts to eradicate poverty" (UNFCCC, 2015). By encouraging countries to develop and submit long-term low-emission development strategies (LT-LEDS) in addition to their NDCs, it reinforces the link between climate action and national development planning.

Similarly, in 2015, the global community adopted the 2030 Agenda for Sustainable Development to end poverty and improve the quality of life for all through17 interconnected Sustainable Development Goals (SDGs) (UNSTATS, 2025). The 2030 Agenda incorporates climate action as one of the 17 SDGs, acknowledging the importance of mitigating and adapting to climate change in the pursuit of socioeconomic and environmental well-being.

2.1.2 COP-Related Initiatives

Several climate COPs have produced initiatives that explicitly link climate mitigation with socioeconomic development (Kuramochi, et al., 2024). Key examples that include G20 member countries are summarised in Table 3.

Initiative	COP/ Year	Objective	SDG Linkages (excerpt)
Global Methane Pledge	COP26 / 2021	Reduce global methane emissions by 30% by 2030	Climate action, health, food security
Global Coal to Clean Power Transition	COP26 / 2021	Support transition away from coal power	Climate action, energy security, job creation, health
Powering Past Coal Alliance	COP26 / 2021	Phase out unabated coal power	Climate action, job creation, technology transfer
Breakthrough Agenda (Industry, Cement, Steel)	COP26 / 2021	Decarbonise key industrial sectors	Climate action, economic growth, job creation, industrial competitiveness
Global Clean Power Alliance	Multiple COPs	Promote clean energy transition	Climate action, energy security, socioeconomic development

Table 3: Overview of key COP initiatives linking climate mitigation with socioeconomic development.

In addition to these initiatives, there are country partnerships, such as the Just Energy Transition Partnerships (JETPs) with Indonesia, Senegal, South Africa, and Vietnam, supported by the International Partner Group, a coalition of developed countries that provides financial and technical support. JETPs are designed to support low-emission transitions in specific economies while promoting socioeconomic priorities, including job creation, social inclusion, and technology transfer.

2.1.3 Financing frameworks for Climate-Development Integration

The Addis Ababa Action Agenda, adopted at the Third International Conference on Financing for Development in 2015, complements the Paris Agreement and the 2030 Agenda by providing a global framework for aligning all sources of finance with the three dimensions of sustainable development: economic development, environmental protection, and social inclusion. It recognises that well-designed actions can "produce multiple local and global benefits, including those related to climate change" (UN, 2015). Similarly, the Compromiso de Sevilla, adopted at the Fourth International Conference on Financing for Development in 2025, "promotes the consideration of environment, biodiversity, climate, disaster risk, food security, nutrition, and sustainability of agrifood systems in fiscal programming in line with national circumstances and sustainable development priorities (UN, 2025).

2.2 G20 Deliberations and Initiatives

G20 members represent 85% of global GDP, 75% of international trade, and two-thirds of the global population (G20 South Africa, 2025). In 2023, they accounted for 82% of global GHG emissions, yet the projected impact of their collective NDCs goes little beyond what is already expected from current policies – suggesting that ambition in NDCs and current policies remains insufficient (UNEP, 2024). Given their weight, the G20 members have a responsibility and opportunity to accelerate mitigation at the pace required to avoid the worst climate impacts, while seizing the socioeconomic benefits of low-emission development.

At the same time, G20 members differ in terms of per capita emissions, national income and human development levels, as well as their historical contributions to climate change, underscoring the need for international cooperation among G20 members to advance the SDGs and climate mitigation in line with the Paris Agreement's equity and CBDR-RC principles.

Recognising the impact of their national policies and actions on global emissions and welfare, the G20 has collectively and repeatedly highlighted the importance of integrated mitigation and development approaches in recent Presidency communication.

- **Saudi Arabia (2020):** The Riyadh Leaders' Declaration focused on Covid-19 recovery while committing to an environmentally sustainable and inclusive future (G20, 2020a). The *Financing for Sustainable Development Framework* was adopted, offering guidelines for aligning SDG implementation with national development and climate

strategies (G20, 2020b). The G20 also endorsed the *Circular Carbon Economy (CCE) Framework* as a voluntary approach to manage emissions, leaving implementation dependent on national circumstances (G20, 2020a).

- **Italy (2021):** The Rome Summit reaffirmed commitment to the Paris Agreement as a driver of the 2030 Agenda (G20, 2021). The Italian Presidency elevated sustainable finance as a central enabler of just transitions, leading to the adoption of the *G20 Sustainable Finance Roadmap*. This roadmap, developed by the G20 Sustainable Finance Working Group, provided a voluntary multi-year strategy to scale up finance for the SDGs and Paris goals (G20, 2022a).
- **Indonesia (2022):** The Bali Summit explicitly connected energy, climate, and development, lifting the global clean energy transition to a G20 leader-level priority (G20, 2022b; G20, 2022c). Leaders endorsed the *Bali Energy Transitions Roadmap*, which framed clean energy transitions as affordable, just, and inclusive, and introduced voluntary actions for net-zero and SDG achievement. The Presidency also launched the *Troika Action Plan* to ensure continuity across presidencies, addressing a persistent challenge of the G20 process.
- **India (2023):** The New Delhi Summit marked a stronger emphasis on the integration of mitigation and development (G20, 2023b). The *G20 Action Plan on Accelerating Progress on the SDGs* highlighted opportunities for sustainable growth through low-carbon development, while recognising the long-term economic risks of inaction (G20, 2023a). Leaders committed to just and orderly transitions, acknowledged the need for scaled-up finance and called for MDB reforms to expand affordable access, particularly for developing countries.
- **Brazil (2024):** The Rio Leaders' Declaration reiterated commitment to SDG acceleration and highlighted debt vulnerabilities and the importance of low-cost financing (G20, 2024). The Brazilian Presidency established the *Taskforce on a Global Mobilisation Against Climate Change (TF CLIMA)*, for the first time bridging the Finance and Sherpa tracks. TF CLIMA reframed climate action as a systemic issue requiring alignment of macroeconomic, financial, and policy actions across G20 members. Its expert group recommended national transition platforms, MDB and climate fund reforms, and stronger coordination to channel resources effectively (TF-CLIMA, 2024). This represented a shift from declaratory commitments toward institutional innovation.

G20 discussions over the years have gradually shifted from broad statements of intent toward the creation of structured frameworks such as the Sustainable Finance Roadmap, the Bali Energy Transitions Roadmap, and the SDG Action Plan, and most recently to institutional mechanisms such as TF CLIMA. While these developments indicate a growing recognition of the links between climate, finance, and development, the emphasis has often remained on general recognition rather than on collective strategies for integrating mitigation and socioeconomic development objectives.

3 LITERATURE REVIEW: THE RATIONALE FOR INTEGRATED APPROACHES

This chapter synthesises findings from existing literature to build the case for integrated approaches to climate mitigation and socioeconomic development. It challenges the notion that climate mitigation hinders economic growth, instead presenting evidence that well-designed mitigation policies can drive both short- and long-term economic and social gains. However, it also highlights that without inclusive policy design, such benefits may be unevenly distributed and create disproportionate burdens on certain groups or regions, requiring mitigation strategies to build equity considerations into their design. This chapter thus aligns with the premise of the G20 ECSWG paper on "Characterising whole-of-economy, whole-of-society just transitions and identifying levers for operationalisation" (Hermanus, et al., 2025).

3.1 Climate Mitigation is a Driver of Socio-Economic Development

This section makes the case that climate mitigation can lead to positive economic growth outcomes, both in the short- and long-term and through direct and indirect effects. In the short term, this is driven by the new industrial and technological investment opportunities presented by climate mitigation policies, as well as their indirect impacts on labour productivity and human wellbeing. In the long term, the positive effect on economic and social wellbeing is compounded by factoring in the avoided economic damages resulting from the amplified impacts of climate change and the crossing of planetary tipping points.

Ambitious climate mitigation can lead to higher GDP in the short and long term

There is wide agreement in academic literature that economic output (measured by Gross Domestic Product or GDP) continues to increase in scenarios with ambitious climate mitigation policies relative to baseline scenarios, indicating that it is possible to decouple economic growth from GHG emissions (Lecocq, et al., 2022).

Several economic modelling studies find that scenarios with ambitious climate mitigation policies lead to higher GDP in the short- to mid-term, compared to reference scenarios (The World Bank, 2022; OECD, 2025a; Lecocq, et al., 2022). The OECD found that accelerated climate mitigation has small but positive effects on global GDP, projected to be 0.12% higher than with current policies in 2030. This goes up to 0.20% higher in 2035 and 0.21% higher in 2040 (OECD, 2025a).

Country-specific modelling studies by the World Bank suggest much larger positive effects of mitigation policies on GDP in the short term, showing an average difference of 1.15% above the current policies scenario across 14 sample countries in 2030. For individual G20 members included in the sample, GDP is estimated to be 0.09% (China), 2.03% (Türkiye), and 2.08% (Argentina) higher in 2030 with ambitious climate mitigation policies as compared to with current policies alone (The World Bank, 2022).

Academic literature in G20 member countries has also found such positive short-term effects of mitigation on GDP relative to reference scenarios, such as in China (Huang, et al., 2019; Glomsrod, et al., 2016), European Union (Antimiani, et al., 2016), France (Pisani-Ferry & Mahfouz, 2023), India (Gupta, et al., 2019), Indonesia (Siagian, et al., 2017), Saudi Arabia (Blazquez, et al., 2017), and Kenya and Ghana (members of the African Union) (Willenbockel, et al., 2017).

Studies that find positive impacts of climate mitigation on GDP account for both the constraining and counterbalancing effects of mitigation policies. For example, introducing a carbon price would increase the costs of fossil energy, prompting households and firms to reduce their energy use and, in turn, decrease short-term economic activity (see Section 3.2). However, it would also encourage investments in energy efficiency and clean technologies and industries, lowering long-term energy costs and boosting productivity (OECD, 2025a; Lecocq, et al., 2022).

The net impact of these opposite forces depends on the time horizon and resource efficiency assumptions used in the studies. In fact, some studies that use a short-term modelling horizon find negative impacts of climate mitigation policies on GDP, as their constraining effects are more pronounced due to short-term rigidities in capital stock or the labour market. However, in the mid- to long-term, economic inputs can respond flexibly to well-designed climate mitigation policies, leading to a shift of capital and jobs towards low-carbon sectors (Lecocq, et al., 2022).

Similarly, some studies assume that mitigation-driven investments would crowd out productive investments elsewhere in the economy, causing a net negative effect on economic output (Lecocq, et al., 2022). However, this does not account for the fact that the global economy is not yet on the resource efficiency frontier, i.e., it is still possible to increase both economic activity and environmental benefits in most parts of the world (Damania, et al., 2023).

In the long term, it is important to account for the avoided economic damages resulting from climate change impacts due to accelerated climate mitigation, which tend not to be reflected in short-term modelling results due to their longer time horizon. It is estimated that ambitious climate mitigation scenarios lead to avoided economic damages in the range of 0.2-4% of global GDP in 2050, increasing further by the end of the century (NGFS, 2024; OECD, 2025a). Avoided damages can account for much higher shares of GDP for developing countries, estimated to be in the range of 4-6%, due to their higher exposure to climate change impacts and lower adaptive capacities. When considering a longer timeframe up to 2100, avoided damages can be as high as 13% of global GDP (OECD, 2025a).

It is important to note that delayed climate mitigation also results in higher adaptation and loss and damage costs in the future, which are not fully captured in these quantitative estimations. In addition, estimates do not account for the increased likelihood of climate ‘tipping points’, such as the melting of ice sheets or the reversal of ocean circulation

patterns, which can cause irreversible economic and social damage. These factors further strengthen the long-term economic case for climate mitigation.

Climate mitigation policies have additional indirect effects on GDP and well-being

The computable general equilibrium models used to study the impact of climate mitigation policies on GDP generally do not quantify their indirect effects – for example, through improvements in economic productivity due to improved public health or agricultural output (OECD, 2025a; Lecocq, et al., 2022). Thus, scenario-based modelling studies are likely to underreport the extent to which climate mitigation drives economic development and social well-being.

These impacts are qualitatively and quantitatively studied in other types of literature. A wide spectrum of research focuses on quantifying the economic value of public health improvements brought about by climate mitigation, through improved outdoor and indoor air quality, diets, and physical activity levels (Karlsson, et al., 2020).

For example, climate mitigation policies that reduce fossil fuel consumption would also reduce air pollution, helping combat the 6.7 million annual premature deaths associated with ambient air pollution and resulting in higher life expectancy and economic productivity (WHO, 2024). The OECD estimates that labour productivity losses due to outdoor air pollution impose an economic cost of USD 330 billion annually, resulting in global GDP losses of 1% by 2060 (OECD, 2016). Another global study estimates that climate mitigation measures result in annual savings of about EUR 250 billion in air pollution control costs by 2050, compared to a scenario without climate measures (Rafaj, et al., 2012). McCollum et al. (McCollum, et al., 2013) find that the synergistic benefits of air quality and energy security improvements due to climate mitigation policies could account for USD 100-600 billion annually by 2030, or 0.1-0.7% of GDP.

Reducing indoor air pollution by replacing traditional biomass used for cooking with improved or electric cookstoves also has economic impacts, mainly in the form of improved health and increased labour force participation among women. For instance, several studies find that the benefits of improved cookstoves in Mexico far outweigh the costs by 4-10 times, particularly due to improved purchasing power from fuelwood savings and improved longevity and productivity from reduced health impacts (García-Frapolli, et al., 2010; Zhang & Wang, 2011).

Other studies have quantified the economic impacts of behavioural changes that can improve public health and mitigate climate change simultaneously. For example, transport policies that promote walking, cycling and public transport could lead to health improvements and economic savings worth up to USD 1.4 trillion annually by 2050 (ITF & OECD, 2025).

Beyond health impacts, climate mitigation has also been linked to economic benefits through improved agricultural productivity. Literature finds that better farming practices and improving soil health can increase crop yields while promoting carbon storage (Ning, et al.,

2015; Biederman & Horpole, 2012). At the same time, it is important to note that land-use-related climate mitigation policies, such as agricultural or afforestation policies, have impacts on biodiversity and ecosystems that cannot be easily quantified in economic terms. For example, large-scale afforestation provides synergistic benefits for carbon storage as well as biodiversity protection that support the achievement of broader sustainable development goals (Karlsson, et al., 2020).

3.2 Equity Safeguards are Essential to Deliver Socio-Economic Development through Mitigation

While there is extensive evidence in the literature of the positive aggregate impacts of climate mitigation policies on GDP and other well-being indicators, they can create winners and losers both within and across countries if implemented without adequate policy design or financial and technical support. This section makes the case for pursuing integrated policies and approaches that combine mitigation measures with equity safeguards to achieve the desired positive socio-economic outcomes described in Section 3.1.

Distributional effects of climate mitigation policies within countries

Within countries, low-emission development pathways lead to structural changes in the economy, for example, through a reduction in carbon-intensive industrial activity alongside an increase in low-carbon industries. Literature examining the impact of climate mitigation policies on employment at the global aggregate level finds only small changes compared to baselines, with the direction of the change depending heavily on policy design assumptions (Chateau & Saint-Martin, 2013; Garcia-Casals, et al., 2019; Malerba & Wiebe, 2021; Vandyck, et al., 2016). However, these small variations at the aggregate level hide significant reallocations from carbon-intensive sectors to clean energy and industrial sectors. There is some evidence that job losses in the fossil fuels sector may be more than compensated by gains in the renewable energy sector (Pai, et al., 2021). However, the social consequences of such reallocations must be managed with adequate redistributive policies such as upskilling and reskilling programmes, outplacement services, job search assistance, and geographical mobility policies (Wong, et al., 2022; Karlsson, et al., 2020; Lecocq, et al., 2022; Riahi, et al., 2022).

Poorly designed climate mitigation policies can increase inequality and poverty within countries. For example, consumer carbon pricing policies can raise energy or food prices if not accompanied by redistributive policies, such as cash transfers and recycling carbon tax revenue (Hasegawa, et al., 2015; Fujimori, et al., 2019). Similarly, structural economic changes can lead to job losses in carbon-intensive industries, disproportionately affecting low-skilled workers. Without adequate reskilling support, workers may be forced to relocate for new jobs in low-carbon sectors, where they may face wage losses and the potential loss of collective bargaining power and union protections (Lecocq, et al., 2022; Riahi, et al., 2022).

Without intentional policy design, climate mitigation policies may also create trade-offs with environmental objectives. For example, expanding renewables or electric vehicles can alter land use, impact indigenous communities, and increase demand for critical minerals, leading to biodiversity loss, pollution and public health concerns (OECD, 2025a). Anticipating and managing these impacts through inclusive, stakeholder-driven approaches is key to ensuring a just and sustainable transition.

A substantial body of literature finds that well-designed policies can mitigate risks and lead to positive outcomes. For example, if carbon pricing instruments are accompanied by targeted revenue recycling measures, such as direct cash transfers indexed to inflation for the most vulnerable households, instruments can lead to a positive outcome on GDP and welfare while also achieving reduced emissions (Yahoo & Othman, 2017; Rivera, et al., 2016; Goulder, et al., 2019; OECD, 2025a).

Distributional effects of climate mitigation policies across countries

Mitigation policies can have different distributional effects across geographies as well. For example, in terms of employment, literature finds that energy importing regions would benefit the most from net job creations, while energy exporting regions experience smaller gains or net job losses (Garcia-Casals, et al., 2019; Malerba & Wiebe, 2021). Similarly, the socio-economic implications of an energy transition are most pronounced for coal dependent countries (Spencer, et al., 2017; Jakob, et al., 2020). Fossil fuel exporting countries are also negatively impacted due to reduced export earnings, but the impact on their overall economic growth rate is small relative to the current policies baseline (OECD, 2025a).

Additionally, mitigation policies in one country can have negative environmental or social implications in other countries due to the integration of global supply chains, raising international equity concerns. For example, the high demand for critical minerals for the energy transition in advanced economies can lead to increased mining, pollution, and health effects in developing countries. Effective international partnerships and governance systems are essential for addressing these issues through coordinated policy design and implementation.

Further, the financial health of a country directly impacts its ability to drive socioeconomic development through climate mitigation, as increased public spending will likely be required to crowd in private investments into low-carbon sectors, at least in the short term. Developing countries with high debt burdens have limited ability to free up fiscal space for public spending, as a growing number of these countries are already spending more on debt service than on public investments. Taking on further debt to finance public spending would create additional debt servicing costs over time, resulting in a lower GDP outcome and increased global disparities in the long term (OECD, 2025a). Meaningful international cooperation on climate finance and reforms to the international financial architecture is thus required to ensure equitable outcomes across countries.

Absence of global climate mitigation would make distributional effects worse

Despite the potential distributional effects of climate mitigation in the short term, it remains true that climate change itself is the worst driver of economic inequalities within and across countries. Lower-income groups are generally more exposed and vulnerable to the impacts of climate change and lack the means to adapt effectively compared to higher-income groups with greater resources (Hodok & Kozluk, 2024). This difference scales up and is even more relevant across countries due to the disproportionate impacts of climate change on developing countries with the least capacity to adapt.

The impact of prolonged and more frequent heatwaves on labour productivity is also more pronounced in developing countries due to their geographical location. Recent cross-country firm-level evidence (Costa, et al., 2024) shows that both more frequent high-temperature days and the occurrence of prolonged heatwaves lead to reduced labour productivity, with the negative effects being more significant in smaller, less productive firms with lower financial resources, less advanced technology and less effective adaptation strategies. Reduced labour productivity impacts smaller firms and thus has the potential to stunt socio-economic development in less industrialised countries.

Implementing mitigation policies can reduce economic inequalities within and across countries by reducing climate change impacts that disproportionately affect low-income countries, firms, and households. Some studies that consider both the distributional impacts and the avoided climate change impacts of mitigation policies find that unmitigated climate change impacts increase inequality, whereas mitigation has the potential to reverse this effect, both within and between countries (Rezai, et al., 2018; Taconet, et al., 2020). However, quantitative evidence on how mitigation pathways impact global inequality and poverty remains scarce, as modelling frameworks cannot fully capture the various dimensions of inequality and poverty or the full range of mechanisms through which climate mitigation influences them (Rao, et al., 2017; Emmerling & Tavoni, 2021; Jafino, et al., 2021).

4 ENABLING SOCIO-ECONOMIC DEVELOPMENT THROUGH CLIMATE MITIGATION

As discussed in Chapter 3, climate mitigation policies can generate overall positive effects on socio-economic development indicators. Climate change mitigation has been found to have far more potential synergies than trade-offs with SDGs across all sectors, although they can produce significant distributional impacts across countries, sectors, and income groups. Effective design and implementation of policies and actions maximise potential synergies and minimise trade-offs (NewClimate Institute, et al., 2018).

This chapter proposes four enablers of an integrated approach to ensure that the positive impacts of mitigation policies materialise, while minimising or avoiding their potential adverse effects. These are: **Policy integration** refers to aligning subnational and national level policies with long-term low-emission development pathways and communicating these internationally through NDCs. **Financial mobilisation** involves jointly raising

investments from diverse sources – public and private, domestic and international – to implement low-emission development pathways. **Technical capacity** is necessary at both the institutional and stakeholder levels to develop and implement integrated policies and promote access to finance. **International cooperation** supports coordinated action to drive systemic shifts towards low-emission development pathways and to facilitate technical and financial flows from developed to developing countries. The latter two enablers are of a cross-cutting nature, i.e., they are necessary to facilitate both policy integration and financial mobilisation.

4.1 Policy integration

Policy integration is central to aligning climate mitigation and socio-economic development. It involves defining a country's development priorities and climate mitigation objectives, identifying key low-emission development opportunities across sectors and regions, and developing a long-term implementation plan with short-term milestones to pursue these opportunities. It also involves implementing integrated and mutually reinforcing policy packages to achieve this plan and establishing adequate monitoring frameworks to ensure progress and adapt flexibly. This process thus defines a country's long-term low-emission development pathway, which in turn must be aligned with its internationally communicated NDCs and form the basis for its international cooperation activities under the Paris Agreement and the 2030 Agenda.

4.1.1 Opportunities to leverage synergies

The importance of **aligning short-term NDC targets with long-term development goals** was noted in the outcome of the first Global Stocktake of the Paris Agreement in 2023 (UNFCCC, 2023). Article 4.19 of the Paris Agreement urges countries to "strive to formulate and communicate long-term low-emission development strategies" or LT-LEDS, which the Global Stocktake outcome encourages countries to align with their NDCs. 18 out of 20 G20 member countries had submitted an official LT-LEDS to the UNFCCC[4] at the time of writing (UNFCCC, 2025). Countries unevenly choose to highlight the links between the mitigation (and adaptation) pledges included in their NDCs with their LT-LEDS and SDG priorities (Denton, et al., 2022).

Combining the LT-LEDS with long-term national development plan into a single integrated development planning process presents a good opportunity for aligning mitigation, adaptation, and national socioeconomic development objectives (TF-CLIMA, 2024). The same process of long-term visioning, policy planning, budgetary planning, and stakeholder engagement can be leveraged to develop an integrated long-term low-emission development pathway for the country in the most resource-efficient manner. The integrated process would enable identification of gaps, synergies and trade-offs between mitigation and development priorities, providing a suitable framework to address them coherently and

[4] Italy submitted its LT-LEDS to the European Commission instead.

efficiently (Janetschek, et al., 2019). The integrated national development pathway so formulated can, in turn, form the basis for sectoral and subnational development planning, policymaking, and finance and investment mobilisation strategies, ensuring alignment across all levels (see **Box 1**: G20 Spotlight | China: Integrated approach to pollution control and climate change mitigation

and **Box 2**: G20 Spotlight | South Africa: Aligning South Africa's NDC with sectoral low-emission development targets

).

G20 Spotlight | China: Integrated approach to pollution control and climate change mitigation

Following the principle that "lucid water and lush mountain are invaluable assets and persisting", China introduced the "Implementation Plan for Synergy Between Reducing Pollution and Bringing Down Carbon Dioxide Emissions" in June 2022. Anchored in national priorities such as the 14th Five-Year Plan and the 2035 Vision, the Plan applies a synergistic or "co-control" strategy aiming to align efforts in pollution control and climate change mitigation. Its broader goal is to accelerate the green transformation of China's economic and social development while minimising economic costs and maximising efficiency (Lei, et al., 2024).

The Plan emphasises coordinated, cross-sectoral action on industrial decarbonisation, clean energy use, pollution control, and ecological conservation through instruments like laws, policies, strategic planning, standards and regulations. By embedding carbon dioxide reduction into existing environmental frameworks such as impact assessments, monitoring, regulation, and verification systems, the Plan ensures a cohesive and cost-effective pathway (Lei, et al., 2024).

Pilot projects have been launched in 21 cities and 43 industrial parks to test integrated air-quality and carbon-reduction measures. For instance, Ordos City is pioneering an integrated pathway with large-scale solar PV projects combined with desertification control to help improve air quality, while also advancing renewables and halting land degradation (Laotian Times, 2025).

Such pilots are demonstrating integrated progress on decreasing pollutants while driving low-carbon economic growth. According to Chinese Government data, in 2024, while China's emissions of nitrogen oxides, volatile organic compounds, chemical oxygen demand, and ammonia nitrogen decreased by 5.0%, 2.8%, 0.7%, and 4.0% year-on-year respectively, the carbon emission intensity also dropped by 3.4% year-on-year (NPC, 2025). Meanwhile, the GDP grew by 5.0% year-on-year, demonstrating synergistic progress in pollution reduction, carbon mitigation, and economic growth (The World Bank Group, n.d.).

While China has mobilised finance from diverse sources and pursued international cooperation efforts to advance its integrated approach, there are gaps that remain to be addressed. These include better alignment between pollution reduction and carbon emission management mechanisms, further technical support for innovation, and stronger fiscal and financial support. Despite challenges, the Plan represents a critical step toward building a low-carbon, high-quality development model for China's future.

Source: Policy Research Center for Environment and Economy (PRCEE)

Box 1: G20 Spotlight | China: Integrated approach to pollution control and climate change mitigation

The integrated planning and policymaking process calls for **integrated monitoring and reporting mechanisms** to ensure progress. Such mechanisms are required at all levels of policy integration, involving institutional actors at the local, subnational, and national levels. Technical capacity and support tools can play an important role in facilitating effective monitoring and reporting.

International mechanisms can also be leveraged to foster **global accountability** towards both climate mitigation and sustainable development goals. This includes mandatory mechanisms, such as the Global Stocktake and Biennial Transparency Reports specified in the Paris Agreement, as well as voluntary reporting, such as Voluntary National Reviews (VNRs), under the 2030 Agenda. For the latter, countries can choose to submit VNRs annually at the High-Level Political Forum on Sustainable Development (HLPF), describing policies and actions undertaken towards SDGs, including SDG13 on climate action, and highlighting the various interlinkages among them. A similar mechanism is available at the city level through Voluntary Local Reviews (VLRs) linking local actions to the SDGs, providing an opportunity to integrate climate considerations into sustainable urban planning (Denton, et al., 2022).

G20 Spotlight | South Africa: Aligning South Africa's NDC with sectoral low-emission development targets

South Africa's Climate Change Act of 2024 provides a comprehensive legislative framework for climate action, across all spheres of government. (Republic of South Africa, 2024). The Act requires all "organs of state" to review their legislation and functions and align these, as required, with national climate change policy goals. This includes climate change response planning processes for regional and local government, as well as provision for provincial and local governments to conduct climate change needs and response assessments and develop implementation plans which are integrated with existing provincial, metropolitan, or district municipality planning.

The Act establishes an integrated approach to mitigation, including the establishment and revision of a national greenhouse gas emissions trajectory, sectoral emissions targets (SETs), and 5-year carbon budgets for large emitters. SETs are specified over short, medium and long-term timeframes, and are the basis for achieving the national emissions trajectory, and successive NDC targets. These sectoral targets are established by the Minister of Forestry, Fisheries and the Environment (DFFE), in consultation with relevant line department, which are also responsible for the development and implementation of mitigation measures to implement these. SETs may be quantitative, or where mitigation policy is less developed, qualitative.

The initial round of SETs, to 2030, focus on seven priority areas: agriculture, industry, energy, mining, human settlements, transport and environment, and are anchored existing sector policies and measures (e.g., regulatory measures, economic measures, support measures, direct government actions and information programmes) that can make a significant impact on GHG reductions up to 2030 (DFFE, 2024). The DFFE is currently revising South Africa's long-term low emissions development strategy (submitted to the UNFCCC in 2021), which will also constitute the long-term national greenhouse gas emissions trajectory, and is also developing medium- and long-term SETs.

Box 2: G20 Spotlight | South Africa: Aligning South Africa's NDC with sectoral low-emission development targets

International partnerships can be highly effective in strengthening capacities for policy integration and implementation among developing countries. Capacity building efforts at the bilateral level can focus on both institutional capacity for effective coordination and policy integration, as well as human capacity building through skill development programs to address the distributional employment effects of mitigation policies. Such partnerships can also serve as platforms to align policies to address any cross-border distributional effects of mitigation policies, for example, by preventing polluting industries from relocating to geographies with weaker environmental regulations or by supporting countries adversely impacted by carbon border adjustment mechanisms. Similarly, technological innovation

and co-development through bilateral partnerships can facilitate the equitable diffusion of low-emission technologies across countries.

4.1.2 Challenges to Policy Integration

Policy integration is a complex undertaking involving a range of decision-makers and stakeholders across multiple sectoral, regional, and temporal scales (Denton, et al., 2022). It involves identifying diverse political and societal perspectives, managing trade-offs and addressing distributional implications of policies, and ensuring consistency across sectors, governance levels, and over time (Kalogiannidis, et al., 2024).

Political will and consensus-building are essential prerequisites for the effectiveness of the policy integration process and the longevity of integrated policies (Biswas & Rahman, 2023; Rakibul & Khalid Md., 2014; Kalogiannidis, et al., 2024). It can be challenging to coordinate and align policies across government institutions (i.e., ministries, departments, and agencies) and governance levels (national, subnational, and local), which may all have different political compositions and priorities and tend to operate in siloes (Cheshmehzangi, 2016; Dabaieh, et al., 2021; Gancheva, et al., 2020; Dubash, 2021). For example, studies of sustainable urban mobility transitions in developing megacities have found a lack of vertical coordination mechanisms to be a significant barrier for decarbonisation (Canitez, 2019).

This process is further complicated by resistance from non-state actors affected in various ways by transitional policies (Song, et al., 2020). For example, clean energy transitions can be met with private sector resistance, requiring adaptive learning and flexible policymaking to be implemented (Lee, et al., 2019). Similarly, if impacted communities and stakeholders are not meaningfully involved in policymaking or consulted on policy design, this can lead to public resistance, lack of buy-in or ownership for local initiatives, and ineffective implementation of policies (OECD, 2023; WHO, 2022). **Participatory and inclusive governance approaches** are essential to engage with diverse stakeholder groups to incorporate traditional and local knowledge into policymaking and to address possible distributional impacts (Kalogiannidis, et al., 2024).

Strong institutional capacity is required for integrated policymaking, particularly in harnessing and integrating knowledge through stakeholder engagement, designing and implementing integrated policies, conducting long-term planning, monitoring and review processes, and coordinating multi-actor processes to create synergies and avoid trade-offs. Developing countries may not have the budget or personnel capacity to set up and implement inter-ministerial and inter-departmental committees to facilitate communication and to ensure coherent, bottom-up, consensus-based policymaking across sectors and governance levels, including at the international level between NDCs and national development plans (Gregorio, et al., 2017; Biswas & Rahman, 2023). In addition, governance institutions, particularly in developing countries, may face a shortage of skilled professionals with expertise in climate mitigation policy, national development policy, and effective

strategies for integrating both. This is compounded by a lack of data availability, as well as inadequate monitoring and evaluation systems to inform policy adjustments.

4.2 Mobilising Finance

The annual global financing gap for sustainable development, including climate change, is in the trillions and growing (OECD, 2025b). Global finance needs for climate change mitigation alone are estimated at USD 5 trillion annually until 2030 (Black, et al., 2023). For developing countries, the annual SDG financing gap totals over USD 4 trillion, with more than half related to the energy transition (UNCTAD, 2023). Finance from diverse sources, domestic and international, public and private, is needed to address the gap.

Evidence suggests that financing that supports both socio-economic development and climate action leads to enhanced scope and outcomes for both. Advancing development and climate mitigation goals demands aligning existing financial flows towards sustainable, long-term investments, addressing barriers to mobilising additional resources, and ensuring enabling conditions for investment (Lecocq, et al., 2022).

4.2.1 Opportunities to leverage synergies

Diverse finance sources are foundational to drive the implementation of integrated climate and development approaches.

Public finance is often the most sustainable source of financing; however, the fiscal space of governments varies, and public budgets are under increased strain (IMF, 2024). To expand fiscal space, some governments are introducing measures to raise revenue, such as carbon pricing or emissions trading schemes, which incentivise emission reductions while generating revenue that can be reinvested in low-emission development opportunities. There are increased calls for international cooperation on international tax reform to modernise global tax rules and move towards a more inclusive system for how governments raise public revenue through taxes. Negotiations are ongoing on a UN Framework Convention on International Tax Cooperation.

Governments can also tap into debt markets to finance public priorities. In recent years, countries including France (Agence France Tresor, n.d.), India (TOI Business Desk, 2024), Indonesia (Credit Agricole CIB, 2024), and the United Kingdom (UK DMO, 2025) have issued green or sustainability-linked sovereign bonds to mobilise capital. Thematic bonds allow governments to attract investors interested in environmental and social outcomes, while diversifying their debt portfolios. Potential to leverage thematic bonds depends on domestic capital market maturity and access to international debt markets, which vary across G20 members (OECD, 2025c).

The scale of finance needed to address climate mitigation and development priorities exceeds public resources, requiring the mobilisation of private finance. Attracting private investment requires conducive enabling conditions. Predictable and credible business and

regulatory frameworks, including investment taxonomies, can advance investment and ensure the alignment of financial flows with national objectives (SBFN, 2024). Well-designed incentives can also improve investor confidence, enhance project bankability, reduce risk, and channel capital towards climate-conscious development priorities. Governments use a wide range of financial (tax credits, subsidies, low-interest loans), regulatory (taxonomies), market-based (compliance carbon markets, guaranteed long-term contracts, auction mechanisms), and risk-sharing (government guarantees, insurance, off-take agreements) incentives. Public procurement policies also offer a powerful lever to align national spending with climate and development objectives, stimulate demand, and catalyse private sector engagement. See **Box 3** for the Climate Club's Financial Toolkit describing the range of instruments that governments can use.

A strategic vision for long-term investment can facilitate predictability and coordination between NDC, LT-LEDS, and development or economic planning objectives, as well as the identification of costs and benefits. It can also highlight public and private investment needs, priorities and planned policy reforms, and incentives to attract finance.

G20 Spotlight | Climate Club: Financial Toolkit

The Climate Club, an intergovernmental forum with 46 members (as of September 2025), promotes industry decarbonisation through three pillars: (I) climate mitigation policies, (II) industrial transformation, and (III) international cooperation. Under Pillar III, the OECD released the Climate Club Financial Toolkit: Economic, de-risking and financing instruments for industry decarbonisation in 2025 (OECD, 2025d).

The Toolkit provides an overview of approximately 30 instruments— economic, de-risking, and financing —that are already in use to support industrial decarbonisation in both developed and emerging economies. It includes 20 case studies that highlight the enabling factors for project implementation and the adoption of low-carbon technologies, alongside initial economic assessments of selected options in hard-to-abate sectors.

Illustrative examples include Denmark's Export and Investment Fund, which in 2022 provided a EUR 38 million Buyer Credit Guarantee for a clay calcination unit in Ghana, resulting in a reduction of cement sector emissions by about 20%.

Between 2023 and 2025, the OECD used the Toolkit to implement its Framework for industry's net-zero transition in South Africa's iron and steel sector, engaging policymakers (OECD, 2022). A techno-economic assessment identified suitable instruments to help close the cost gap between hydrogen-based Direct Reduced Iron and conventional production methods.

The Toolkit is designed for governments and financial actors, including providers of technical assistance. It is updated regularly to incorporate additional instruments, case studies and applications across industrial subsectors.

Box 3: G20 Spotlight | Climate Club: Financial Toolkit

International public finance plays an important role in supporting climate mitigation and development opportunities in developing and emerging economies. Direct financial transfers in the form of grants or concessional loans from developed to developing countries can help close the gap and achieve more equitable socio-economic outcomes for mitigation policies across countries, in line with Article 9 of the Paris Agreement. It is important for developed countries to fulfil their climate finance commitments under the UNFCCC and its

Paris Agreement, and to provide developing countries with new, additional, adequate and highly concessional climate finance. Innovative risk-sharing mechanisms and blended finance also play a role in mobilising private finance.

Coordination among international and multilateral funders is essential to minimise duplication and fragmentation and to ensure optimal use of limited public resources. Country platforms have emerged as a country-driven approach to consolidate and coordinate diverse funding streams at the national level and support economy-wide or sectoral transitions that deliver on both long-term development and NDC goals. Brazil launched its Climate and Ecological Transformation Investment Platform in 2024, which streamlines financing and ensures policy coherence between national climate and development priorities outlined in key climate and development plans (BIP, n.d.). Coordinated technical assistance can also play a role in building enabling environments for finance mobilisation and outlining investment strategies. International support mechanisms like the Integrated National Financing Frameworks (INFF) Facility offer guidance for aligning climate mitigation and development goals with broader financial strategies, identifying key policy actions and institutional reforms to strengthen financial ecosystems (INFF Facility, 2024; OECD, 2025a).

Many countries are increasingly turning to **carbon markets** as an additional means to attract finance, leveraging readiness frameworks under Article 6 and exploring emerging opportunities in the voluntary carbon market (VCM). In a positive scenario, this approach could enable developing countries to generate and trade verified emission reductions, supporting high-cost or hard-to-implement investments (See **Box 4**), without crowding out ambitious climate mitigation in developed countries. Carbon markets are not climate finance, and payments are usually made ex post—after emission savings are verified—offering little upfront capital for low-carbon investment. In general, reliance on international carbon finance carries two key risks. First, it may conflict with the country's own NDCs, as selling emissions reductions could lead to the risk of overselling (Hamrick & Granziera, 2023). Second, the strategy is exposed to the broader credibility issues of carbon markets, which have historically suffered from a lack of integrity (Probst, et al., 2024).

G20 Spotlight | India-Japan approach to Article 6

Under Article 6 of the Paris Agreement, countries can establish "positive" or "negative" lists that determine which activities are eligible for international cooperation through carbon markets. This mechanism attempts to ensure that projects supported through Article 6 deliver additional value, focusing on activities that would not otherwise be feasible without external investment and support, while avoiding projects that a country could implement independently. India established a positive list that prioritises capital-intensive projects to accelerate innovative clean technologies in hard-to-abate sectors, such as green hydrogen, sustainable aviation, fuel cells, thermal energy and carbon capture, utilisation and storage activities (Government of India, 2024).

Building on this framework, India and Japan agreed to a Joint Crediting Mechanism (JCM) through which Japanese companies will invest in capital-intensive clean technologies in India in exchange for carbon credits (AACCI, 2025). Japan can then use these credits to meet its own mitigation commitments, including within its national carbon market. By utilising a positive list under Article 6, India demonstrates how international carbon market mechanisms have the opportunity to expand domestic clean industrial

capacity and attract foreign investment. However, significant risks remain for purchasing countries with relying on Article 6 to meet their mitigation targets (CAT, 2025).

Box 4: G20 Spotlight | India-Japan approach to Article 6

4.2.2 Challenges to Mobilising Finance

Policy and regulatory certainty remain major challenges for scaling climate and sustainable development finance. Weak or inconsistent policy signals create uncertainty, which undermines investor confidence and slows the flow of capital. Even where strong frameworks exist, a lack of interoperability across jurisdictions raises transaction costs, making it harder for global institutions to mobilise finance at scale. The absence of a common lexicon of definitions, terminology, and conceptual frameworks for "green-" or "development-focused" investments among banks, regulators, and science further complicates alignment within and between countries and increases the risk of financing misaligned activities. Once policies are in place, continued political will is necessary to ensure enforcement and address the distributional impact of measures.

Yet another challenge in mobilising finance is **capacity constraints across the stakeholder landscape**. At the regulatory level, limited institutional capacity can hinder the design and enforcement of effective policies and monitoring mechanisms. At the country level, governments and national development finance institutions can struggle to identify and prepare bankable investment opportunities. There can also be significant gaps in data availability, quality, and transparency. Financial institutions – both public and private, as well as domestic and international – can also face capacity gaps in assessing risk, structuring innovative financial instruments, and aligning lending with climate and development objectives.

In developing countries, **public finances are under growing strain**, limiting the capacity of governments to directly invest or mobilise private investment. Global public debt is at a record high post the Covid-19 pandemic, with 61 countries allocating 10% or more of government revenue to servicing interest payments (Dabla-Norris & Furceri, 2025; UNCTAD, 2025). High public debt levels raise the perceived risk of default and contribute to poor sovereign credit ratings, limiting access to long-term financial markets, driving up borrowing costs, reducing the availability of long-term financing, and impacting the ability of governments to derisk private investments. This cycle of high sovereign borrowing costs, limited fiscal space, and poor access to long-maturity debt markets traps governments in a vicious cycle of rising debt and low investment. The international community can further explore ways to enhance developing countries' access to financing, strengthen the long-term sustainability of financing, and better achieve a positive cycle between debt and development.

While the volume of international climate and development finance is a central concern, the quality of finance available is equally important. High global interest rates increase the cost of capital, making it more difficult to finance low-emission development projects and heightening the need for concessional finance, blended finance, and risk mitigation

instruments. This comes at a time when concessional international public climate finance to emerging markets and developing economies fell from 57% in 2018 to 47% in 2022 (CPI, 2024). Although some low-emission development opportunities are increasingly attractive to private investors, access to low-cost finance, both public and private, remains essential for early-stage technologies, public infrastructure projects (e.g., grids), and mechanisms that de-risk private capital. Access for affordable and inclusive finance from multilateral climate funds and banks, bilateral development finance institutions, country platform approaches, and national climate funds remains a key obstacle for sovereigns and the private sector (OECD, 2025c).

Despite growing global consensus on the urgency of reform and a renewed global financing framework, systemic challenges remain (Fuiret, et al., 2025). Initiatives such as the Bridgetown Agenda and the Summit for a New Global Financing Pact highlight the need to increase fiscal space, address debt sustainability, scale up concessional finance, and reform MDBs to better respond to climate and development priorities (Government of Barbados, 2022; Government of France, 2023). As noted in the Compromiso de Sevilla, there is room to make global economic governance more inclusive, representative, and responsive to today's challenges (UN, 2025).

5 CASE STUDY ANALYSIS: COMMON ENABLERS, SUCCESS FACTORS, AND CHALLENGES OF INTEGRATED APPROACHES

This chapter showcases real-world examples of integrated approaches to climate mitigation and socio-economic development employed by G20 members with different development levels, socio-economic contexts, and mitigation and SDG priorities. It presents cross-cutting findings on their use of key enablers, success factors, and challenges, linking each of these to the potential for G20 cooperation. The objective is to supplement the theoretical arguments presented in the preceding chapters with practical examples.

For this analysis, a sample of four case studies was selected – the **ABC+ Plan** or the Sectoral Plan for Climate Change Adaptation and Low Carbon Emission in Agriculture Seeking Sustainable Development 2020-2030 from Brazil, the **European Union Green Deal** from the European Union, the **PM-KUSUM** (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan) scheme from India, and the Renewable Energy Independent Power Producer Procurement Programme (**REIPPPP**) and South African Renewable Energy Masterplan (**SAREM**) initiatives from South Africa. Key features of the case studies are summarised in **Table 4**.

Inputs for the case studies were provided by think tank experts from the respective countries (see **Acknowledgments**) and supplemented with secondary research. Detailed case studies are provided in the accompanying publication of the **Annex** (NewClimate Institute, 2025 (forthcoming)).

Case	Country	Sector	Description	Success achieved as of 2025
ABC+ Plan	Brazil	Agriculture	Main policy for sustainable agriculture, aimed at promoting climate change adaptation, reducing GHG emissions, and enhancing the efficiency and resilience of production systems through science-based technologies and integrated landscape management.	• Restored 16.94 million hectares of degraded pastures between 2020-2022, reaching 56% of the 2030 target • Avoided emissions worth 41.38 million $MgCO_2eq$ from intensive cattle finishing methods between 2020-2025, reaching 255% of the original target
Green Deal	EU	Economy-wide	Roadmap of policy initiatives that support climate neutrality of the EU by 2050, including through a just transition for workers and households. Supplemented by the Clean Industrial Deal (CID) for low-emission industrial development in 2025.	• EU Green Deal policies accelerating the green transition support employment in the environmental goods and services sector, which employed 5.2 million workers in 2021. • Projected to achieve 50% emissions reduction by 2030 (91% of target)
PM-KUSUM	India	Agriculture & Power	Financial incentivisation scheme to increase solar uptake to meet India's agricultural power demand and boost farmers' incomes via small-scale solar plant installation (Component A), diesel pump replacement (Component B), and solarisation of grid-connected pumps at the individual as well as electricity feeder-levels (Component C).	• Installed 641 megawatt (MW) of decentralised solar plants (6.4% of target) • Installed 853,330 standalone solar irrigation pumps (61% of target) • Solarised 9,707 grid-connected solar pumps (16% of target) • Solarised 7,27,906 pumps at feeder level (20% of target)
REIPPPP and SAREM	South Africa	Power and industry	The REIPPPP is a competitive government procurement programme designed to encourage investment by Independent Power Producers (IPPs) in renewable energy generation. The SAREM is a complementary industrialisation roadmap for renewable energy and battery storage value chains, aiming to localise component manufacturing and enhance economic and employment opportunities.	REIPPPP • Offset 128.1 Mt CO_2-eq • Added 6180 MW of renewable capacity to the grid by the end of March 2025 SAREM • Increase[5] local content in the renewable energy and battery manufacturing sectors to: Solar 50% by 2030; Wind 47% by 2030; Storage 60% by 2030 • Grow employment in the renewable energy and battery manufacturing and associated sectors to 25,000 jobs by 2030

Table 4: Key features of the selected case studies.

[5] No progress data is available for SAREM. Only the targeted success indicators are presented.

5.1 Key Enabler: Policy Integration

5.1.1 Key Success Factors

Coordination and coherence across sectors: Effective policy integration requires coherent policymaking across the sectors relevant for national development priorities and climate mitigation goals. Several case studies highlighted that this is predicated on coordination and collaboration across sectoral actors, including policymakers, governance institutions, and industry stakeholders. Brazil's ABC+ Plan, India's PM-KUSUM and South Africa's SAREM bring together various ministries representing the different integrated priority areas of their respective programmes to facilitate joint implementation. SAREM was developed in consultation with industry stakeholders – domestic industry associations for renewables and battery storage – to ensure efficacy.

Long-term continuity: Designing policies or programmes to sustain over time and across political changes facilitates stakeholder confidence, institutional learning, and scaling. Brazil's ABC+ Plan and India's PM-KUSUM both build on years of experience with similar programmes (ABC Plan and state-level schemes respectively), and this long-term continuity has been crucial in enabling capacity building, investor confidence, and gradual scaling of successes. The EU Green Deal (EUGD) provides a long-term, legally binding framework for achieving climate neutrality by 2050, incentivising Member States to design integrated National Energy and Climate Plans (NECPs) linking short-term policies and actions to the 2050 target.

Multi-level governance with local ownership for implementation: Multi-level governance mechanisms combining local institutional ownership with national guidance and accountability can catalyse effective and context-specific policy implementation. Both the EUGD and India's PM-KUSUM establish mandates and guidelines at the supranational and national level respectively, while allowing flexibility and ownership at Member State- and state-levels to drive context-specific implementation and ensure greater buy-in. Brazil's ABC+ Plan emphasises its multi-level governance framework as a key feature, bringing together committees of political and technical institutions at the federal, state, and sectoral levels to facilitate coordination and implementation.

Built-in mechanisms for equity: Policy integration for transitioning to low-emission economies should incorporate mechanisms to address any distributional implications of such transitions. The EUGD's Just Transition Mechanism (JTM) provides targeted financial, technical and policy advisory support for regions and sectors most socio-economically affected by the transition (e.g., coal-dependent Member States). India's PM-KUSUM enables small and marginal farmers to invest in solar irrigation pumps by offering a flexible mix of central and state government subsidies (alongside preferential loans), allowing states to scale up the subsidy share depending on the socioeconomic profiles of their farmers. In South Africa, the REIPPPP and the SAREM both incorporate mechanisms for equity – the former by including requirements for local content, job creation, and community ownership

in renewable energy project tenders, and the latter by financially incentivising large project developers to invest in local manufacturing capacity, focusing on Black Economic Empowerment and small, medium, and micro enterprises (SMMEs).

Table 5 provides an overview of the above success factors and links each of them to the potential for G20 cooperation.

Success factors	Examples	Potential for G20 cooperation
Coordination and coherence across sectors	Brazil, India, South Africa	• Promote institutional coordination across sectors to facilitate coherent policymaking
Long-term continuity	Brazil, EU, India	• Promote institutional coordination to build political consensus for long-term policymaking • Promote long-term programming and policymaking over short-term projects
Multi-level governance with local ownership for implementation	Brazil, EU, India	• Promote institutional coordination across levels to facilitate multi-level governance • Build local institutional capacity to take ownership and drive implementation
Built-in mechanisms for equity	EU, India, South Africa	• Promote institutional coordination to reflect distributional implications across governance levels in policy design • Facilitate experience sharing on integrating equity policies and mechanisms

Table 5: Overview of key success factors for Policy Integration from case study analysis, linked to the potential for G20 cooperation.

5.1.2 Key Challenges

Potential silos: Integrated policy packages addressing climate mitigation and development priorities can still experience challenges in addressing all relevant priority policy goals. Several case studies highlight that integration challenges can lead to persistent silos in policymaking and governance – for instance, incentive design which does not address all the integrated policy goals evenly. **Table 6** links this to the potential for G20 cooperation.

Challenges	Potential for G20 cooperation
Potential silos	• Promote institutional coordination across sectors to facilitate coherent policymaking • Facilitate experience sharing on holistic policy integration to create a repository of best practices

Table 6: Overview of key challenges to Policy Integration from case study analysis, linked to the potential for G20 cooperation.

5.2 Key Enabler: Mobilising Finance

5.2.1 Key Success Factors

Supply and demand side incentives: A combination of supply- and demand-side incentives enable producer capacity and consumer uptake to evolve together. Through the Clean Industrial Deal (CID), the EU is considering tax incentives for investments in clean industrial production capacity and revising the EU's public procurement framework to create demand

for sustainable, circular, and resilient technologies. Under the ABC+ plan, Brazil offers direct fiscal incentives (tax-related) and market-based instruments (certifications, carbon credit trading) to promote the adoption of sustainable agricultural priorities among farmers and businesses. In India, PM-KUSUM supports local manufacturing by requiring subsidised standalone and grid-connected solar pump projects to source their components locally. Component A of the scheme uses procurement-based incentivises for electricity distribution companies (DISCOMS) that reduce power procurement costs and help meet renewable purchase obligations, providing investors (farmers and developers) with greater offtake certainty.

Public credit lines and concessional lending: Public finance plays a central role in addressing market failures by lowering risk, reducing costs, and improving access to capital for the most vulnerable. In Brazil's ABC+ Plan, public funds support a credit line, which uses recurring allocations from Brazil's annual agricultural plan (Plano Safra) to provide subsidised loans and technical assistance to producers adopting sustainable practices and technologies, with a focus on smallholder farmers and medium-sized producers. India's PM-KUSUM scheme allocates central financial assistance for subsidies covering 30% of solar pump investment or feeder-level solarisation costs, with additional support from state governments for standalone pumps. Component A of the scheme also offers interest-subsidised loans through the Agricultural Investment Fund.

Investment frameworks: Clear investment guidelines were key to channelling private and public capital towards low-emission technologies and into sectors with high social or economic returns, and geographic regions that are underserved. For example, South Africa's REIPPPP created a framework that directs private investment toward economic development by setting minimum thresholds for jobs, local content, ownership, and socioeconomic contributions. On a broader scale, the EU Sustainable Finance taxonomy encourages climate-friendly and socially beneficial investments by defining clear criteria for beneficial investments across environmental, social, and economic dimensions, and including minimum social safeguards aligned with OECD guidelines, the United Nations' human rights principles, and the International Labour Organisation's labour standards.

Innovative mechanisms to crowd in private investment: Innovative mechanisms across contexts attract private investment to complement public funding, reducing risks, enhancing efficiency, mobilising capital, and aligning finance with social, economic, and climate goals. South Africa's REIPPPP programme conducts competitive auctions to attract private participation, ensuring transparent and efficient pricing of renewable energy projects. Government-backed power purchase agreements[6] from the National Treasury are also offered to de-risk and attract private investment. In Brazil, the ABC+ Plan encourages farmers and agribusinesses to tap into private capital markets (e.g., through green or sustainability-

[6] South Africa is partnering with the World Bank Group to develop a credit guarantee facility that will issue guarantees for private grid developers in place of the National Treasury.

linked bonds) and facilitates connections with impact investors and agribusinesses through partnerships with both public and private institutions, helping to broaden access to capital.

Diverse sources of finance: Several cases highlight the mobilisation of diverse sources of finance to enable implementation, reduce perceived and real risks, and enable tailored support. India's PM-KUSUM combines central and state subsidies with concessional loans funded through the national government's Agriculture Infrastructure Fund. Similarly, the EUGD was financed using a combination of earmarked budgetary resources, economic recovery funds set up with Member State contributions, development finance from the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD), and mobilised private finance.

Table 7 provides an overview of the above success factors and links each of them to the potential for G20 cooperation.

Success factors	Example	Potential for G20 cooperation
Supply and demand side incentives	EU, India, Brazil	• Facilitate experience sharing on enabling conditions for investment, including supply and demand side incentives
Public credit line and concessional lending	Brazil, India	• Coordinate internationally to improve fiscal space for public spending
Investment frameworks	EU, South Africa	• Collaborate internationally to share best practices for investment frameworks and enhance their interoperability • Support inclusive regulatory frameworks tailored to local contexts
Innovative mechanisms to crowd in private investment	South Africa, Brazil	• Share best practices and lessons learned from deploying innovative mechanisms • Cooperate and coordinate on the joint deployment of innovative mechanisms
Diverse sources of finance	EU, India, South Africa	• Support the mobilisation of diverse sources of finance, public and private

Table 7: Overview of key success factors for mobilising finance from case study analysis, linked to the potential for G20 cooperation

5.2.2 Key Challenges

Bureaucratic and procedural hurdles: Administrative and procedural obstacles can create financial and operational risks that slow investment, reduce private sector confidence, and undermine the ability of programs to achieve climate mitigation and development goals simultaneously. Several case studies highlighted challenges in implementing policies and incentives in a timely and streamlined manner, including due to the scale and complexity of implementation.

Technical know-how: Limited technical knowledge and capacity among stakeholders can slow down the rollout and uptake of innovative finance mechanisms, constrain access to funding, and hamper effective tracking of integrated investments. Several case studies highlighted gaps in technical knowhow among local financial institutions in providing finance

as well as the stakeholders in accessing finance. Institutional capacity to track integrated spending in multi-layered financing frameworks is also a challenge.

Inadequate incentives: Integrated policies or programmes may not be able to provide sufficient financial incentives, thus potentially limiting demand and stakeholder participation and slowing down the implementation of initiatives with integrated benefits. Several case studies highlighted that incentive gaps for stakeholders to participate in schemes can be in terms of financial incentives or technical capacity building incentives.

Table 8 provides an overview of the challenges and links to potential G20 cooperation.

Challenge	Potential for G20 cooperation
Bureaucratic and procedural hurdles	• Promote exchange and knowledge sharing on stakeholder engagement and streamlining
Technical know-how	• Promote bilateral partnerships on skill sharing and capacity development •
Inadequate incentives	• Promote knowledge sharing and technical assistance on the design and implementation of incentive schemes • Explore cooperation opportunities and partnerships on demand- and supply-side incentives • Explore solutions to address systemic challenges to accessing finance and the cost of capital

Table 8: Overview of key challenges mobilising finance from case study analysis, linked to the potential for G20 cooperation.

5.3 Cross-Cutting Enabler: Technical Capacity

5.3.1 Key Success Factors

Demand-driven technical support: Technical capacity building support based on the identified needs of stakeholders contributes to effective and resource-efficient capacity building programmes and the success of integrated approaches. For example, the EUGD's Technical Support Instrument provides tailored non-financial support to Member States, including expert advice, analytical tools, policy studies, and workshops. In South Africa, the SAREM requires a biannual assessment of technical and non-technical skills and sets out requirements and incentives for large project developers to invest in building local manufacturing capacity. In India, international partners of the PM-KUSUM scheme created spaces for co-development of technical capacity for agri-photovoltaics deployment, based on international experiences but highly adapted to the local context.

Targeted training programmes: Training and capacity building programmes are often utilised in a targeted manner to build technical capacity among selected stakeholders with identified needs. For example, in India, PM-KUSUM offered training programmes for farmers on operating solar power plants and irrigation pumps, for regulators on setting tariffs that adequately reflected factors affecting project viability, and for bankers and financial institutions to improve technical evaluation capacity and lending appetite. In Brazil, the

Technical Assistance and Rural Extension (ATER), Training and Technology Transfer strategy of the ABC+ Plan was formulated to offer targeted training programmes for key stakeholders, including agricultural workers, businesses, government agencies, and financial institutions involved in implementing sustainable agriculture projects.

Availability of support tools: Technical capacity for planning, monitoring, and implementation can be aided by the provision of appropriate support tools. In India, digital tools with various use cases were available for different stakeholders involved in PM-KUSUM – developers of solar power plants or pump projects had access to decision support tools, such as for pump sizing or for identifying and aggregating suitable land, electricity DISCOMs and regulators had tools for tariff analysis, and State Nodal Agencies had tools for tracking project milestones and addressing bottlenecks in real time. Brazil's ABC+ Plan envisions several digital systems to aid monitoring and verification on progress towards its sustainable agriculture and emissions reduction targets, including the ABC+ Governance System (SIGABC) and the ABC+Calc tool. South Africa's SAREM envisions a matchmaking platform to connect actors with identified technical capacity needs to providers of capacity building services. The EU also empowered Member States to employ data tracking tools to monitor progress towards EUGD targets.

Involvement of research institutions: Research and innovation play a crucial role in developing solutions tailored to local contexts and are key to strengthening technical capacity for implementation. In Brazil, a dedicated strategy for Research, Development, and Innovation was established under the ABC+ Plan, coordinated by the Brazilian Agricultural Research Corporation (Embrapa), which focused on advancing and refining sustainable agricultural technologies and practices. In India, state-level research institutions were engaged to support locally adapted innovation and address region-specific challenges in the PM-KUSUM scheme. Similarly, local research entities were actively engaged with the REIPPPP and the SAREM.

Table 9 provides an overview of the above success factors and links each of them to the potential for G20 cooperation.

Success factors	Examples	Potential for G20 cooperation
Demand-driven technical support	EU, India, South Africa	• Support capacity needs assessment through demand-driven partnership models • Share experiences with capacity needs assessments to enable replication across contexts
Targeted training programmes	Brazil, India	• Support targeted training and capacity building programmes through demand-driven international partnerships
Availability of support tools	EU, Brazil, India, South Africa	• Share experiences with support tools to enable replication across contexts • Cooperate through international partnerships to adapt and scale support tools

Success factors	Examples	Potential for G20 cooperation
Involvement of research institutions	Brazil, India, South Africa	• Facilitate exchanges among the G20's think tank and research community (T20) with domestic sector-specific research institutions to drive knowledge sharing and co-development of tailored solutions

Table 9: Overview of key success factors for Technical Capacity from case study analysis, linked to the potential for G20 cooperation.

5.3.2 Key Challenges

Limited data and monitoring capacity: The technical capacity for monitoring implementation progress can be constrained by limited data availability or inadequate monitoring mechanisms or capabilities. Several case studies highlighted the gaps in integrated data systems, specialised expertise, or institutional resources to implement integrated monitoring mechanisms. Mandating the use of monitoring systems without sufficient outreach on their benefits in terms of real-time problem solving can create administrative burdens for institutions and lead to non-compliance.

Disparities in stakeholder capacity: Even if capacity building efforts are targeted and demand-driven, they may still fail to identify and address all the relevant capacity gaps. Several case studies found that there be disparities in stakeholder capacities for implementation, particularly since they may have varying levels of capacity across geographical regions or for the different functions they are required to undertake in integrated programmes.

Table 10 provides an overview of the challenges and links to potential G20 cooperation.

Challenge	Potential for G20 cooperation
Limited data and monitoring capacity	• Exchange best practices on tools and mechanisms to strengthen data on and monitoring of integrated policies and initiatives • Invest in building capacity to collect data and monitor impact
Disparities in stakeholder capacity	• Promote coordination and consultation with stakeholders to ensure accurate and comprehensive capacity needs assessment

Table 10: Overview of key challenges to Technical Capacity from case study analysis, linked to the potential for G20 cooperation.

5.4 Cross-Cutting Enabler: International Cooperation

5.4.1 Key Success Factors

Bridging local and international knowledge: All cases highlight the importance of bridging international best practices with local experience to develop context-specific solutions and strengthen implementation capacity. For ABC+, Brazilian actors partnered with international organisations to develop monitoring tools and assess socioeconomic and environmental impacts. In India, international best practices on agri-photovoltaics deployment were adapted to state-level contexts through co-design and collaborative learning workshops, complemented by collaboration between state actors and domestic research institutions.

Similarly, South Africa's REIPPPP was designed with the support of international partners and adapted to the local energy sector and community context, incorporating Broad-Based Black Economic Empowerment (B-BBEE) and community ownership. The European Union has also shared its best practices and first-mover implementation challenges from the EUGD with international partners to facilitate the development of locally tailored solutions.

International public finance: Multilateral development banks and development finance institutions play a key role in providing concessional finance, equity and technical assistance packages. Brazil's ABC+ Plan receives implementation support from the World Bank and Inter-American Development Bank. India will leverage concessional credit lines from the Asian Development Bank to strengthen grid integration and support the uptake of grid-connected pumps under the PM-KUSUM scheme. South Africa's REIPPPP benefited from early-stage donor funding for technical assistance during programme set up, and approved projects also received project funding and equity investment funding via the Development Bank of Southern Africa and other international development institutions. Finally, the EUGD includes an external dimension funding arm—the Neighbourhood, Development and International Cooperation Instrument—earmarks 25% of its budget for climate objectives.

Table 11 provides an overview of the above success factors and links each of them to the potential for G20 cooperation.

Success factors	Examples	Potential for G20 cooperation
Bridging local and international knowledge	Brazil, EU, India, South Africa	• Prioritise bottom-up solutions based on collaborative learning through international partnerships • Share experiences to build a repository of knowledge to be adapted • Support holistic country-driven partnerships
International public finance	Brazil, India, South Africa	• Support the mobilisation of international public finance • Scale successful models

Table 11: Overview of key success factors for International Cooperation from case study analysis, linked to the potential for G20 cooperation.

5.4.2 Key Challenges

Scope for South-South cooperation: South-South cooperation can create more opportunities for developing countries to share experiences, align strategies, and address common challenges. Lessons learned from programmes such as India's PM-KUSUM, Brazil's ABC+, and South Africa's REIPPPP can inform opportunities for peer learning, joint capacity building, and coordinated action among developing countries. This is particularly relevant as the areas of solar irrigation, sustainable agriculture, and renewable energy value chains are closely aligned with the climate and development priorities of the Global South.

Scope for technology transfer or co-development: North-South cooperation is crucial for the transfer and co-development of technologies critical to implementing integrated approaches but was found to be a missed opportunity in the analysed case studies. India's

PM-KUSUM would benefit from strengthened cooperation of agri-photovoltaics, which refers to the dual use of land for agriculture and solar energy. Technology cooperation could support the development and refining of sustainable agriculture technologies and practices in Brazil, which is an explicit priority under the ABC+ Plan. Cooperation on renewable energy lifecycle management is also relevant for India's PM-KUSUM and South Africa's SAREM, as recycling and upcycling of solar PV components require supportive policy frameworks, technical capacity, and infrastructure.

Table 12 provides an overview of the challenges and links to potential G20 cooperation.

Challenge	Potential for G20 cooperation
Scope for South-South cooperation	• Facilitate experience and information sharing through dedicated platforms for South-South exchange • Provide technical assistance to co-design local solutions adapted from international best practice
Scope for technology transfer or co-development	• Promote technology transfer and co-development through demand-driven partnership models

Table 12: Overview of key challenges to International Cooperation from case study analysis, linked to the potential for G20 cooperation.

6 G20 CONSIDERATIONS AND RECOMMENDATIONS

The G20 plays a key role in fostering international cooperation to deliver progress toward increasingly urgent development and climate goals. Previous G20 Summits have recognised the interconnections and synergies between development and climate mitigation agendas and committed to working towards them in an integrated manner. Past Presidencies have underscored the strategic role of the G20 forum itself in advancing the uptake and implementation of such approaches within and outside of its member countries. Continued cooperation in this area helps avoid fragmented efforts, improve resource efficiency, and establish shared priorities and joint action to address climate mitigation and socioeconomic development simultaneously.

To this end, the G20 can consider the following recommended areas for cooperation, based on the analysis of the literature and case studies.

6.1 Facilitate experience-sharing on integrated approaches at the G20

The G20 provides a platform to share best practices and lessons learned from experiences with integrated approaches across its member countries to promote mutual learning and leapfrogging. This supports newly implementing countries in structuring integrated efforts and provides starting points for bilateral and multilateral partnerships that build on and adapt international experience to different country contexts. The G20 can:

- **Utilise the inter-ministerial cooperation forums** under the Sherpa Track to share experiences in integrating mitigation and development policies while avoiding distributional impacts. This includes mechanisms for cross-sectoral coordination,

multi-level governance, stakeholder outreach and inclusion, and technical capacity building.

- **Utilise the cooperation forums** for finance ministers and central banks under the Finance Track to exchange on enabling conditions for mobilising finance, such as transparent and effective investment and regulatory frameworks, supply- and demand-side incentives, and innovative financial instruments to mobilise private investments.
- **Utilise its think tank engagement forum (T20)** to facilitate **knowledge exchange** among research institutions and drive co-development of innovative solutions for implementing integrated approaches.
- **Establish a repository of successful case studies** of integrated approaches, including international partnership models, across country contexts to provide an evidence base and practical resource for peer learning at the South-South, North-North, and South-North levels.

6.2 Foster international coordination for enhanced implementation at the G20

Coordination and institutional alignment underpin the effective integration of climate mitigation and development policies, as well as efforts to mobilise finance. The G20 forum provides a platform for multi-stakeholder coordination to advance implementation. The G20 can:

- **Leverage the G20 forum's convening power** to facilitate coordination among subnational and national governments, multilateral and bilateral donors, national and private financiers, private sector businesses, and civil society, indigenous, and vulnerable groups on joint priorities.
- **Strengthen alignment between the Sherpa and Finance tracks** through working group collaboration mechanisms like Taskforce CLIMA or between the ESCWG and the Finance Track Working Group on Sustainable Finance to facilitate enhanced international coordination on integrated approaches, including coordination on NDC and LT-LED alignment and mobilising diverse sources of finance.
- **Support enabling conditions and address structural challenges** to enhance access to diverse sources of finance and coordinate to explore initiatives set out in the Bridgetown Agenda, New Global Financing Pact, and Compromiso de Sevilla as a starting point.
- **Coordinate to identify and address equity implications** of domestic policies with cross-border effects.

6.3 Engage in demand-driven partnerships to support country-level implementation

G20 members can advance integrated approaches globally through their roles as bilateral partners and shareholders in multilateral institutions, championing demand-driven models that align finance, technology, and capacity-building with national climate and development priorities. Specifically, G20 member countries can:

- **Channel international public finance** in the form of grants, concessional finance, innovative de-risking instruments, as well as technical assistance for project preparation and pipeline development to support the mobilisation of private finance.
- **Provide technical assistance to co-design bottom-up solutions** and incentives for implementing integrated approaches adapted from international best practice.
- **Facilitate technology transfer and co-development** to accelerate integrated solutions equitably across countries.
- **Support capacity building** at the local level, including for assessing capacity needs, providing targeted training, developing data collection systems, and using support tools for planning, monitoring, and evaluation.
- **Support the scaling of holistic partnership** approaches through nationally driven country platforms for coordinated transition planning and financial mobilisation, as recommended by TF-CLIMA.

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8 ABBREVIATIONS

ABC+	Low Carbon Agriculture Plan
B-BBEE	Broad-based Black Economic Empowerment
CBDR-RC	Common But Differentiated Responsibilities and Respective Capabilities
CID	Clean Industrial Deal
CO_2	Carbon dioxide
COP	Conference of the Parties
DISCOMs	Distribution Companies
ECSWG	Environment and Climate Sustainability Working Group
ETS	Emissions Trading System
EUGD	European Union Green Deal
GDP	Gross Domestic Product
GHG	Greenhouse gas
INFF	Integrated National Financing Frameworks
IPCC	Intergovernmental Panel on Climate Change
JETP	Just Energy Transition Partnership
JTM	Just Transition Mechanism
LT-LEDS	Long-term Low-Emission Development Strategies
LULUCF	Land use, land use change, and forestry
MDB	Multilateral Development Bank
MW	Megawatt
Mt	Megatons
NDC	Nationally Determined Contributions
NECP	National Energy and Climate Plans
ODA	Overseas Development Assistance
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SAREM	South African Renewable Energy Masterplan
SDG	Sustainable Development Goals
SET	Sectoral Emission Targets
SMME	Small, medium, and micro enterprises
SNA	State Nodal Agency
tCO_2-eq	Tonnes of carbon dioxide equivalent
TF-CLIMA	Task Force on a Global Mobilisation Against Climate Change
TSI	Technical Support Instrument
UNFCCC	United Nations Framework Convention on Climate Change
VNR	Voluntary National Reviews

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Just Transitions

Characterising Whole-of-Economy, Whole-of-Society Just Transitions Across Economic and Social Systems, and Identifying Levers for Operationalisation

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EXECUTIVE SUMMARY

This technical paper characterises a whole-of-economy, whole-of-society approach to just transitions, focusing on its expansion to include the energy sector together with other economic sectors, as well as society, more broadly. It proposes an integrated approach to pertinent issues, such as adaptation, resilience, and mitigation, with an emphasis on international dimensions considered in relation to domestic dynamics. It grounds this characterisation in the development over time of the just transitions agenda within the G20 and, to a lesser extent, beyond it, as well as the positioning of just transitions in relation to inequality and global political and economic stability. The paper then turns to the operationalisation of this approach, characterising levers, mechanisms and barriers that can be used to achieve just transition outcomes within this reframed understanding. Levers are considered with reference to the example of finance as a lever, as well as concrete cases drawn from the South African context. Finally, international cooperation is presented as a lever for just transitions, focusing specifically on the mechanisms that exist in relation to G20 roles and their current and potential application to operationalising just transitions. The paper concludes with a proposal to enhance the G20's leverage in this regard.

1 INTRODUCTION

This paper explicates a 'whole-of-economy, whole-of-society' approach to just transitions to net zero[2] to shape international cooperation that enables ambitious and effective climate action, aligned to the Paris Agreement adopted under the United Nations Framework Convention on Climate Change (UNFCCC), and in the context of deepening inequalities within and between countries. This integrated approach is not without precedent in international agreements (see Section 2), nor is it without a sound scientific basis (IPCC, 2022, 2023). Integration adds to, and does not replace, targeted, sector- or stakeholder-specific interventions, thereby ensuring more coherent, better-informed and more efficient planning and action. To enable the operationalisation of the whole-of-economy, whole-of-society approach, this paper identifies and begins conceptualising a range of 'levers' and 'mechanisms' that can be used to realise just transitions outcomes. This is achieved, first, by considering the means of implementation (finance, technology transfer and development as well as capacity-building) as such levers, utilising finance as an illustrative example. This paper then broadens the range of available levers being considered beyond the means of

[2] Just transitions are sometimes referred to in the singular. However, this paper follows to convention of reference in the plural, in line with Decision 1/CMA.5: Outcome of the first global stocktake, which refers to "just transitions" (Article X) and "just transitions to net zero", while Decision 3/CMA.5 referes to "just transitions' and "just transition pathways" (UNFCCC, 2024). Under the Brazilian G20 Presidency, the G20 Taskforce on a Global Mobilization against Climate Change (TF-CLIMA) G20 Enhanced Ambition Agenda also refers to "climate transitions" and "just transitions to a sustainable, low-GHG emission economy" (Brazil G20, 2024).

implementation, reflecting on the extent to which these currently function to produce just transition outcomes. This reflection is undertaken with reference to concrete cases. Thirdly, international cooperation is analysed as a specific lever for whole-of-economy, whole-of-society just transitions, identifying mechanisms within the G20, in light of the roles played by the G20 and their current and potential application to operationalising just transitions.

The preamble of the UNFCCC's Paris Agreement recognises the "intrinsic relationship that climate change actions, responses and impacts have with equitable access to sustainable development and eradication of poverty", while highlighting "the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities", as well as calling for, in Article 2.2, implementation, "to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances" (CBDR-RC) (UNFCCC, 2015). The latter has been identified as difficult to operationalise in multilateral architecture or domestic action (see, for example, Ekanayake, Moriarty and Honnery, 2015; Ciplet and Roberts, 2017; Okereke, 2018; Kolmaš, 2023). The global transition is unfolding unevenly and inadequately. The intersecting climate and transition risks are increasing and compounding existing vulnerabilities, and the cost of inaction[3] is becoming progressively clearer (ClimateWise, 2019; IEA, 2023; International Energy Agency, 2023; Energy Agency, 2024; World Economic Forum, 2025).

The reality in 2025 is the multiple dimensions of inequality that necessitate CBDR-RC continue to define the landscape of climate and transition risk and opportunity. "Staggering inequality" is growing within 113 of 182 countries, and still "more pronounced" between countries (United Nations University, 2025a). In particular, most developing economies are severely challenged by inequality within and between countries, with many facing stunted economic development, with most countries falling behind on the Sustainable Development Goals (SDGs) (IMF, 2024; United Nations, 2024). Most countries and populations are thus already "left behind", with many low-income and emerging economies having inadequate capacity to transition without assistance (Diffenbaugh and Burke, 2019). The negative consequences of arrested transitions extend beyond domestic borders, with implications for other countries, populations, and the global economy (Feng and Li, 2021; Adriana Anisimov *et al.*, 2023).

A whole-of-economy, whole-of-society approach is presented here as a response to the intersecting risks and opportunities for integrated climate action across all sectors – including energy – in a richly interconnected global economy in which inequality is a definitive force. It, therefore, also foregrounds the transnational and global dimensions of these holistic transitions, through, for example, global value chains, trade, finance, taxation, logistics, and migration, and is embedded in shared ecosystems. This is consistent with the

[3] As noted in the Intergovernmental Panel on Climate Change (IPCC) Synthesis Report for the Sixth Assessment Report (AR6), "Delayed mitigation and adaptation action would lock in high-emissions infrastructure, raise risks of stranded assets and cost-escalation, reduce feasibility, and increase losses and damages (high confidence)" (IPCC, 2023).

position of the South African 2025 G20 Presidency and builds on the work of the Brazilian 2024 G20 Presidency, as well as other preceding presidencies.

This paper begins by tracing the successive deliberations and outcomes related to just transitions within the G20 and beyond, demonstrating how this international agenda has become more explicitly connected to inequality and, more recently, has expanded its concerns to encompass a range of economic sectors. It then articulates a case for just transitions, emphasising the international dimensions, and characterising a whole-of-economy, whole-of-society approach. With reference to this characterisation, it identifies levers to realise aligned just transition outcomes, using the example of finance to illustrate this potential and current shortcomings. Case studies are presented as provocations to consider the efficacy of potential levers in relation to specific initiatives aimed at achieving just transition outcomes. Lastly, international cooperation is presented as a lever to achieve whole-of-economy, whole-of-society just transitions, recommending roles and specific actions for the G20 to realise this potential.

2 SUMMARY OF JUST TRANSITIONS IN G20 AND OTHER MULTILATERAL PLATFORMS

A more holistic, whole-of-economy, whole-of-society just transition approach is a relatively new development, driven through the G20 and the UNFCCC, and finding partial expression in aspects of national and regional policy, including those of G20 members[4]. This is also reflected in the IPCC's AR6, which calls for economy-side policy responses, along with social security nets and investments in infrastructure resilience (IPCC, 2023). The concept of a just transition has gradually gained prominence as countries attempt to reconcile climate goals with social equity and economic development, growing from an initial labour-driven focus on mitigating the impacts of environmental policies on workers in carbon-intensive industries (ILO, 2015; Cha, 2024). Nearly half of the previously submitted Nationally Determined Contributions (NDCs) reference just transitions, often highlighting employment and social equity, although few outline specific financing or governance mechanisms to support implementation (ILO, 2025). As noted below, the continued integration of just transitions in NDCs is a clear intervention point, as are National Adaptation Plans (NAPS) and Long-Term Low Emission Development Strategies (LT-LEDS).

2.1 The Evolution of Just Transitions in the G20

Over the past decade, G20 statements have expanded their recognition of the need for just transition, although often remaining within the scope of energy transitions and employment protection, as demonstrated in the emerging G20 framing shown in Table 13. While energy

[4] Examples include Canada's Sustainable Jobs Plan (Government of Canada, 2023) and Italy's Piano Nazionale Integrato per l'Energia e il Clima (PNIEC) (Ministero dell'Ambiente e della Sicurezza Energetica (MASE), 2024), South Africa's Framework for a Just Transition and Just Energy Transition Investment Plan (Presidential Climate Commission (PCC), 2023), and the African Green Minerals Strategy (African Minerals Development Centre, 2024).

remains central to transitioning in line with the UNFCCC's Paris Agreement[5], other sectors have also been addressed.

Table 13. Evolving framing of Just Transition in G20

G20 Presidency	Engagement	Just Transition Framing	Appeared in
Japan 2019	Early Acknowledgement	Mention of inclusive and employment-protective climate policy and 3E+S Framework	Energy Transitions Communiqué and Karuizawa Innovation Action Plan on Energy (G20 Japan, 2019)
Saudi Arabia 2020	Early Acknowledgement	References through cleaner and sustainable affordable energy G20 Reference Framework for Effective Country Platforms	Energy Ministerial Meeting Communiqué (G20 Saudi Arabia, 2020)
Italy 2021	Early Acknowledgement	"Leave no one behind" framing for employment and social protection Just transitions of energy systems for sustainable economies	Rome Leaders' Declaration and Energy and Climate Communiqué (G20 Italy, 2021b)
Indonesia 2022	Emphasis	Just energy Transition as a key theme Integration of equity via JETP, focus on energy and finance	Bali Leaders' Declaration, Energy Transitions WG, and Indonesia Just Energy Transition Partnership (JETP) (G20 Indonesia, 2022)
India 2023	Emphasis	Voluntary Principles for Clean, Sustainable, Just Energy Transition Implementing sustainable, inclusive and just transitions globally to accelerate SDGs	New Delhi Leaders' Declaration, 2023 Action Plan on Accelerating SDGs, and Energy Transitions Ministers' Meeting (G20 India, 2023)

[5] Decision 1/CMA.5: Outcome of the first global stocktake paragraph 28 refers to significant changes required in the energy sector in (a), "Tripling renewable energy capacity globally and doubling the global average annual rate of energy efficiency improvements by 2030", (d) states, "Transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science", and (e), "Accelerating zero- and low-emission technologies, including, inter alia, renewables, nuclear, abatement and removal technologies such as carbon capture and utilization and storage, particularly in hard-to-abate sectors, and low-carbon hydrogen production".

G20 Presidency	Engagement	Just Transition Framing	Appeared in
Brazil 2024	Advanced Conversations	High-level principles, just and inclusive energy transition planning, and call for global equity The just transition, as a process of socioeconomic transformation towards a sustainable model G20 Enhanced Ambition Agenda calls for whole-of-economy, whole-of-society, and also whole-of-government approaches to climate action	Rio Leaders' Declaration, across several Working Groups, Sherpa and Finance Track, and Ministerial meetings (G20 Brazil, 2024a)
South Africa 2025 (Ongoing)	Advanced Conversations	Foregrounding just transitions across its Sherpa and Finance Tracks as whole-of-economy, whole-of-society transformations	Ahead of the 2025 Summit, just transitions have been integrated through relevant Working Groups and Task Forces within both the Sherpa and Finance tracks, as well as by the T20, B20, and Y20 engagement groups

During Japan's 2019 G20 Presidency, the importance of ensuring that climate policies are socially inclusive was acknowledged. Italy's 2021 G20 Presidency further recognised the need for recovery efforts that "leave no one behind" (G20 Italy, 2021a). However, the contribution of developing country members has been the clarion call for articulating equity and inclusion, as well as alignment with sustainable development. Indonesia's 2022 G20 Presidency advanced the discussion by integrating equity into sustainable finance and resilience frameworks, informed by its experience with its own JETP, as well as that of South Africa and Vietnam (UNFCCC, 2021). India's 2023 G20 Presidency explicitly connected the transition to sustainable development (G20 India, 2023). Brazil's 2024 G20 Presidency (G20 Brazil, 2024a) framed just transition within its unflinching concern with inequality (and poverty) as the definitive global challenge. In 2024, the Brazilian G20 Presidency facilitated the development of both the Principles for a Just and Inclusive Energy Transition and the Enhanced Ambition Agenda. The latter was an outcome of the Task Force on a Global Mobilisation against Climate Change (TF-CLIMA), which played an integration role across the Sherpa Track and Finance Track, producing recommendations across both tracks (Brazil G20, 2024).

South Africa has further advanced the holistic and international dimensions of just transitions, explicated in Section 3, giving expression to just transitions across both the Sherpa and Finance Tracks. Under the current South African G20 Presidency, the work of integration is distributed across relevant Working Groups and Task Forces, including important contributions from the Environment and Climate Sustainability Working Group (ECSWG).

2.2 The Advancement of Just Transitions in other Multilateral Forums

Other multilateral frameworks, such as the UN Global Accelerator on Jobs and Social Protection for Just Transitions, have also emphasised the need for just transitions across all economic sectors (including energy) and social systems. The International Labour Organisation's (ILO) "Guidelines for a just transition towards environmentally sustainable economies and societies for all" (ILO, 2015), and its subsequent work on just transitions (ILO, 2016, 2018), have covered additional sectors. This work has also included a focus on just transitions-aligned opportunities, in addition to risks.

Most recently, at the UAE Just Transition Work Programme (JTWP), launched at COP28, a whole-of-economy, whole-of-society approach has been an area of ongoing deliberation. This framing is coherent with references to the economy-wide approaches agreed in decisions under the UNFCCC[6]. Several Parties have called for multisectoral just transitions efforts, while integrating gender, youth, and indigenous peoples' and local communities' perspectives[7]. This aligns with calls from intergovernmental organisations (IGOs), civil society and think tanks for more holistic, context-sensitive policies that embed just transition imperatives into national development planning and promote cross-sectoral cooperation (World Bank, no date). A significant JTWP emphasis and area of ongoing deliberation is the extension of just transitions beyond the domestic scope to the international dimensions of transitions[8], in the context of inequality between countries (see Section 3.1).

[6] Decision 1/CMA.5: Outcome of the first global stocktake paragraph 38 recalls the role of developed countries as, "undertaking economy-wide absolute emission reduction targets, and that developing country Parties should continue enhancing their mitigation efforts and are encouraged to move over time towards economy-wide emission reduction or limitation targets in the light of different national circumstances"; and pargraph 39 refers to ,"nationally determined contributions with ambitious, *economy-wide* emission reduction targets, covering all greenhouse gases, sectors and categories and aligned with limiting global warming to 1.5 °C, as informed by the latest science, in the light of different national circumstances" (italics added). Additionally, Decision 2/CMA.5: Global goal on adaptation notes the need to understand, "how transformational adaptation is defined and understood *at different spatial scales and sectors*" (italics added).

[7] Paragraph 5 of the preamble to Decision 3/CMA.5 states, "Acknowledging that climate change is a common concern of humankind and that Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to a clean, healthy and sustainable
environment, the right to health, the rights of Indigenous Peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity".

[8] While this is not a universal concern of all Parties, it is notably reflected in the submissions of developing countries (G77 and China, 2023).

3 MAKING THE CASE FOR INTERNATIONAL COOPERATION FOR WHOLE-OF-ECONOMY, WHOLE-OF-SOCIETY JUST TRANSITIONS, WITH REFERENCE TO FINANCE

3.1 The Case for Just Transitions in Support of Global Economic Stability

Just transitions cannot be usefully conceptualised without considering the nexus between global climate change and transitions to net zero, with the challenge of stagnating or worsening inequality within and between countries. Transitions to net zero necessitate profound economic reconfiguration, with the complexity and scale of this transition potentially contributing to economic instability (Dani Rodrik, 2018; J.D. Farmer *et al.*, 2019; ILO, 2024; World Economic Forum, 2025). Countries need to transition in the context of global inequality, which skews the distribution of capacity, resources, and risks, with existing development deficits and vulnerabilities compounded by the increasing impact of climate change (IPCC, 2023; IMF, 2024). Many countries must also contend with various domestic inequalities, which have context-specific characteristics and implications. This inequality is itself recognised as a risk multiplier that threatens to undermine political and economic stability (Diffenbaugh and Burke, 2019; Dwarkasing, 2023; Federal Ministry of Economic Cooperation and Development, 2023; Qureshi, 2023; United Nations University, 2025a, 2025b).

There is a shared recognition among several G20 members that inequality undermines economic stability and climate ambition and action (emissions reductions and adaptation)[9]. A more robust understanding of the intersection between climate change, transitioning in line with UNFCCC's Paris Agreement goals[10], and inequality[11] is crucial to facilitate

[9] The EU Adaptation Strategy is progressive in its consideration of "nexus between climate hazards and socio-economic vulnerabilities and inequalities" and the need for "international solidarity" (European Commission, 2021). Additionally, Germany's Federal Ministry of Economic Cooperation and Development developed a position paper that boldly states (Federal Ministry of Economic Cooperation and Development, 2023): *"Gross inequality constrains development opportunities, makes human rights harder to realise and frustrates poverty reduction efforts. It negatively impacts economic growth and threatens social cohesion and the proper functioning of democracies around the world. It can also accompany financial market instability and corruption."*

[10] Article 2(a) of the Paris Agreement articulates the goal, "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change". The achievement of this goals requires a transition entailing 'transitioning in' and 'transitioning out', as noted in Decision 1/CMA.5: Outcome of the first global stocktake paragraph 28, this includes, for example, (a), "Tripling renewable energy capacity globally and doubling the global average annual rate of energy efficiency improvements by 2030", and (d) states, " Transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science".

[11] The Working Group III Contribution to the IPCC AR6 scenarios, "Illustrative Mitigation Pathways (IMPs)", also show how reducing inequality, in alignment with broader sustainable development, can be linked to emissions reductions (IPCC, 2022).

inequality-sensitive just transitions that foster greater political and economic stability. Without active, ambitious and mutually enabling domestic actions and international cooperation, some developing countries (including low- and middle-income countries), vulnerable groups within countries, and exposed businesses across formal and informal economies will be unable to make essential contributions to global greenhouse gas (GHG) emissions reduction and avoidance efforts and could fall further behind in all aspects of sustainable development (Mattos and Follly, 2025). This will result in the limited and uneven implementation of transition within countries, as well as the associated risks that have implications at the domestic, regional, and international levels. The OECD and UNDP published a report in 2025 arguing that climate action can be designed in a way that delivers "development dividends" and that it can contribute to reducing inequality (OECD and UNDP, 2025).

3.2 Foregrounding the International Dimensions of Just Transitions

Just transitions are inherently multiscale[12], encompassing both domestic (national and subnational) *and* international levels. Just transitions have specific, place-based, contextual features and concerns, while involving interconnected systems, networks, and flows that cross national borders. The predominant policy approach has been to emphasise domestic features, while excluding or deemphasising international dimensions. The latter encompasses, for example, global value chains, trade (Feng and Li, 2021; Malik *et al.*, 2024), global finance (Naran *et al.*, 2024; Runfeng Yang, Massimiliano Caporin and Juan-Angel Jiménez-Martin, 2024), international taxation, logistics, knowledge and innovation systems, migration, and ecosystems (Hickel, Sullivan and Zoomkawala, 2021; Adriana Anisimov *et al.*, 2023). These international dimensions[13] of just transitions have implications for inequality within and between countries. The recognition of international inequalities must always include a sensitivity to the vulnerability of particular groups within countries, especially those groups that are disproportionately exposed to intersecting climate change and transition risks. Existing human rights, labour rights, and decent work frameworks, standards, and guardrails should apply to all transition measures[14]. Additionally, just transitions measures should encompass meaningful participation (including free, prior and

[12] Recognising and addressing international dimensions can complement the recognition of specific national circumstances, providing a more comprehensive understanding that considers both national and international dynamics.

[13] It should be noted that G20 members hold varying perspectives regarding the comprehensive approach to international dimensions of just transitions presented in this paper. Some members indicated that just transitions are fundamentally domestically rooted and favor a more focused approach to international dimensions and cooperation.

[14] These include, but are not limited to the United Nations Global Accelerator on Jobs and Social Protection
for Just Transitions, the United Nations Guiding Principles on Business and Human Rights, and the and the United Nations Declaration on the Rights of Indigenous Peoples.

informed consent (FPIC)), gender-sensitive approaches, and appropriate social protections[15].

There are several channels through which international dimensions are involved in domestic transitions, four of which are considered here. Domestic transitions depend on international systems such as global finance, which may be more or less suited to enable, disable or shape a transition in a particular country (Chiriac, 2022; Naran *et al.*, 2024). Like global systems, networks such as global value chains are organised and governed across national borders while being territorialised in different geographies (Gereffi, Humphrey, and Sturgeon, 2005; Kano, Tsang, and Yeung, 2020). Transitions in the context of climate change will cause "cascading effects across international supply chains" (European Commission, 2021), with distinct impacts across these locations, necessitating coordinated responses (Karaosman and Marshall, 2023; Maluf *et al.*, 2023; Montmasson-Clair, Hermanus and Dane, 2024). Climate change and transition risks also transcend borders through relationships and flows, such as trade (Malik et al., 2024) and migration (Adriana Anisimov *et al.*, 2023). Moreover, finally, climate action (mitigation, adaptation and resilience) in one country can have negative or positive impacts in other countries (Lager, F., Coninx, I., Breil, M., Bakhtaoui, I., Branth Pedersen, A., Mattern, K., van den Berg, H., Sini, E., Gallucio, G. and R., & Vierikko, 2023; Ramos, 2023; Shift, 2023; Klein, 2024). International dimensions – systems, networks, and flows – drive both transition risks and opportunities. They generate levers and mechanisms, as well as barriers to implementing just transitions (see Sections 3.4, 3.5 and 4.2).

3.3 Articulating the South African G20 Presidency's Characterisation of Just Transitions

The South African G20 Presidency, building on previous G20, UNFCCC, regional and national developments, has put forward a strategic approach to just transitions as a basis for international cooperation, while respecting the sovereignty of members in shaping their own transition pathways. This approach entails a whole-of-economy, whole-of-society scope, recognising that the energy sector, while central to the achievement of the goals of the UNFCCC's Paris Agreement[16], is not the only sector in transition or facing transition impacts, and that transitioning the energy sector has implications for all economic sectors. This scope encompasses a balanced attention and resources devoted to its composite elements, ensuring that underrepresented but strategically relevant issues are adequately addressed. Areas of relevance include the balanced consideration of adaptation, resilience[17], and

[15] Additionally, where the participation of marginalised groups is facilitated, inclusive governance structures should be developed, beneficiaries are not passive but active partners in policy co-design.

[16] As noted in Footnote 9.

[17] There is an emerging emphasis on 'just resilience' interconnected with adaptation and mitigation efforts, sensitive to the international implications of climate action, notably across national borders, transmitted through, for example, trade, financial flows or shared ecosystems (Lager, F., Coninx, I., Breil, M., Bakhtaoui, I., Branth Pedersen, A., Mattern, K., van den Berg, H., Sini, E., Gallucio, G. and R., & Vierikko, 2023; Shift, 2023; Klein, 2024).

mitigation, as well as attention to the transition into value chains for new net zero compatible products in parallel with the phase-out, restructuring and reform of others. Another feature is a focus on reducing systemic inequitable access to economic opportunities, as well as barriers to more equitable access to these opportunities, in addition to reducing inequities in climate and transition risk management[18]. Finally, this approach entails the informed consideration of the international dimensions of transitions, as noted in Section 3.2. Table 14 distinguishes this approach from a conventional just energy transitions approach.

Table 14: Comparison of key features of a whole-of-economy, whole-of-society approach to just transitions

Conventional approach to Just Energy Transitions	Whole-of-economy, whole-of-society approach to just transitions
Energy sector focus (in some cases narrowed to electricity)	Focus on the mitigation and adaptation requirements and impacts on all sectors, as well as the implications of the energy transition for other sectors and implications for addressing energy poverty
Primary focus on transitioning out of carbon-intensive activities, with a secondary focus on scaling up renewable energy generation and other net zero compatible technologies	Integration of focus on 'transitioning in' of new processes, infrastructure and value chains, including but not limited to renewable energy, other net zero compatible technologies, as well as shared private, public and community benefits of energy and other industries, and addressing legacy environmental and social harms caused by carbon intensive industries
Focus on the distribution of risks arising from the transition	Extending the focus to include the distribution of fair access to opportunities (transition-aligned employment, businesses, industries)
Focus on mitigation over adaptation	Responding to the interconnection of adaptation and resilience with mitigation efforts
Focus on direct, formal employment in energy value chains	Inclusion of workers in informal employment, as well as indirect employment in declining as well as new value chains
Prioritise technology-driven mitigation solutions	Including nature-based solutions, biodiversity-aligned transitions, and a holistic approach to drivers of climate change
Predominantly domestic scope	Complementary focus on domestic, regional and international dimensions, particularly where enabling and constraining conditions, as well as key levers involve international systems and actors
GHG emissions reduction (mitigation) is the goal that motivates climate ambition	GHG emissions reduction remains critical, but it is conceptualised as one of several parallel sustainable development outcomes, along with, for example, climate resilience, economic development within planetary boundaries, and poverty alleviation

This approach to just transitions enables the comprehensive identification of transition risks, barriers, and costs on one hand, as well as opportunities, enabling conditions, and returns (both financial and broader economic returns). While it can help define a solution space, moving toward actual solutions demands that just transitions are operationalised to enable

[18] The OECD recently published a report with the UNDP, which suggests that it is possible to design climate policies so that they contribute to reduced inequality within countries (OECD and UNDP, 2025).

domestic implementation, achieve global climate goals, and facilitate global economic stability. IPCC AR6, which takes a broad economic and societal approach to transitioning, points to the potential ways to achieve this, including "economy-wide structural change", and "systems transformation" (IPCC, 2022, 2023). It proposes a number of concrete interventions that can be utilised under a just transitions frame.

3.4 Identifying and Shaping Levers for Just Transitions

Operationalising just transitions requires a pipeline of compelling and investable propositions that generate climate change mitigation, adaptation, and resilience benefits, alongside credible development dividends, with roles that can be feasibly undertaken by different actors. To support the operationalisation of just transitions, this paper considers levers and mechanisms, as well as barriers, for implementing just transitions (see Sections 3.5 and 4.2). The means of implementation (finance, technology transfer and development as well as capacity-building) can be framed as such, and their effectiveness then depends on how well it responds to the nexus of climate change, transitions and inequality, while maintaining interlocking goals of enabling ambitious climate action and decreasing inequality.

To demonstrate how this framing would work, global finance[19] can be considered as an illustrative example, identifying its 'levers' (e.g. project financing), mechanisms (e.g. targeted instruments) and 'barriers' (e.g. high costs of capital)[20], noting that a similar undertaking is required for technology and capacity-building. The potential of finance as a lever is described in relation to specific outcomes that it should facilitate in line with the whole-of-economy, whole-of-society approach in Table 14. It also describes barriers to this potential (below). These outcomes and related barriers are not final or exhaustive, and they would need to be identified and unpacked for technology and capacity building, respectively.

For finance to function as a lever for just transitions, it must achieve certain outcomes aligned to a context-relevant understanding thereof[21]. Four examples of just transition

[19] In this paper, finance is understood in a broad sense, as an ecosystem of capital and financial intermediation that enables the mobilisation and allocation of resources. This includes: a) capital, such as money and financial instruments (including debt, equity, derivatives, transfers, and risk-sharing tools like insurance and guarantees); b) markets, practices, and conventions that shape financial flows; c) concepts, conventions and rules, both domestic and international regulations, policies and frameworks; and d) actors, including public entities (e.g., states and development finance institutions) and private entities (e.g., corporations and civil society).

[20] The approach to just transitions implementation through a schema that identifies options, levers, mechanisms, actors and conditions is under development by Southern Transitions (Montmasson-Clair, Hermanus and Dane, 2024).

[21] This way of characterising finance for just transitions in relation to its outcomes is deliberately used to avoid disagreements on the scope for just transitions to prevent engagement with the approach proposed in this paper. While there is value in further substantive definition of finance for just transitions, it is suggested that this should be undertaken through platforms like the G20 ECSWG.

outcomes are listed here, noting that this is a non-exhaustive list that should be refined over time[22]:

- Enabling mitigation, adaptation, resilience measures, and transition-aligned economic investments where barriers (e.g. high cost of capital, high-risk investment environments, lack of access to technology) currently prevent implementation.
- Augmenting the socio-economic performance of mitigation, adaptation, and resilience measures, as well as transition-aligned economic investments.
- Augmenting the mitigation, adaptation, and resilience performance of public investments mainly targeting socio-economic outcomes (e.g. water treatment works, public housing).
- Mitigating the negative impacts of climate action on economies, populations and ecosystems within and across national borders.

For finance to be directed toward these outcomes, a compelling investment case must be made for projects that generate climate change mitigation and resilience, as well as development dividends, alongside financial sustainability (IPCC, 2023). In terms of the concepts, conventions, and rules informing finance, these must move beyond narrow definitions of bankability or short-term returns, toward a broader understanding of value that encompasses long-term, sustainable development outcomes and shared prosperity in the context of transition (World Bank, 2020). Another necessary conceptual shift is the reframing of just transitions considerations as core rather than marginal investment priorities in climate investments and other complementary investments necessary for sectoral and system transformation to achieve net zero targets.

These shifts can provide an impetus to utilise, combine, and change different mechanisms to just transition-aligned ends. Pertinent mechanisms include instruments that enable cost and risk-sharing between actors, clear and consistent policy and regulatory instruments, as well as plans for cooperation that can align incentives and shape both financial and non-financial returns. A mix of policy-based lending and risk-sharing instruments, underpinned by credible transition plans[23], and coordinated public and private initiatives that align incentives across sectors, and enable the conditions to add appropriate finance at scale. The impacts of all mechanisms, including grants, must be assessed for unintended consequences, such as exacerbating debt sustainability risks in beneficiary countries. This approach demands collaboration in thinking, planning, and implementation, requiring different actors to play different and complementary roles in just transition investments.

While the imperative is increasingly recognised, financial models that implicitly embed social and environmental benefits as part of the overall return on investment (ROI) remain

[22] An additional consideration that cannot be addressed within the scope of this paper is what kind of finance would be best to de-risk investments in vulnerable areas, characterising appropriate levers and mechanisms, in relation to, for example, economic policy and planning or carbon pricing.

[23] Such mechanisms have already been tabled, with guidance, through the G20's Enhanced Ambition Agenda

limited and fragmented. Many financial structures still allocate a specific portion of an investment's transitional benefits to a designated counterparty bearing the associated costs, whether through ring-fenced transfers or concessional financing. Without targeted measures, structural challenges will persist, leading to continued capital concentration in particular sectors and over-reliance on 'traditional' funding channels.

Utility-scale commercial renewable energy plants – which are crucial for transitioning to net zero – attract capital more readily than novel, smaller, or less profitable initiatives. Additionally, finance for such projects remains at the lowest levels in sub-Saharan Africa, a region with significant renewable energy access and security needs. Both the project itself and its context (geographical and otherwise) impact its likelihood of attracting finance. An important further consideration is that it is not only the quantum of finance that needs to increase, but also qualitative aspects (Chiriac, 2022; Naran *et al.*, 2024).

Some, but not all, of the barriers that inhibit the just transition 'leverage' of finance, include:

3.4.1 Insufficient integration of international dimensions:

- Some actors emphasise national approaches to just transitions, while others highlight the international dimensions. A national framing often centers on the role of national governments (including low- and middle-income countries) funding just transitions by relying primarily on domestic resources and institutions, including development finance institutions (DFIs), multilateral development banks (MDBs), national development banks (NDBs), and public development banks (PDBs). This focus, while conscious of national priorities and circumstances, may not fully capture the importance of international support aligned with the CBDR-RC principle.
- Without evidence-based planning and adequate monitoring, domestic investments in one country may be compromised by policy decisions made elsewhere. As such, domestic and regional policy decisions in major economies (such as those related to trade, investment, development cooperation, or climate targets) can generate spillover effects across borders. As these can range from negative to positive, it is important that they are tracked and appropriately managed. This is particularly relevant for developing countries with limited domestic financial resources to manage risk or maximise benefits arising from the actions of other states or businesses. These realities underscore the critical importance of international cooperation to ensure that national actions, at the very least, do not undermine efforts in other countries and help create enabling conditions for all.

3.4.2 Insufficient clarity on the scope of just transitions:

- It should be noted that the scope of just transitions is addressed in internationally agreed texts, notably including the ILO guidelines on a just transition towards environmentally sustainable economies and societies for all (ILO, 2015). However, diverse interpretations and approaches of the established scope have emerged among

G20 members and various organizations through ongoing domestic and international framing.

- To date, just transition support has often been subsumed under other sources of funding, such as climate finance, infrastructure investment and general budget support, as notably illustrated in the case study on country platforms in Section 3.5. While principles and considerations for just transitions should be integrated across these areas of finance, as appropriate, failing to allow for specifically targeted or additional public and private finance for just transitions (as in, for example, country platforms or JETPs), may obscure some opportunities to effectively implement just transitions.

3.4.3 Barriers in the financial ecosystem affect the emergence of public and private finance for just transitions that enables high-risk investment:

- The lack of adequate grants, venture capital, and angel investment creates a market gap that undermines early-stage, small-scale, higher-risk andnovel technology-based projects, most acutely felt in many developing country contexts.

3.4.4 The understanding of just transitions between actors articulating the 'demand' and 'supply' of means of implementation (finance, technology transfer and development as well as capacity-building) is not aligned.

- Constraints in the quality of finance[24] required are compounded by capacity limitations on both project developers and financiers. Project developers often fail to meet the strict requirements of the financial ecosystem (such as track records, financial strength, etc.). Meanwhile, financial institutions may lack the internal capacity and capability to source and evaluate just transitions projects, leading to risk mispricing in ways that materially impact investment decisions.
- Conceptual clarity must be established to ensure alignment among all parties in just transitions investments. An approach to achieving such alignment is captured in Box 5.

While significant work exists to facilitate appropriate public and private finance for just transitions, more is required. Some of the solutions lie in more general interventions that are not unique to just transitions. Overcoming the above challenges requires not only interrogating the quantity and quality of finance, but also critically engaging with the role and

[24] The Third report of the Independent High-Level Expert Group on Climate Finance calls for, "climate finance system that meets the test of both scale and quality requires shifting beyond a traditional focus on mobilising funding to prioritising impact and systemic change"(Bhattacharya *et al.*, 2024). Similarly, an OECD review of bilateral climate finance evaluations (Vij and Kennedy-Chouane, 2023) notes, "An over-emphasis on financial input targets has implications for both relevance and impact. Prioritising the quality of climate finance – and not just the quantity – and maintaining an optimum leverage ratios for mobilised private finance, can strengthen effectiveness and help meet global needs."

structure of the financial ecosystem[25]. It necessitates changing how finance works as well as its relationship with the real economy and broader aim of just transitions and sustainable development (Zadek, 2019; Lowitt, 2021). It is equally important to note that while finance (or indeed any one lever for just transitions) can be utilised to realise implementation, it is likely that complementary levers will be needed in conjunction.

Operationalising just transitions requires fostering a wide range of interventions, on multiple scales. Building on the theoretical understandings of just transition, implementing just transitions necessitates identifying qualifies as a just transition initiative. Indeed, financial sector stakeholders, from commercial and investment bankers, impact investors, DFIs, private equity funders, asset managers to institutional investors, have stressed the lack of clarity about what constitutes a just transition investment, project, initiative, financial vehicle or product as a key impediment to financing reaching on-the-ground beneficiaries (Impact Investing Institute, 2023; Lowitt, 2021, 2024; Lowitt et al., 2023).

At a conceptual level, projects would need to meet a specific set of criteria to be deemed supportive of a just transition. However, just transitions initiatives are diverse, and to date, there is no universal definition or taxonomy. Interventions vary in their (i) geographic scope or location (place-based or not), (ii) the nature of their deliverables (enabling or tangible projects), and (iii) phase in a project development life cycle (from proof of concept, to project preparation, to implementable projects). Given their diversity, such requirements vary depending on the type of projects.

An approach that can be considered is taken by the "Just Transition Finance Tool" developed by TIPS in South Africa, adapted to the South African context (with relevance to other developing country contexts) (Lowitt, Mokoena and Steuart, 2023; Lowitt, 2024). First, a project must demonstrate that it has a costed engagement policy for the most relevant stakeholders. The focus of the stakeholder engagement should be a function of the project's location, objectives and activities and include labour, community or both. Then, enabling projects must pursue either environmental or socio-economic objectives to be compatible with the just transition agenda. These can range from capacity building, skills development and training, to the improvement of government administrative and development processes, project development and preparation, as well as strategic planning, policy research, and support.

By contrast, tangible projects, which have direct, on-the-ground impacts, should meet stricter requirements than enabling ones, fostering both environmental or socio-economic objectives. Importantly, a 'primarily environmental' project should meet a higher threshold in terms of environmental objectives (such as climate change mitigation or adaptation, pollution prevention, sustainable use of water and marine resources, sustainable resource use or circularity, or ecosystem protection and restoration) while meeting a lower threshold in terms of socio-economic improvement (such as employment and livelihood support, access to services, the strengthening and development of existing and new supply chains, or the improvement of community spaces, organisations and services), and vice-versa. Additionally, a higher level of ambition can be demonstrated by meaningfully empowering disadvantaged individuals (for instance, through ownership or direct representation).

Box 6: Illustrative approach to tagging just transitions investments from South Africa

[25] Other relevant initiatives include the G20 Roadmap towards better, bigger and more effective MDBs (G20 Brazil, 2024b) and the World Bank Just Transition Taxonomy (World Bank Treasury Sustainable Finance & ESG Advisory Program & World Bank Extractives Global Unit, 2024), and ongoing work under the G20 International Financial Architecture Working Group (IFA), concerning issues such as sovereign debt restructuring and country platforms.

3.5 Case Studies Demonstrating a Whole-of-Economy, Whole-of-Society Approach in Practice

Levers for just transitions are not limited to the more conventionally identified means of implementation (finance, technology transfer and development as well as capacity-building)[26], and may include international cooperation (e.g. JETPs and country platforms), national climate change policies and commitments (notably NDCs, NAPs and other adaptation plans, and LT-LEDS), industrial policy (e.g. transition-aligned sector-specific plans), economic diversification (e.g. place-based bioeconomy value chains), industry plans (e.g. multistakeholder supply and demand-side partnerships), market mechanisms, or the promotion of indigenous and local knowledge and practices. To further demonstrate the utility of thinking in terms of levers and mechanisms to achieve just transitions, this paper provides concrete examples of implementation, referencing the outcomes identified in Section 3.4. To this end, case studies are drawn from the South African context and presented in Table 15, noting that other G20 members will have context-specific considerations informing the design of initiatives. These cases are presented as examples – without prescriptive solutions – for critical and ambitious thinking about how the opportunities presented by each one could be harnessed and the benefits maximised. The extent to which a project can demonstrate just transitions outcomes can frame an inquiry into the adequacy and appropriateness of specific mechanisms, drawing on credible evidence, and reveal potential intervention points targeting those mechanisms or the conditions in which they are used. Included in these outcomes should be improved sustainable development outcomes, as well as the implementation of human rights, labour rights, and decent work frameworks, standards and guardrails, for vulnerable groups.

Table 15: Just transitions levers identified in the case studies of initiatives drawn from the South African experience

Just transition outcomes	Case studies considered in relation to these outcomes
Enabling mitigation, adaptation, resilience measures, and transition-aligned economic investments where barriers currently prevent implementation	**Lever: International Cooperation (Country Platforms)** Country platforms (are the latest attempt at crafting mutually beneficial North-South partnerships to enable just transitions in developing countries pursuing ambitious climate targets, but lacking means of implementation (finance, technology transfer and development as well as capacity-building). As a precursor to country platforms, in 2021, South Africa and a consortium of predominantly European partners struck the first JETP, pioneering this new donor-coordinated and transactional approach. It implemented commitments for international support (investments and technical assistance) from developed to developing countries in their pursuit of just transitions to a green economy. However, recent analysis (EYL-MAZZEGA *et al.*, 2024) calls into question whether the current design, and level of support (including the quantity and quantity of finance) does overcome barriers to financial flows, as a substantial financing gap remains, notably for just transitions elements such as social investment and inclusion, skills development, economic diversification,

[26] IPCC AR6 identifies a range of potential levers for just transitions under the categories of finance, technology and capacity-building, and additional to these categories

Just transition outcomes	Case studies considered in relation to these outcomes
	technology innovation and industrial competitiveness. Country platforms should build on lessons learnt from JETPs.
Augmenting the socio-economic performance of mitigation, adaptation, and resilience measures, as well as transition-aligned economic investments	**Lever: Industrial policy (Transition-aligned sector-specific plans)** The South African government aims to maximise the economic benefits of low-carbon energy investments, using the South African Renewable Energy Masterplan (SAREM). The SAREM aims to drive the inclusive development of new industrial activities, positioning South Africa as a leading renewable energy and battery storage manufacturing location. It identifies key parts of renewable energy and battery storage value chains where South Africa is or can be competitive over the short term (2030). Then, through a set of 49 short-term interventions, the plan covers both demand- and supply-side considerations, along with cross-cutting ecosystem building. In a challenging high-unemployment environment like South Africa, there is significant pressure for industrial initiatives like this to solve fundamental structural economic issues. Finance is required for the institutionalisation of the Masterplan, as well as for the manufacturers. While many developing countries have renewable energy industrial policies with some localisation and inclusion (e.g. of small or medium enterprises), they often lack the means to use incentives to kickstart or sustain new businesses and industries.
Augmenting the mitigation, adaptation, and resilience performance of investments mainly targeting socio-economic outcomes (e.g. water treatment works, public housing)	**Lever: Economic diversification (Place-based bioeconomy value chains)** An economic approach to transition-aligned economic diversification[27] can provide integrated mitigation, adaptation and resilience benefits, while providing employment and generating wealth. An example of an early-stage project is the Magingqi Community Trust's systemic approach to the development of an agro-processing value chain anchored in the production of hemp for local industrial processing. One of the defining features of this project is the thoughtful integration of Indigenous Peoples and traditional knowledge and governance systems with industrial and policy systems. The hemp production underpinning this economic diversification is undertaken by smallholder farmers on traditionally owned and managed land. While these farmers are central to the project, it is the downstream uses of hemp that increase economic value capture potential for all stakeholders. The community seeks to secure equity participation in downstream value chains using existing South African Government-driven industrial support at the East London Industrial Development Zone (IDZ), ensuring value capture rather than raw material export. This model transforms the community from primary producers to shareholders in manufacturing, creating what they term "Agripreneurs". Despite multiple non-financial returns and the potential for sustainable financial returns once scaled, these kinds of projects struggle to attract finance of the quantity and quality necessary to maximise just transitions outcomes. This project requires a financing model that is able to account for the project's integrated climate benefits. The initiative simultaneously delivers mitigation (carbon sequestration in biomass and soil), adaptation (diversified income streams reducing climate vulnerability), and resilience (ecosystem restoration). It also requires finance that is affordable and enables local ownership, from pilot through to scale.

[27] This case study is based on project documentation provided by Stephen Wormald, TASC, regarding the Magingqi Community Bioeconomy Project.

Just transition outcomes	Case studies considered in relation to these outcomes
Mitigating the negative impacts of climate action on economies, populations and ecosystems within and across national borders	**Industry just transitions plans (Multistakeholder supply and demand-side partnerships)** The transition of South Africa's steel industry presents an opportunity to intervene in a 'hard-to-abate' sector, protecting existing employment and maximising the positive socio-economic benefits for workers and their communities in transition-impacted sectors. The steel industry accounts for 7 – 10% of worldwide emissions and the industry is not on track for to meet net zero targets by 2050 (IEA, 2023). The cost of this transition, as well as the complexity of relationships involved in driving these parallel techno-economic and socio-economic aims, has also posed challenges. While developed countries are making subsidies available to their steel industry, it is challenging for developing countries to do the same. Inequitable capacity for subsidisation has concrete implications for the global trade of steel and steel products affecting issues such as competitiveness. As part of advancing a Just Steel Transition Partnership, there have been facilitated engagements with ArcelorMittal South Africa (AMSA); community partners; technical experts; think tanks and potential financiers in order to better understand the challenges and opportunities facing the steel industry in South Africa. Current discussions have led to the articulation of a just steel transition plan. The key challenges for implementation relate to obtaining off take agreements for green primary iron as well as concessional and grant financing to support this plan. Partners in potential offtake markets are key to success. In the case of South Africa, this could include EU Global Gateway and Clean Trade Partnerships.

These cases can also be used to consider how international cooperation can be used as a lever to improve each initiatives outcomes, drawing on additional mechanisms. Further engagement with these cases, together with the development of case studies, tracking outcomes over time, would be important to advance and refine the operationalisation of just transitions (captured in Table 16). It is critical that additional cases are developed to allow cross-contextual learning, also for potential scaling (replication and expansion).

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

4.1 The G20's Potential to Drive Effective International Cooperation

Having articulated a relationship between just transitions and global economic stability (which should be further investigated with reference to specific interventions) with reference to both domestic and international dimensions of transition and characterising a whole-of-economy, whole-of-society, integrated approach, it is necessary to clarify the relevance of this case to the G20, specifically. The G20 can play a critical role in operationalising whole-of-economy, whole-of-society just transitions. Many member and non-member states have already expressed a shared understanding that international cooperation and a multilateral architecture (platforms, bodies, and processes) are essential to the governance and implementation of just transitions, commensurate with the scale and complexity of the necessary techno-economic and socio-ecological transformation (European Commission,

2021; BMZ, 2023; Gouvernement de la République Française, 2023; Ministry of External Affairs, 2023; The International Climate Initiative (IKI), 2023; G20 Brazil, 2024a). This paper asserts that inequality within and between countries should be central to just transitions planning, shaping international cooperation to effectively manage risks, opportunities, and facilitate economic stability within and across countries. However, it should be noted that not all G20 members are of the view that just transitions involve equity matters between countries.

There is significant value in coordination and integration in the operationalisation of just transitions, given that they are cross-cutting, both impacting and impacted by various parts of the G20 structure. Under the South African G20 Presidency, it is explicitly included in the work of the ECSWG, the Sustainable Finance Working Group (SFWG), the Energy Transition Working Group (ETWG), and Task Force 1. However, it is also addressed within several other working groups and structures of the G20 across the Sherpa and Finance Tracks, as well as its engagement groups. To ensure maximal value, integration should be continued, which enhances alignment, leverages synergies, and avoids duplication, to ensure progress. This approach can also be extended through Working Groups and Engagement Groups to include non-state actors, such as businesses, development finance institutions, IGOs, and civil society. The Principles for Just and Inclusive Energy Transition present an agreed, voluntary basis from which a whole-of-economy, whole-of-society approach to just transitions can be elaborated for additional economic sectors and social systems (G20 Brazil, 2024b) (see Section 4.3).

4.2 G20 roles in Relation to Just Transitions

Drawing on the characterisation of levers for whole-of-economy, whole-of-society just transitions in this paper, this final section presents international cooperation as a lever, focusing on the mechanisms available within the G20, and the distinct roles to which these mechanisms contribute. Table 16 summarises G20 mechanisms in relation to these roles and their potential applications in support of just transitions. The application and scope for all proposed measures should be determined through technical and political engagement, as appropriate to each measure.

Table 16: G20 roles, mechanisms and potential applications for just transitions

G20 roles	Mechanism	Potential application for just transitions
Norm-setting: The G20 proposes standards that members incorporate into national frameworks, where applicable	• Leadership declarations • Communiques • Principles	• Building on Brazil's G20 Presidency's Principles for Just and Inclusive Transitions, encompassing developing and operationalising whole-of-economy, whole-of-society just transitions principles • Integrating just transitions more explicitly in existing Working Groups and official Communiques and Declarations • Encouraging and facilitating the integration of just transitions into national commitments and policies, notably the notably NDCs, NAPs and other

G20 roles	Mechanism	Potential application for just transitions
		adaptation plans, and LT-LEDS, as well as regulatory frameworks
Policy coordination: Members align their economic and financial policies	• Working Groups • Task Forces • Cooperation frameworks	• Undertake parallel review and coordination as below • Review existing just transitions-focused internationally relevant frameworks, standards and policies to identify synergies, contradictions, and gaps within and outside of the G20, and alignment with human rights, labour rights, and decent work frameworks, standards and guardrails, especially for vulnerable groups (e.g. The G20's Recommendations for Financial Frameworks that respond to the Paris Agreement adopted under the UNFCCC), leveraging the capacities of knowledge partners and the T20, scoped to be manageable • Cooperation frameworks can guide national and regional development that facilitates partnering, for example, in the upgrading of value chains, as part of broader sustainability or green industrialisation initiatives • Support the ongoing integration of just transitions elements and commitments, measures and multi-stakeholder engagement platforms into relevant MDB frameworks and policies
Guidance: support the integration of principles of equity and fairness in the implementation of climate action within and outside of the G20	• Working Groups • Task Forces	• Curate tools and resources to support and enable the whole-of-economy, whole-of-society approach to just transitions • Provide guidance on alignment with human rights, labour rights, and decent work frameworks, standards and guardrails, especially for vulnerable groups • Provide guidance such as “Framework for transition planning and country platforms” (Brazil G20, 2024)
Knowledge sharing: sharing good practices and policy experiences, and identifying and tracking knowledge gaps	• Technical papers • Task Forces	• Develop and analyse case studies to demonstrate, advance and improve implementation • Improve the shared understanding of international dimensions of just transitions • Improve the shared understanding of specific needs by all relevant Working Groups • Develop and improve implementation models drawn from particular cases (projects, programmes and other interventions), with these models being replicable designs that can be aligned to national circumstances and developmental pathways
Capacity building: Technical assistance for implementing international standards	• Initiatives • Action plans	• Members with relevant technical capacity and access to technical resources need to drive standard setting and assessments for key sectors involved in advancing green industrialisation • Reducing barriers to accessing and utilising climate technologies • Sharing resources and skills

G20 roles	Mechanism	Potential application for just transitions
		• Facilitate learning through member-led policy experimentation
Transition partnership: Facilitate partnerships that support implementation	• Initiatives • Action plans • Cooperation frameworks	• Matchmaking between finance actors (e.g. MDBs) and relevant national and/or regional initiatives (e.g. country platforms) or specific industry initiatives (e.g. steel transitions) • Facilitation of discussions between members that integrate international dimensions into domestic and bilateral policy (e.g. trade) focused broadly or targeting specific value chains • Map the incentives of actors designing, implementing and responding to just transitions, facilitating alignment of those incentives where possible and identify relevant mechanisms outside the G20 • Facilitate thematic partnerships to enable technology transfer

4.3 Proposed actions for the G20

The G20 should demonstrate global leadership through cooperation, applying its roles and mechanisms to further develop and operationalise a whole-of-economy, whole-of-society approach to just transitions, continuing to advance international cooperation as an indispensable lever for just transitions. This approach should engage other levers (e.g. finance, technology transfer and development as well as capacity-building, and national policy, such as notably NDCs, NAPs and other adaptation plans, and LT-LEDS) that enable implementation and outcomes, aligned to the principles and provisions of the UNFCCC's Paris Agreement and supportive of global economic stability. In this application, sensitivity to inequality within and between countries must be central so that just transitions raise climate ambition and action (mitigation and adaptation), and enable access to economic opportunities aligned to the SDGs. It is essential that the G20 tackles the nebulous challenges that emerge as countries, regions and the global economy transition, while concurrently driving discrete, feasible, broadly supported projects that represent achievable wins that can strengthen cooperation and demonstrate progress.

Recommended actions are outlined below:

- **Policy coordination:** The G20 should minimise overlap and misalignment of international frameworks and processes, and maximise alignment to maximise synergies within and outside of the G20, taking stock of all existing endeavours, streamlining action, and identifying fundamental gaps and associated interventions. The roles of the ECSWG, ETWG, and SFWG are particularly important in this regard, as they employ mechanisms such as cooperation frameworks.

- **Guidance:** The G20 should guide the integration of principles of equity and fairness in the implementation of climate action within and outside of the G20[28], across domestic and global scales, including sending signals as appropriate to the finance actors (public and private) and private sector actors. It can curate and enable effective utilisation of existing tools and resources, as well as articulate process steps, self-assessment approaches, and guardrails.
- **Knowledge sharing:** The G20 should facilitate the appropriate consolidation of, and access to data, information, knowledge and foresight in support of justice (including equity) into relevant policies and processes at domestic (and subnational) and international levels. It ought to identify and facilitate the sharing of good practices between countries, identify knowledge gaps[29] that can be addressed (directly commissioning research or signalling to knowledge partners), and identify fundamental uncertainties arising from the complexity of transitions, that need to be carefully monitored, or which can be addressed through experimental approaches such as policy implementation labs, living labs, regulatory sandboxes, finance experiments, industry hackathons, pilots, cultural prototypes, or co-creation platforms.
- **Capacity building:** The G20 should address technical capacity and capability challenges across developed and developing countries and partnerships, facilitating technical assistance and advisory support that is demand-driven, and, to the extent possible, reflecting the interests of all members, in line with equity principles. This support must be tailored to specific contexts, enabling action with regard to challenges such as the integration of mitigation, adaptation and resilience through a justice lens. Support can target state and non-state actors.
- **Transition partnerships:** The G20 should enable partnerships oriented toward implementing just transition, and shape and apply just transition levers, focusing on mutual benefits (e.g., improved climate and transition risk management, and complementary access to economic opportunities). This role can encompass convening state and non-state actors, as well as more proactive matchmaking for agreements and deals related to transition implementation. For partnership design, the Framework for transition planning and country platforms should be considered and supplemented as needed (Brazil G20, 2024).
- **Technology transfer partnerships[30]**: The G20 could facilitate engagements to encourage specific partnerships that support technology transfer, aiming to enable the

[28] This integration must also ensure that human rights, labour rights, and decent work frameworks, standards and guardrails are implemented, especially for vulnerable groups.

[29] Examples noted by some members include more detailed analysis of international dimensions such as transboundary impacts of mitigation, adaptation and resilience policies and investments, and the role of systems, networks and rules, such as those pertaining to trade. However, it should be noted that this is not a priority for all members.

[30] The Working Group III contribution to IPCC AR6 proposes “transnational partnerships” to support “technology diffusion” (IPCC, 2022).

scaling up of technologies essential to just transitions to net zero in various regions. Knowledge sharing and guidance activities could be directed at the identification and bolstering of mechanisms for technology transfer (such as country platforms identified by TF-CLIMA (Brazil G20, 2024).

- **Institutional arrangements that support integration:** Appropriate institutional arrangements need to be determined that balance the need to create spaces and structures commensurate with the importance and complexity of operationalising just transitions, with the need to be efficient, taking care to augment the relevant functions and impact of existing structures within the G20. A just transitions initiative[31] is proposed as an action-oriented, flexible vehicle to design such arrangements that produce annual guidance for incoming G20 presidencies. There should also be standing agenda items related to whole-of-economy, whole-of-society just transitions for relevant G20 Working Groups, encouraging multi-year associated action plans as applicable.

While it is essential that the above actions be made more concrete, it is proposed that more specificity should be the outcome of deliberations between parties, with technical inputs provided as needed from knowledge partners and organisations such as MDBs. Facilitating the supplementation of the Principles for Just and Inclusive Energy Transitions[32], to include other economic sectors and social systems, could be a starting point for this work.

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[31] TF-CLIMA demonstrated the value of strategic integration to advance whole-of-economy, whole-of-society climate action, bringing Sherpa and Finance Track actors together within the structure of a temporary Task Force in line with the Brazil G20 Presidency priorities (Brazil G20, 2024). Given that Task Forces are limited to particular presidencies, a more durable and more flexible vehicle for integration could look instead to the the Global Alliance Against Poverty and Hunger to inform its design, noting the Aliiance's role, "as a neutral facilitator, the Alliance builds partnerships and mobilises financial and knowledge resources to implement these policy instruments" (Global Alliance Against Poverty and Hunger, 2025). The Alliance is both focused around a goal and clear objectives, and it is cross-cutting, drawing on different domains such as health and finance. The institutional arrangements for a just transitions initiative should be similarly focused and yet multi-sectoral in its reach. It should also take into account, (a) the particular structure and role of the G20 in relation to the UNFCCC, notably the JTWP, and (b) the function of organisations such as the ILO, IRENA, and International Energy Agency (IEA).

[32] This work would supplement the energy focus on the Principles for Just and Inclusive Energy Transition, as well as the operationalisation thereof in the Blueprint for Action on Just and Inclusive Energy Transitions (International Energy Agency, 2025).

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Identifying and Implementing Effective Air Quality Policies

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[1] *This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.*

EXECUTIVE SUMMARY

Air pollution kills.

It keeps children home from school and stops their parents from going to work.

It reduces supplies of the food we eat and costs the global economy trillions of dollars each year.

And those already among our most vulnerable populations are often hardest hit.

Fortunately, we have proven solutions and investments in clean air have been shown to return benefits many times over in terms of health, food security, and sustainable economic development.

While air pollution is a universal problem, impacting 9 out of 10 people globally, progress in combatting it has not been universal and air pollution levels in some places are twenty times higher than what is considered safe. These disparities must be addressed to ensure the benefit of clean air is felt globally. The South African G20 Presidency, in parallel with other global and regional initiatives, presents an opportunity for G20 members to partner with African nations and the international community to achieve real and sustainable change.

This technical paper was developed to support the Environment and Climate Sustainability Working Group's priority on air quality and is organized as follows:

- ***Section 1** provides a summary of evidence on the impacts of air pollution, the economic returns that come from investing in clean air as an asset, and the global call to action.*
- ***Section 2** identifies four key challenges – the transboundary nature of air pollution, access to monitoring and data, capacity gaps, and funding – and illustrates how these have been successfully addressed in a variety of contexts.*
- ***Section 3** summarizes previous G20 discussions of air quality and work in collaboration with African nations.*
- ***Section 4** offers recommendations for action by G20 members.*

1 INTRODUCTION: A CASE FOR INVESTING IN CLEAN AIR

1.1 Impacts of Air Pollution

Exposure to household and outdoor air pollution kills millions of people each year. The State of Global Air report estimates air pollution caused 8.1 million deaths in 2021 alone, including 709,000 deaths of children under 5 years old. Air pollution is now the second leading risk factor for premature death, ranking behind only high blood pressure for adults and malnutrition for children (HEI, 2024, p. 3). Even when exposure is not fatal, air pollution lowers quality of life by worsening respiratory and cardiovascular conditions, triggering

asthma attacks, and causing people to miss school or work (HEI, 2024). The effects of air pollution can be compounded by other environmental factors, such as extreme heat (Brown and Kelso, 2025).

The impacts of air pollution are not shared equally and are subject to geographic, demographic, and socioeconomic disparities. A recent World Bank report notes "air pollution exacerbates existing socioeconomic inequalities… with disadvantaged groups and low-income populations exposed to higher pollution levels while having fewer resources to mitigate related health impacts" (2025, p. XX). The World Bank's analysis estimates that 95% of deaths attributable to air pollution occur in developing countries and nearly all of the global population exposed to dangerous particulate matter concentrations exceeding 35 $\mu g/m^3$ live in South Asia, East Asia, Sub-Saharan Africa, North Africa, and the Middle East (p. 2, XIX).

Around the world, children, pregnant women, the elderly, and those with pre-existing health conditions are more susceptible to harm (HEI, 2024, p.4). Women and children in low-income households without access to cleaner fuels have higher exposure to household air pollution caused by cooking or heating with solid fuels (WHO, 2024). In 2021, more than 70% of the air pollution linked deaths of children under 5 were attributable to household air pollution (HEI, 2024, p. 21). Studies show that exposure to high levels of air pollution negatively impacts academic performance (Our Common Air Commission, 2024a, p. 10) meaning childhood exposure can potentially have lifelong impacts on academic achievement, employment, and earnings.

While the specific mix of sectors contributing to air pollution may vary from location to location, in general the key sources of human-made air pollution globally are residential fuel use for cooking and heating, power generation, industry, transport, agriculture and waste. Residential sources are the leading contributor to premature death associated with PM2.5 exposure (HEI, 2024, pp. 10 – 11).

The World Bank estimates the economic cost of ambient air pollution at $6 trillion a year – 4.6% of global GDP (2025, pp. 2, 21). This figure rises to at least $8 trillion if the costs of household air pollution are included (World Bank, 2022, p. XIV). Without intervention, these figures are expected to increase alongside growing economic activity, populations, and urbanization (World Bank, 2025, p. 134). In 2016, the OECD estimated 1.2 billion working days were lost annually due to ambient air pollution, a figure projected to rise to 3.7 billion by 2060 (p. 14). Crop yields are also negatively impacted by air pollution, with production of staple crops[2] estimated to be reduced up to 16% by current levels of ground-level ozone (Tai et al., 2021, p. 2). These losses are also not borne equally, with some crops hit harder than others and certain regions expected to experience higher losses (OECD, 2016, p. 70).

[2] Maize, rice, soybean, and wheat

1.2 The Opportunity

While the problem is substantial, it is by no means insurmountable and proven solutions have been successfully implemented in a variety of contexts. There is increasing recognition that clean air is a "societal asset" and investing in cleaner air is an opportunity to invest in improving global health, food security, and economic prosperity (Our Common Air Commission, 2024b, p. 2). The return on these investments can be sizeable – not only for the most obvious outcomes such as lives saved and avoided healthcare costs, but also for increased worker productivity, new jobs building environmental technologies, increased crop yields, improved efficiency of renewable energy sources, and improved educational outcomes (Our Common Air Commission, 2024a).

The World Bank analysed scenarios to achieve a 50% reduction in exposure to PM2.5 globally by 2040, based on technically feasible and locally appropriate interventions in key sectors – cooking, residential heating, agriculture, industrial sources, power generation, transportation, and municipal solid waste. The analysis shows that it is possible to reduce the number of deaths by 28% annually with an economic benefit of $1.9 to $2.4 trillion each year (2025, p. 15). Achieving these benefits will require the annual investment in air quality management increasing from $8.5 billion in 2020 to $13.9 billion in 2040 (p. 76).

While the total costs are high, they are substantially outweighed by the annual benefits. This finding is consistent with other studies of environmental legislation. A report by the U.S. Environmental Protection Agency shows the benefits of the Clean Air Act have outweighed the costs by a factor of 30 to 1 (2011, p. 7-1). Similarly, analysis of the European Union Ambient Air Quality Directive shows cleaner air has contributed to €50 to €60 billion of economic growth each year since 2014 (Mejinó-Lopez and Oliu-Barton, 2024, p. 40).

The World Bank analysis highlights the importance of an integrated approach, both in considering interventions across multiple sectors but also in aligning policies for air quality, climate, and energy to achieve multiple benefits. The World Bank estimates the cost of an integrated approach on air quality and climate is 40% lower than implementing air quality measures in isolation, as reductions in fuel use eliminate the need for some end-of-pipe controls (2025, p. 81). In addition to the opportunity to simultaneously reduce co-emitted air pollution and greenhouse gases through an integrated approach, some air pollutants are themselves short-lived climate pollutants (SLCPs)[3] and reductions will have an impact on near-term climate effects (p. 22).

[3] SLCPs are "super pollutants" that remain in the atmosphere for a much shorter period than carbon dioxide but have a greater warming potential. Certain SLCPs – like black carbon or tropospheric ozone – are also air pollutants that have harmful effects for people, ecosystems, and agricultural productivity.

1.3 The Global Call to Action

There is a clear global call to act on air pollution. In 2022, the UN General Assembly passed a resolution recognizing "the human right to a clean, healthy, and sustainable environment" (p. 1). The General Assembly had previously established the International Day of Clean Air for Blue Skies (2019), to be celebrated on 7 September each year. This followed the 2030 Sustainable Development Agenda, agreed in 2015, which includes targets related to clean air that measure progress toward implementation of three Sustainable Development Goals (SDGs): SDG 3 Good Health & Well-Being, SDG 7 Affordable & Clean Energy, and SDG 11 Sustainable Cities & Communities (UN, no date).

At the first session of the UN Environment Assembly (UNEA), member states adopted Resolution 1/7 to strengthen the role of the UN Environment Programme (UNEP) in promoting air quality (2014). This was followed by Resolution 3/8 calling on member states to take action to prevent and reduce air pollution (UNEA, 2017) and Resolution 6/10 focused on promoting regional cooperation on air pollution (UNEA, 2024). Initiatives specifically identified in Resolution 6/10 that have advanced since its adoption include the Africa Clean Air Programme, the Global Air Quality Cooperation Network, and the Air Quality Management Exchange. These are described in more detail in Section 2 of this report.

The health sector has also joined the call for action, with the 2015 World Health Assembly passing a resolution on addressing the health effects of air pollution. In January 2025, health ministers agreed a roadmap for air quality in 2040, including a target of reducing the premature deaths from air pollution by 50% relative to 2015 levels (WHA Executive Board, 2025, p. 1). This target was supported by commitments announced at the World Health Organization's 2nd Global Conference on Air Pollution and Health (WHO, 2025a) and approved at the World Health Assembly (WHO, 2025b).

Case Study: Beijing's Investment in Clean Air

In the 1990s, rapid industrial expansion and private vehicle ownership began to exert unprecedented pressure on Beijing's air quality. Routine public reporting of pollution levels started during the 1980s and, by 2013, real-time data from a network of 35 automated monitoring stations were accessible to citizens and officials. Global attention ahead of the 2008 Olympic Games, together with the extreme haze episodes of the winter of 2012–13, strengthened the case for decisive action.

In 2013, a five-year action plan was developed targeting the highest emitting sectors and ramping up compliance and enforcement. In addition to action within Beijing, efforts were made to address regional sources through an airshed management approach. The city-led approach formed part of a coordinated approach at regional and national levels has helped to shape national policy on air pollution.

While the investments required have been substantial – the city's air quality management budget increased from $0.43 billion in 2013 to $2.6 billion in 2017 – the benefits have been immense. By 2023, annual average PM2.5 concentrations had fallen by 64% compared to 2013. Economic appraisal suggests that air quality improvements between 2015 and 2018 contributed to avoided health and productivity losses worth CNY 95.6 billion ($13.3 billion). In addition, China is now a leading producer of environmental technologies. The sector accounts for nearly 2% of the country's GDP and employs more than 3.2 million people.

For more details, see Annex 2 *Air Quality Governance Case Studies: Policy Interventions that Deliver Economic and Health Benefits*.

2 CHALLENGES AND SOLUTIONS

Managing air pollution is complex, requiring interventions in multiple sectors with responsibility dispersed across a wide range of actors (e.g., different ministries within government, multiple jurisdictions, and public/private sector institutions). While there is widespread agreement on the impacts of air pollution, a compelling economic argument for addressing them, and a global call to action, there are also challenges that threaten progress. However, proven solutions have been successfully demonstrated. This section focuses on four key challenges – 1) the transboundary nature of air pollution, 2) access to monitoring and data, 3) capacity, and 4) funding – and highlights lessons learned from initiatives that have successfully overcome them.

2.1 Addressing Transboundary Air Pollution through Regional and Global Cooperation

The Challenge: Air pollution doesn't stop at national borders.

What Works:

- Getting high-level political buy-in
- Applying an airshed approach to addressing air pollution
- Developing shared evidence using collaborative approaches to monitoring and modelling
- Acting at all levels of government – sub-national, national, and regional
- Implementing locally-appropriate measures that address multiple pollutants to achieve multiple benefits and "win-win" solutions
- Harmonizing policies and standards across countries within a region
- Building technical capacity between partners
- Creating opportunities to share expertise and experiences

Air pollution can travel great distances and requires collaborative efforts within and between countries to successfully combat it. As of 2021, only 31% of countries had legislation in place to address transboundary air pollution (UNEP, 2021a, p. 9).

Many of the principles of successful cooperation were established in the first international treaty dealing with regional air pollution – the Convention on Long-range and Transboundary Air Pollution (CLRTAP or "the Air Convention"). In 1979, in response to damage from acid rain caused by air pollution traveling across borders, 32 countries signed the Air Convention. Over time, the scope has expanded to also address pollutants affecting human health (UNECE, no date).

Parties to the Air Convention have achieved significant emission reductions at the same time they have been able to decouple economic growth and emissions growth (Sanz Noriega, 2025). The success of the Air Convention in reducing emissions of its target pollutants – some by as much as 86% – can be attributed to several factors:

- The Air Convention is informed by a strong shared scientific foundation and dialogue between scientists and policymakers.
- A collaborative approach to monitoring and modelling advances scientific understanding while building trust between parties.
- A multipollutant approach adopted in the Gothenburg Protocol in 1999 has led to more cost-effective strategies to achieve emission reductions.
- Cooperation between countries has helped build capacity and bring new parties into the Air Convention (UNECE, no date).
- Voluntary agreements have helped to facilitate fast action and progress formal agreement thereafter (Sanz Noriega, 2025).

Subsequent initiatives for regional cooperation have built on these principles with approaches tailored to local circumstances. This section highlights recent examples from Africa and South Asia, but these are only a small sample of the regional efforts currently active. Others from the Arctic, Asia, and Latin America are described in Annex 1.

In 2019, the African Ministerial Conference on the Environment (AMCEN) noted the need for an integrated assessment of air pollution and climate change in Africa (AMCEN decision 17/2). In 2022, the Climate and Clean Air Coalition (CCAC), UNEP, and the African Union Commission (AUC) partnered in a process supported by the Stockholm Environment Institute and involving over 100 African scientists and institutions and over 27 AU member states to produce the Integrated Assessment of Air Pollution and Climate Change for Sustainable Development in Africa.

The Assessment identifies 37 proven measures across 5 sectors – transport, residential, energy, agriculture, and waste – that are expected to achieve substantial reductions in air pollutant and greenhouse gas emissions, prevent 200,000 premature deaths per year by 2030, protect food security by improving crop yields, and align with a 1.5°C global warming pathway alongside regional climate benefits for rainfall and temperature. The proposed measures enable individual countries in the region to pursue their development goals while improving air quality, consistent with the African Union Agenda 2063 – The Africa We Want, as well as the objectives of the African Union Climate Change and Resilient Development Strategy and Action Plan (UNEP, 2022, p. 6).

The Assessment recommended the creation of an Africa Clean Air Programme (ACAP) by the AUC as a collaborative effort between the Assessment partners to implement the recommendations of the report, built around strong country-led initiatives linked to the Regional Economic Communities (RECs) and higher levels of policy. ACAP has received

ministerial support at the national, regional, continental, and global levels. In September 2024, the CCAC Ministerial approved $1 million to kick-start activities related to ACAP and the United Kingdom committed a further £700,000 at the WHO Conference on Air Pollution and Health. These are first steps towards a $20 million goal to deliver the Programme in full.

Five CCAC Champion Countries have been identified for the first phase of implementation of ACAP: Ghana, Kenya, Madagascar, Morocco, and South Africa. The Champion Countries will play a pivotal role in advancing ACAP—leading by example, piloting innovations, and fostering peer learning across the continent. Building on the previous success of regional framework agreements, such as in driving adoption of clean fuel standards (i.e., unleaded and low-sulphur fuels), the RECs will be supported to enable coordination, knowledge-sharing, and sustained implementation of clean air policies across member states. In parallel, regional centres of excellence are proposed to provide technical support and advance implementation at national, subregional, and regional levels. This process will feed into this year's AMCEN and UNEA meetings — both as a platform for reporting back and as a critical opportunity for elevating ACAP and securing broader political and institutional support — making it a key moment to align Africa's clean air ambitions with global aspirations.

In South Asia, 60% of the population is exposed to average PM2.5 concentrations as much as 20 times higher than safe levels (World Bank, 2023, p. XVII). As in other regions, pollution can sometimes travel several hundred kilometres, crossing city, state, and national borders to impact air quality far from the original source (p. XVIII). In response, government representatives from Bangladesh, Bhutan, India, Nepal, and Pakistan have come together, supported by the International Centre for Integrated Mountain Development (ICIMOD) and the World Bank, to agree a collaborative approach to air quality management in the Indo-Gangetic Plain and Himalayan Foothills (IGP-HF) airsheds.

As with CLRTAP and ACAP, this cooperation is built on a foundation of science-based air quality management, multipollutant strategies and building regional capacity for monitoring, modelling, and implementation (ICIMOD, 2023). Recognizing the contribution of sub-national governments to air quality management, the science-policy-finance dialogues include city, state, and provincial representatives in addition to those from national ministries. The IGP-HF airshed cooperation also highlights the importance of a collective aspiration to drive action. This cooperation seeks to advance progress toward the region's "35 by 35" goal to bring average PM2.5 concentrations below 35 µg/m3 by 2035, in line with the first WHO interim target (ICIMOD, 2024).

To connect the many national and regional efforts on air quality, UNEA Resolution 6/10 requested UNEP to "form and facilitate a cooperation network on air quality" (2024). The goal of the Global Air Quality Cooperation Network is to empower governments at different levels to reduce air pollution through enhancing air quality management capacities, increasing the

uptake of solutions to reduce air pollution from high-impact sectors, and improving access to finance, funding, and other forms of support.

Following a formal expression of interest process, a total of 70 Member States nominated focal points to engage in the Network, alongside representatives from regional cooperation initiatives, UN entities, and other organizations. UNEP convened the first meeting of the Network on the margins of the WHO's Global Conference on Air Pollution and Health.

Case Study: Regional Cooperation to Address Transboundary Haze
Following severe land and forest fires in 1997-98, the Association of Southeast Asian Nations (ASEAN) Member States signed the ASEAN Agreement on Transboundary Haze Pollution in 2002. This agreement aims to prevent, monitor, and mitigate land and forest fires to control transboundary haze pollution through concerted national, regional, and international efforts. The 2016 Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation serves as a strategic framework to mobilize resources, strengthen legal and policy frameworks at all levels, enhance cross-sectoral cooperation and coordination, and increase public awareness and engagement. The roadmap outlined collaborative actions ranging from sustainable peatland management to fire prevention, aimed at reducing associated health and environmental risks. The Agreement has led to increased information and data sharing between countries, and the Roadmap has been instrumental in enhancing cooperation and progress toward policies and practices that reduce burning. A second Roadmap adopted in 2023 includes targets for achieving significant and sustained reductions in haze episodes and attainment of the World Health Organization's third interim target for PM2.5 of 15 µg/m^3 by 2030. For more details, see Annex 2 *Air Quality Governance Case Studies: Policy Interventions that Deliver Economic and Health Benefits*.

2.2 Expanding Access to Monitoring and Air Quality Data

The Challenge: Many countries lack access to reliable air quality monitoring and other data.

What Works:

- Applying a range of available tools
- Focusing on incremental improvements – even one data point can make a difference
- Making air quality data publicly available
- Collaborating with locally influential organizations, including the health and academic sectors
- Ensuring long-term sustainability of monitoring programmes by investing in staff, supplies, and maintenance of equipment
- Acting now on known sources of pollution

Data is an important input for the design, delivery, and enforcement of air quality policies. However, many countries still lack access to reliable air quality data. This can lead to organizational paralysis, where policy makers know there is a problem but believe they cannot act until sufficient information is gathered. Analysis shows 31% of countries have the

legal authority to introduce ambient air quality standards but have not yet done so (UNEP, 2021a, p. 7).

Monitoring air quality can be a complex and costly undertaking, and there are large disparities in capacity worldwide. Globally, 39% of countries have no public air quality monitoring in place (EPIC, 2024, p. 2) and 37% of countries have no legal requirement to monitor air quality (UNEP, 2021a, p. 8). The air quality data gap is especially notable in Africa, where 17 of the 25 countries without a single government-run PM2.5 monitor are located and fewer than 7 percent of countries provide fully open air pollution data (EPIC, 2024, pp. 2, 5).

Methods for monitoring ambient air pollution include a range of different tools and equipment, each with their own advantages and limitations summarized in Table 1 (WHO, 2023; WMO 2025). Most air quality monitoring networks use a combination of these tools, and different tools are appropriate for different purposes. The network operated by Airparif for the Greater Paris region provides an example of an extensive and robust network comprising more than 50 reference measurement stations, supplemented by passive diffusion tubes, low-cost sensors, and satellite data. The data produced is freely accessible, and is readily usable by academics for research projects, local authorities to support air quality improvement policies, and the general public for information on day-to-day exposure (Airparif, 2024).

Table 1: Comparison of Monitoring Tools

Methods	Advantages	Limitations
Reference-grade monitoring stations	• High accuracy of data • High temporal resolution • Long lifespan	• High cost • Complex maintenance and calibration • Reliant on a limited number of instruments • Requires access to calibration standards
Low-cost sensors	• Low cost • Portable • High temporal resolution	• Low accuracy of data • Short lifespan
Passive diffusion tubes	• Low cost • Good accuracy of data • No power requirement	• Low temporal resolution • Require access to a laboratory for sample analysis
Remote sensing (satellite measurements)	• Open access • Wide spatial coverage	• Low temporal resolution • Moderate spatial resolution • No data in case of cloud coverage • Satellite measurement outputs generally require modelling to be translated into local concentrations
Air quality models	• Adjustable spatial and temporal coverage	• Requires trained personnel, computing facilities and validation of model output

While the prospect of developing a network on the scale and complexity of the one in Paris is unachievable in most contexts, it is critical to remember that substantial progress can be made with much more modest resources. It has been shown that, in data-scarce environments, even a single point of data can lead to change. One of the important aspects of the Paris network – open access to data by the public – can be replicated on any network regardless of size.

Studies have found that in countries with very little, or even no, publicly available air quality data, setting up a single reference grade PM2.5 monitor and sharing that data with the public can bring tremendous benefits by sparking public demand for clean air and providing decision-makers with a baseline for action. PM2.5 sensors installed at US embassies in more than 50 countries, for which real-time data was made available to the public, helped catalyse measurable reductions in air pollution resulting in health benefits in the cities covered (Jha and La Nauze, 2022).

The Energy Policy Institute at the University of Chicago (EPIC) has identified 10 high priority countries – of which 8 are in Africa – where a relatively small investment in air quality monitoring could bring national-level impacts by closing air quality data gaps (EPIC, 2024). For instance, in The Gambia, a single reference-grade monitor for PM2.5 deployed by the Permian Health Lung Institute and complemented by a network of low-cost sensors led to collaboration with the National Environment Agency and Ministry of Health on public messaging and recommendations to reduce exposure to air pollution. The data from this monitoring network will also support incorporation of air pollution into national strategic planning and policy making (EPIC, No Date). Air quality managers should also consider how publicly available satellite data can be used to supplement limited ground-level monitoring (Vital Strategies, No Date).

Equipment alone is insufficient for a sustainable monitoring network. EPIC highlights the importance of adequate staffing, supplies, maintenance, power, security, and IT infrastructure alongside the need for a multi-year investment to ensure time for the system to be set up and generate actionable data (2024, p. 21). Countries also require the capacity to analyse the data collected in order to meaningfully act on it.

Critically, a lack of comprehensive data cannot be a barrier to action. For countries in the early stages of air quality management, general knowledge on air pollution sources and impacts is enough to take action and a wide variety of effective proven solutions have been implemented (World Bank, 2025). In the absence of air quality monitoring data and source apportionment studies, activity-based emission inventories can be developed to arrive at initial estimates of relative source contributions.

In many contexts, priority policy interventions are clear, even in the absence of data (e.g., regulating fuel quality, banning the open burning of waste, and providing clean cooking fuels and technologies). There are a number of resources available which extensively detail successful sectoral interventions in multiple contexts. Examples include the World Bank's

Accelerating Access to Clean Air for a Liveable Planet report (2025), sector-specific documentation in the Air Quality Management Exchange[4], and the forthcoming benchmarking report for ACAP.

Case Study: Sectoral Interventions to Improve Air Quality in Mexico City

The Mexico City Metropolitan Area (MCMA) – surrounded by mountains that trap pollutants – was singled out by the United Nations in 1992 as one of the world's most polluted urban centres. Mexico's national government and the MCMA were pragmatic in acting quickly to address key sources of pollution – notably transport – even as they worked to improve the data on the situation.

To address high levels of pollution associated with transport, the Cars Don't Circulate (Hoy No Circula) programme placed limits on the days on which cars could be operated based on their license plate numbers. Other initiatives included expansion of the metro system, stricter vehicle emission and inspection standards, and the introduction of unleaded petrol. Mexico City has also run a pilot diesel particulate filter (DPF) retrofit programme for buses since 2015. In parallel, programmes were also implemented in the MCMA to better understand the sources of air pollution, and to measure and monitor air pollution levels. This improved understanding facilitated additional mitigation measures.

For more details, see Annex 2 *Air Quality Governance Case Studies: Policy Interventions that Deliver Economic and Health Benefits*.

2.3 Building Capacity to Fight Air Pollution

The Challenge: Limited technical capacity or human resources can hinder progress.

What Works:

- Sharing best practices, tools, data, and expertise
- Ensuring implementation is someone's job by funding posts with the specific remit to advance policy priorities
- Creating partnerships with a well-defined common goal
- Drawing on expertise from all relevant stakeholders, including government, NGOs, IGOs, and the private sector
- Working across all jurisdictions of government to drive action

The political will to act on air pollution is a necessary condition for addressing it, but political will must be backed by sufficient human resources and technical expertise to implement policy priorities. Capacity gaps have been identified as a barrier to monitoring, analysis, development, and enforcement of environmental policy (UNEP, 2021b).

UNEA Resolution 6/10 directed the development of an online platform to facilitate open access to the extensive library of resources that already exists on air quality management (2024). The Air Quality Management Exchange (AQMx) is an online knowledge platform launched by the CCAC and its partners on International Clean Air Day 2024, responding to this mandate.

[4] www.AQMx.org

AQMx aims to be a "one stop shop" for technical tools and models, data, and knowledge to build capacity among air quality managers worldwide. It is designed to provide guidance and resources to support governments, implementers, and stakeholders on the path to meeting interim targets identified in the WHO Air Quality Guidelines.

The AQMx platform includes two key components:

- Curated Guidance for 8 areas of air quality management: Air Quality Monitoring; Emissions Inventory; Source Attribution; Health Impact Assessment; Sustainable Development Benefits Assessment; Decision Support; Public Engagement and Communications; and Legal Framework, Policy Design, and Implementation.
- Resource Exchange Library: more than 900 trusted resources and knowledge products on air quality management.

More advanced curated guidance is planned for release along with sectoral guidance that will provide further information on sector-specific interventions. Feedback from users has highlighted the utility of AQMx, particularly in providing a benchmark for best practices and ideas for long-term planning.

Even with the best intentions and access to technical resources, governments can still face the challenge of simply not having enough capable staff to take on new policy initiatives. One of the factors that has contributed to the widely acknowledged success of the Montreal Protocol on Substances that Deplete the Ozone Layer has been the establishment of National Ozone Units (NOUs) in developing countries. NOUs are supported by the Montreal Protocol Multilateral Fund and staffed with local officers who are responsible for managing compliance with the Montreal Protocol. This includes coordinating between ministries, developing policy, collecting and reporting data, implementing projects, engaging with industry, and raising public awareness (UNEP, 2025). These officers have opportunities to engage with peers through regional networks where they can share experiences (Rae, 2012). CCAC has followed a similar model recruiting local experts to build capacity in partner governments to integrate SLCPs into national policy and has found that sustained funding support for national consultants has created long-term ambition and capacity within governments.

Partnerships between governments, civil society, universities, private sector, and international organizations can also help bring together the technical expertise required to drive transformative change. The Partnership for Clean Fuels and Vehicles (PCFV) has been one notable example, assembling 73 organizations representing developed and developing countries, the fuel and vehicle industries, civil society, and leading world experts to provide technical, financial, and networking support. Initiated in 2002, the PCFV helped to facilitate the elimination of lead in gasoline globally by 2021 – and after only a few years in Sub-Saharan Africa. PCFV has supported a "systems approach" to advance complementary adoption of cleaner fuel and vehicle standards, working with sub-regions to harmonize standards where there is cross-border movement of fuel and vehicles (UNEP, 2014). Several

factors that have contributed to the success of the initiative include: 1) a design well-focused on the stated objectives, 2) a partnership representing all key stakeholders from whom action is required and 3) an approach tailored to the available finance (UNEP, 2010, pp. 2-3).

The CCAC Sector Hubs are communities of practice to build capacity to drive mitigation of SLCPs from the agriculture, waste, fossil fuel, household energy, and heavy-duty vehicles and engines sectors. Membership includes governments, non-governmental organizations, intergovernmental organizations, and private sector entities. Through the work of the Sector Hubs, the CCAC has 117 specific projects under implementation in support of more than 65 countries focused on capacity building; enhanced emissions reductions commitments; sector plans, policy, and regulatory development; integrated monitoring, reporting, and verification; and, increasingly, investment and financial plans.

The benefit of collaboration to build capacity is not limited to mitigating emissions from specific sectors. UNEP's Montevideo Environmental Law Programme aims to support the development and implementation of effective legislation and legal frameworks to address environmental issues such as air pollution. The Programme provides tools and capacity building, facilitates information exchange between legal practitioners, supports awareness raising, and promotes training in the field of environmental law (UNEP, 2020).

Furthermore, specialized agencies can play a key role in supporting capacity development actions across regions. The World Meteorological Organization (WMO) has led a series of comprehensive courses on air quality prediction and forecasting for African applications. Training sessions organized in several African countries since 2019 have built and strengthened local capacity on air quality prediction and forecasting and promote the use of available data products when local infrastructure is lacking. WMO is also conducting training for the instrument operators who help support air quality observations in developing countries. Several WMO member countries support calibration facilities, organize instrument comparisons and station audits and support station twinning (WMO 2025).

Sub-national governments have an important role to play in combatting air pollution both through the implementation and enforcement of national policy as well as the development of ambitious local initiatives. Breathe Cities is a partnership that seeks to build local government capacity for action on air quality through expanding access to data, raising public awareness, providing technical assistance for policymaking, and facilitating a network through which cities can share their experiences (Breathe Cities, 2025).

Case Study: Increasing Capacity for Air Quality Management in Greater Johannesburg

South Africa's Constitution guarantees "an environment that is not harmful to health or well-being" through legislative and institutional frameworks for cleaner air. Progress has been made in the country's approach to air quality management over the last decades as evidenced by the progress in a range of policy and technical achievements.

The Gauteng Province, made up of the three metropolitan municipalities of Johannesburg, Ekurhuleni, and Tshwane (JET), is the economic hub of South Africa. Residential fuel burning, waste, transport, and industry are key sources in the region, with emissions from power generation and mining from outside the region contributing to air pollution in the JET. In response to the challenges of air pollution across the three metropolitan areas, the government is working on a regional approach to manage air quality. The region is under consideration to be recognised as air pollution priority areas, which would be required to the establish measurable multisectoral emission reduction action programs as well as monitoring evaluation mechanisms to assess implementation of interventions.

This regional approach prioritises activities that have been central to many progressive air quality management approaches internationally including undertaking participatory methods for engaging with stakeholders, improving understanding of the health and other co-benefits of clean air and low carbon policies, implementing sustainable policies and interventions that can have the greatest potential to reduce exposure to air pollution taking into account social equity, continuing to build capacity and capability, promoting knowledge exchange both nationally and internationally, and engaging civil society on the awareness and outreach initiatives.

For more details, see Annex 2 *Air Quality Governance Case Studies: Policy Interventions that Deliver Economic and Health Benefits*.

2.4 Funding to Scale-up Solutions

The Challenge: There is insufficient funding for air quality projects and the funding available does not reach those who need it most.

What Works:

- Making use of existing funding sources where air quality can be integrated into projects
- Reducing barriers to access, including for sub-national authorities
- Repurposing subsidies for polluting sectors
- Demonstrating the multiple benefits of projects outweigh the costs
- Incentivizing private sector investment
- Mobilizing the philanthropic sector
- Recognizing that improvements in air quality require long-term investment

Currently, funding for air quality projects is not sufficient, making up only 1% of global development aid (CAF and CPI, 2024, p. 4). Further, many of the most polluted countries receive only a tiny share of what is available (p. 21). Low proportions of concessional finance (i.e., grants and low- or no-interest loans) available for air quality projects means that developing countries already struggling to service sovereign debt may not have the capacity to take on additional lending (p. 24).

More funding must be directed to air quality. However, recognizing that national budgets are not infinite, even in the best of circumstances, ensuring sufficient funding for air quality will require a combination of new investment from all possible sources, including collaborative projects between multiple finance or funding entities, alongside initiatives targeted at making more efficient use of existing resources and reducing barriers to accessing funding.

Because projects can have multiple benefits (e.g., air quality and climate), one part of the solution is ensuring air quality benefits are integrated into existing funding opportunities, such as climate financing and global programmes such as the Global Environment Facility. Recent guidance targeting Development Finance Institutions (DFIs), multilateral and bilateral funders, and the banking sector seeks to build capacity among institutions that fund or finance actions to reduce air pollution. The Air Quality Toolkit for DFIs provides information on the impacts of air pollution as well as a step-by-step guide for integrating air quality into projects, including by considering air quality benefits in assessment criteria (ADB, CAF and IADB, 2025). The toolkit also includes several case studies to illustrate to project officers how the principles described can be applied (pp. 63-65). A UNEP Finance Initiative guide similarly provides a roadmap for banks as they "navigate" the subject of pollution (2024).

Project design and business case development are specialized skills, and investment in support for project preparation can help address a key barrier for countries accessing funding. Our Common Air highlighted two Global Environment Facility-funded schemes as an example of how capacity building and project-design support could be successfully combined. For the Global Platform on Sustainable Cities (GEF-6) and UrbanShift (GEF-7), grant funding was provided to cities to engage technical expertise on sustainable planning while the GEF Secretariat worked closely with multilateral development banks and the cities to assist in identifying and preparing projects for funding (2024c, p. 20).

Governments also have an opportunity to consider how existing budgets might be deployed to meet air quality goals. In 2009, G20 leaders committed to, on a voluntary basis, increasing funds available for renewable energy and to "phase out and rationalize over the medium term inefficient fossil fuel subsidies" (G20, 2009, p. 3). This commitment is consistent with recommendations from recent reports highlighting the opportunity to redirect subsidies from polluting sectors to incentivize uptake of air quality solutions (CAF and CPI, 2024; World Bank, 2025).

Where new funding is needed, governments and DFIs need not be the only sources. There is an opportunity to leverage private sector investment in support of air quality projects where there is potential for a direct financial return. Perceived risk is a barrier for investment, particularly in developing countries where investors often overestimate the risk of default (Blended Finance Task Force, 2023, p. 4). Guarantees facilitate financing by minimizing the potential loss to the investor and have been shown to mobilize more capital per dollar of investment than either loans or credit lines (p.6). The Bangladesh Environmental Sustainability and Transformation (BEST) project has deployed a $170 million Green Credit

Guarantee Fund to successfully encourage private sector investment in air pollution control projects (World Bank, 2025, p. 89). In April 2024, the World Bank's Multilateral Investment Guarantee Agency (MIGA) pledged $1 billion in guarantees to de-risk air quality projects in low- and middle-income countries (CAF and CPI, 2024, p. 18). Emissions inventory guidance can also support private sector companies in understanding how to reduce their own contribution to air pollution (SEI and CCAC, 2022).

The philanthropic sector provides another opportunity to expand the base of funding available for air quality projects. While philanthropic support for air quality has increased by a factor of four in the past 10 years, it remains only 0.1% of funding from the sector and, as with broader air quality funding, is not reaching the countries with the highest need. There remains an opportunity to facilitate additional funding whether by creating new programs, building air quality into existing grants, scaling up proven solutions, or working collaboratively with other organizations, including governments, DFIs and the private sector (CAF, 2024, p. 4).

Case Study: Bridging the Finance Gap in Bangladesh
Rapid growth led Bangladesh to experience high levels of air pollution linked to emissions from industry, construction, and road transport. Bangladesh put in place the legal, policy and institutional frameworks needed for cleaner air, but financing remained a bottleneck. To help bridge this gap, Bangladesh partnered with the World Bank on the Bangladesh Environmental Sustainability and Transformation (BEST) project to further build its environmental management capacity and deploy strategies to increase private sector investment in green initiatives. Along with deployment of the $170 million Green Credit Guarantee Fund, the project included a pilot Green Credit Guarantee Scheme which offered partial credit guarantees to financial institutions investing in green solutions in polluting sectors paired with matching grants and capacity building for both financial institutions and high emitting sectors. For more details, see Annex 2 *Air Quality Governance Case Studies: Policy Interventions that Deliver Economic and Health Benefits*.

3 PAST G20 DISCUSSIONS

3.1 Air Quality

Despite air quality being regularly noted as a co-benefit of other policies, the G20 has not made a clear commitment to work toward cleaner air.

The first G20 Summit was held in 2008 under the cloud of a global financial crisis with a targeted focus on financial markets and the world economy. The resulting declaration acknowledged the importance of other global issues noting the G20 remained "committed to addressing other critical challenges such as energy security and climate change, food security, the rule of law, and the fight against terrorism, poverty and disease" (2008, p. 4).

Since 2009, clean air has been referenced in approximately three dozen working group papers, statements or other documents, typically as a co-benefit of other policies –

particularly those related to energy transitions, greenhouse gas reductions, or health.[5] The Osaka Leaders Declaration also mentions air quality, but as one item in a long list of "pressing global challenges" to be addressed urgently alongside climate change, fresh water, marine plastic litter, biodiversity loss, sustainable production, and others (2019, p. 9).

3.2 Partnership with Africa

In 2023, the G20 welcomed the African Union as a permanent member, strengthening the voice of the Continent in the forum (p. 28).

Under the 2017 German presidency, the G20 launched the G20 Africa Partnership, to support "private investment, sustainable infrastructure and employment in African countries" (p. 1). The Partnership was organized around three pillars: 1) improving inclusive economic growth, 2) developing quality infrastructure (especially in the energy sector) and 3) creating an enabling environment for private finance through the Compact with Africa (pp. 1-2).

The G20 Africa Partnership cites the G20 Energy Access Plan to support voluntary collaboration on access to sustainable energy (G20 Energy Sustainability Working Group, 2015, p. 1). The plan identifies key opportunities for the G20 to partner with Sub-Saharan African countries to advance access to energy through collaboration on: 1) policy and regulation; 2) development, deployment and scale-up of innovative technology; 3) investment and finance; 4) capacity building; 5) regional integration; and 6) coordination (pp. 3-12).

Both the Compact with Africa and Energy Access Plan could be considered as vehicles to advance work in the battle against air pollution.

4 G20 CONSIDERATIONS AND RECOMMENDATIONS

There will be no better opportunity for the G20 to make its first statement directly acknowledging the global impact of air pollution and adding its collective voice to the call for action. As representatives of the premier forum for international economic cooperation, the G20 Leaders are perfectly positioned to make a powerful statement in which they:

- Acknowledge the urgent opportunity to invest in clean air, both indoors and outdoors, as a means to protect public health, improve food security, and increase economic prosperity;
- Note the multi-sectoral global call to act on air pollution demonstrated by resolutions endorsed in the UN General Assembly, UN Environment Assembly, and World Health Assembly and reiterate national commitments made in those fora;

[5] See (G20 Development Working Group, 2012), (G20 Climate Finance Study Group, 2016), (G20 Energy and Environment Ministers, 2019), (G20 Energy Transition Working Group and G20 Climate and Sustainability Working Group, 2021), (G20 Energy and Climate Ministers, 2023), and (G20 Health Ministers, 2024) as examples.

- Recognize the progress that has already been undertaken through national and sub-national actions, regional cooperation, and collaborative efforts to build capacity;
- Join with the South African Presidency, the African Union Commission, and partners in promoting the Africa Clean Air Programme and other similar initiatives, noting the opportunity for best practices from their development and implementation to be shared between regions; and
- Commit to identifying, as appropriate to national circumstances, opportunities to share expertise or contribute resources to support progress toward improvements in household and ambient air quality, in Africa and around the world.

This report identified four key challenges in the fight for clean air: the transboundary nature of air pollution; lack of access to monitoring and data; insufficient capacity; and low levels of funding. In addition to a political statement, there is an opportunity for all G20 members to take concrete action to address these challenges through actions appropriate to their national circumstances.

G20 members can collectively and individually support action on transboundary air pollution by promoting airshed based air quality management approaches where pollution crosses multiple jurisdictions, joining and engaging constructively in regional initiatives, and advocating for application of the best practices identified for such fora.

There is an urgent need to increase funding for air quality projects and improve access to the funding that is available. A commitment from G20 members to increasing the proportion of concessional funding for air quality (i.e., grants and no- or low-interest loans), targeting funding to countries that have historically been underfunded, and reducing barriers to access through project preparation facilities are important steps toward ensuring funds are reaching the locations with the greatest need. Opportunities to leverage existing sources of funding (e.g., climate finance) should be considered where a project will achieve multiple benefits.

In parallel, collaboration with DFIs, the private sector, and philanthropic organizations to support projects through blended financial instruments (e.g., a mix of grant funding and guarantees) presents a clear opportunity to maximize the impact of funding streams. There is also an opportunity to reaffirm the G20's 2009 commitment to "phase out and rationalize over the medium-term inefficient fossil fuel subsidies" and, on a voluntary basis, redirect those toward investments in improving household and ambient air quality (G20 2009, p. 3).

There is a particular need for investment in monitoring networks as well as building the technical capacity to operate them. Noting the demonstrated impact of a single point of data, a commitment from G20 members to work toward a world in which every country has at least one reference grade monitor publicly sharing data, with local staff trained to operate and maintain the equipment, could have transformative results. The work by the Energy Policy Institute at the University of Chicago could form a starting point for this effort,

complemented through other local and global expertise, identifying both priority countries for intervention and principles for funding successful projects.

Investments of time and expertise are as important as financial investments and contribute to building sustainable local capacity. National research institutions and development agencies already working in different regions could be called upon to support efforts to improve air quality. Recognizing the proven benefit of scientific and technical cooperation, it is recommended that a series of mutually beneficial technical exchanges between experts from G20 members, African nations, and other developing countries be organized on topics including:

- Monitoring and analytical techniques, including harmonizing data to ensure comparability
- Mitigation strategies and implementation of measures to achieve multiple benefits in key sectors, including household, transportation, energy generation and industry, agriculture, and waste management
- Enforcement and compliance
- Public and political communication, including making the economic case for action

It is envisioned that these exchanges be framed as working sessions where experts from participating countries collaborate to identify solutions to common challenges rather than simply making presentations on work in individual countries or regions.

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ANNEX 1: ADDITIONAL EXAMPLES OF REGIONAL AGREEMENTS AND COOPERATION

1 ARCTIC COUNCIL - 2017 FAIRBANKS DECLARATION

The Arctic Council addresses air pollution and climate change impacts in the Arctic through initiatives such as its Framework for Action on Black Carbon and Methane adopted in the Council's 2017 Fairbanks Ministerial Declaration, where Arctic states committed to a collective goal for reducing their black carbon emissions. Supported by its Arctic Monitoring Assessment Programme (AMAP) Working Group and Expert Group on Black Carbon and Methane (EGBCM), the Council conducts scientific assessments, monitors pollutants, and develops policy recommendations on air pollution and climate change issues. AMAP assessment results feed into international processes including work under the Intergovernmental Panel on Climate Change, UNECE Air Convention, UNEP and WHO. The Arctic Council promotes collaboration among member states, Indigenous Peoples' Organizations, and observers to tackle transboundary pollution and implement mitigation strategies, including cleaner energy and sustainable transport solutions. By combining scientific research with practical policies, the Arctic Council contributes to protecting the Arctic environment and supporting global air quality and climate goals.

2 ASIA PACIFIC CLEAN AIR PARTNERSHIP

The Asia Pacific Clean Air Partnership (APCAP) was launched by UNEP and partners following UNEA resolutions 1/7 and 3/8. The APCAP Joint Forum has become an important venue for partners to share knowledge regarding air quality management and to promote regional approaches to shared challenges. A science panel established under APCAP, alongside CCAC and UNEP, supported development of the report Air Pollution in Asia and the Pacific: Science-based Solutions which identified 25 clean air measures to benefit human health, crop yields, climate change and socio-economic development (UNEP 2018). In addition, APCAP has provided support and capacity building to members and has supported the launch of the United Nations Economic and Social Commission for Asia and the Pacific's Regional Action Programme on Air Pollution.

3 EANET

The Acid Deposition Monitoring Network in East Asia (EANET) was established in 2001. This initiative, born out of intergovernmental cooperation, aims to create a common understanding of acid deposition problems in East Asia, and support decision making to combat acid deposition. Over the years, EANET's scope has expanded to address wider air pollution issues, leading to the establishment of the EANET Project Fund. It is the only network in East Asia monitoring both acid deposition and air pollution, therefore producing high-quality open data, providing knowledge-sharing, capacity-building, and public awareness to government officials, researchers, and the public. Through shared research and understanding, participating countries contribute to informed decision-making and cooperation in the region.

4 LAC INTERGOVERNMENTAL NETWORK ON AIR POLLUTION

The Intergovernmental Network on Atmospheric Pollution for Latin America and Caribbean (LAC) was established in 2008 under the framework of the LAC Forum of Ministers of Environment. The Network is comprised of the heads of Air Quality Units in LAC countries and other key stakeholders. Through implementing activities guided by Regional Air Quality Action Plans (currently 2022-2025), the Network has enhanced capacity to mitigate air pollution, including through monitoring, solid waste management, cleaner production and energy efficiency in industry and sustainable transport.

5 MALE DECLARATION

The Malé Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia emerged in 1998 as the first regional agreement on air pollution in South Asia. This pioneering declaration has prompted collaborative efforts among countries like the Maldives, Bangladesh, Bhutan, India, Pakistan, Sri Lanka and Nepal to develop emission inventories, monitor air pollutants, and assess the impacts on various sectors. The declaration's revival in recent years underscores the region's commitment to addressing air pollution as a communal, regional problem. South Asian countries reinforced their desire for the Malé Declaration to be revived at the last South Asia Cooperative Environment Programme (SACEP) Governing Council in June 2024.

6 WEST ASIA AIR QUALITY NETWORK

West Asian countries met in 2023 and recommended the establishment of a West Asia Air Quality Network to enhance regional coordination and cohesion on air quality management issues. To date, a regional cooperation framework and 2025-2026 work plan has been developed based on a consultation meeting and regional assessment.

ANNEX 2: AIR QUALITY GOVERNANCE CASE STUDIES: POLICY INTERVENTIONS THAT DELIVER ECONOMIC AND HEALTH BENEFITS

1 INTRODUCTION

South Africa's G20 Presidency has placed **Priority 5 – Air Quality** at the centre of the agenda for the G20 Environment and Climate Sustainability Working Group (ECSWG). Delegates will consider how cleaner air can deliver rapid health, climate and economic dividends in line with the ECSWG Work Programme's call for "measures aimed at reducing air pollution" and for sharing countries' experiences and investment opportunities in this field.

This annex distils international experience into a set of illustrative case studies drawn largely from G20 economies to provide further context to the information presented in the technical paper.

The examples are organised around three complementary domains of effective action:

- National policy, regulation and programmes that drive sustained air quality improvements.
- Innovative and blended financing models that unlock public-private investment for clean air.
- Regional or airshed-wide cooperation that tackles transboundary pollution collectively.

Across these domains, the paper draws out common enabling factors - strong governance, transparent data, multisectoral coordination and strategic mobilisation of finance - and summarises transferable lessons for ECSWG members.

The case studies are illustrative, not exhaustive. Many other G20 and non-G20 jurisdictions are achieving impressive clean air gains; their absence here should not be read as a judgement on the quality of their efforts. The intention is to spark discussion, highlight actionable precedents and encourage delegates to share additional examples and insights during the meeting.

2 EFFECTIVE NATIONAL ACTION

2.1 Mexico City: Tackling Air Pollution Through Pragmatic, Integrated Government Action

During the 1980s and 1990s, Mexico's rapid economic growth brought a sharp rise in transport- and industry-related emissions. The Mexico City Metropolitan Area (MCMA) – hemmed in by surrounding mountains that trap pollutants – was singled out by the United Nations in 1992 as one of the world's most polluted urban centres. Two factors accelerated public concern. First, the Automatic Atmospheric Monitoring Network (RAMA), became operational in 1986, delivering hourly data that revealed routine breaches of World Health Organization (WHO) guidelines. Second, NGOs used this evidence to highlight health risks, mobilising residents to demand decisive government intervention.

2.1.1 Policy and Programme Response

The federal response began with the 1988 General Law of Ecological Balance and Environmental Protection (LGEEPA), which required each state to prepare air-quality plans and empowered federal agencies to run emission-reduction programmes. In the MCMA, this mandate translated into the Comprehensive Programme Against Air Pollution (PICCA) in 1990 and, five years later, the first Management Programmes to Improve Air Quality (PROAIRE), formally adopted in 1996. Early measures concentrated on transport: the "Hoy No Circula" scheme kept cars with specified licence-plate numbers off the roads one weekday each week; unleaded petrol was introduced; in 1991 and mandated in 1997 (followed more recently by ultra-low sulphur gasoline in 2016); metro capacity was expanded; and progressively stricter vehicle-emission limits were issued.

These actions were underpinned by continuous source-apportionment studies and enhanced monitoring, enabling policies such as relocating high-emitting industries (for example, the oil refinery, Refinería 18 de Marzo, in 1991) and upgrading public-transport fuels to be fine-tuned over time (Molina & Molina, 2006; Molina et al., 2010; Molina et al., 2019). Consistency of purpose was reinforced in 2017 when the environment ministry published the Estrategia Nacional de Calidad del Aire (ENCA), Visión 2017-2030, the first national framework to align local PROAIRE plans and sectoral regulations with a goal of meeting WHO standards nationwide by 2030.

Complementing statutory action, a voluntary industrial audit scheme enrolled twenty-seven plants and, according to C40, cut PM2.5 and NOx by about 1 per cent and 0.02 per cent respectively. In the transport sector the city introduced onboard diagnostic emissions testing, piloted diesel particulate filter retrofits for buses from 2015 and committed to renewing its bus fleet with soot-free Euro VI/EPA technologies. This has been coupled with a focus on public transport in the last 10 years, leading to about 80% of trips in the MCMA being made by public transport.

The results have been striking. Between 1990 and 2018, ambient concentrations of lead, sulphur dioxide and carbon monoxide fell below current Mexican standards, while levels of PM2.5, PM10 and ozone declined markedly, even though they still exceed the limits that apply today (Molina et al., 2019; C40, 2022). A 2016 study by Gutierrez-Avila, Dockery & Cifuentes concluded that this prevented about 22,500 premature deaths between 1990 and 2015.

Enabling Factors	Details
Focus on quick wins	*Hoy No Circula* delivered immediate behavioural change even as monitoring networks were still expanding.
Integrated multilevel governance	National legislation (LGEEPA) and the ENCA provided a federal backbone; successive PROAIRE plans coordinated city- and state-level investments in transport, fuels and industry.
Voluntary industrial compliance	A multi-tier audit programme covered 27 industries, yielding measurable reductions in PM2.5 and NOx.
Technological upgrades	Strict inspection and maintenance with OBD testing, cleaner fuels, diesel particulate filter pilots and a commitment to soot-free Euro VI/EPA buses modernised the vehicle fleet.

2.2 Beijing, China: Innovative City-Led Action on National Air Quality Policy

In the 1990s, rapid industrial expansion and soaring private vehicle ownership began to exert unprecedented pressure on Beijing's air quality. Routine public reporting of pollution levels started during the 1980s and, by 2013, real-time data from a network of 35 automated monitoring stations were accessible to citizens and officials, providing high-resolution insight into urban conditions (Chen et al., 2015). Global attention ahead of the 2008 Olympic Games, together with the extreme haze episodes of the winter of 2012-13, strengthened the case for decisive action.

2.2.1 Beijing's Policy Approach

In response, the municipality adopted the Clean Air- Action Plan 2013-2017, raising annual expenditure on air quality measures from US $0.4 billion in 2013 to US $2.6 billion in 2017 (Zhao et al., 2022).

The city used targeted municipal measures that later became national models to tackle air pollution at its source:

- **Coal to clean energy** – The government switched from coal for heating and power to gas or electricity between 2013 and 2022, while Beijing's last large coal-fired power plant closed in March 2017.
- **Transport controls and electrification** – Progressively tighter vehicle emission limits were paired with a licence plate lottery that, since 2021, reserves 70 % of new registrations for new energy vehicles (Beijing Municipal Commission of Transport, 2023).
- **Four-colour emergency alert system** – Forecast-based red / orange / yellow / blue alerts trigger temporary restrictions on traffic, industry and construction when high pollution is predicted (MEE, 2016).
- **Regional joint prevention and control** – A shared high-resolution emissions inventory with Tianjin and Hebei guides coordinated caps on power generation, industry and heating across the Beijing–Tianjin–Hebei (BTH) region (Zhao et al., 2022).

These actions were scaled further through national policy. Beijing's approaches fed directly into the State Council's **Air Pollution Prevention and Control Action Plan** (2013), the **"Blue Sky Defence War"** three-year plan (2018) and the 2015 revision of the **Air Pollution Prevention and Control Law**, which established realtime disclosure requirements and strengthened penalties. Annual PM2.5 caps were integrated into performance contracts for senior officials, and central inspection teams have rotated nationwide since 2016 to audit compliance.

Results

- Average concentrations of air pollutants fell between 2013 and 2023 by 64 % for PM2.5, 43% for PM10 89% for SO_2 and 54% for NO_2 (Beijing Municipal Ecology and Environment Bureau, 2023).
- Short-term PM2.5attributable mortality across the BTH region fell by ≈ 11 000 deaths between 2013 and 2020 (Clean Air for Health, 2023).

- Economic appraisal suggests that air quality- improvements between 2015 and 2018 avoided health and productivity losses worth CNY 95.6 billion (Zhao et al., 2022).

Enabling factors	Details
Clear political leadership & binding targets	State Council action plans and annual PM2.5 caps in cadre evaluations drove accountability.
Strengthened legal & enforcement mechanisms	2015 law revision plus rotating central inspection teams ensured consistent, well-resourced enforcement.
Science-based regional cooperation	Shared BTH emissions inventory and joint forecasting aligned provincial measures.
Large-scale energy infrastructure change	Coalto-gas/electric conversions and closure of the last coal plant in 2017.
Integrated transport strategy	Licence plate quotas favouring EVs and rapid expansion of charging points and e-bus fleets.
Transparent data & public engagement	Real-time disclosure from 35 stations and a colourcoded alert system fostered public trust and compliance.
Targeted fiscal incentives	Subsidies for household fuel switching, vehicle scrappage, and VOC controls eased transition costs.

2.3 Greater Johannesburg Region, South Africa

2.3.1 Context of Air Quality Challenges:

South Africa's Constitution guarantees "an environment that is not harmful to health or well-being" through legislative and institutional frameworks for cleaner air. Progress has been made in its approach to air quality management over the last decades; this is especially evident based on the substantial growth in capacity and capability through advanced governance mechanisms, public information platforms such as South African Air Quality Information System (SAAQIS https://saaqis.environment.gov.za/), the number of regulations and notices published, delivery of statutory obligations such as air quality management plans, ambient air quality standards and the regulation of industrial polluters contributing significant air pollution through licenses.

2.3.2 An Evidence-Based Approach to Regional Air Quality Management

The province of Gauteng – which includes the three metropolitan municipalities of Johannesburg, Ekurhuleni and Tshwane – is the economic engine of the country. Its inhabitants are exposed to a complex pollution mix generated locally (industry, transport, waste burning and residential solid fuel use) and transported from the coal-fired power and mining belt to the east of Gauteng Province. Monitoring shows that PM10, PM2.5 and ozone remain the pollutants of greatest concern (DFFE 2024; SAAQIS 2024). Steps continue to be taken to understand better how changes in future transport provisions must be considered. This includes issues such as the introduction of disruptive technologies, mobility as a service, and alternative fuels, while also providing more enabling behaviour change alternatives such as better public transport and use of alternative transport

In response to the regional challenges of air pollution transcending the three metropolitan areas, the government is working on a regional approach to manage air quality. The three metropolitan

areas are under consideration to be recognised as air pollution priority areas, required to the establish measurable multisectoral emission reduction action programs as well as monitoring evaluation mechanisms to assess implementation of interventions. This regional approach prioritises the following activities as these are central to many progressive air quality management approaches internationally including:

- Engaging with citizens, policymakers, public health practitioners and other stakeholders through systems based on participatory methods that can result in co-production and therefore co-ownership of the air pollution problem and also solutions.
- Improving the understanding of the potential impacts (including co-benefits and negative effects) of clean air, low-carbon policies/interventions on individuals, public health, the environment and the economy.
- Transforming perceptions of the potential health, societal, economic and environmental co-benefits of clean air, low-carbon interventions that aim to simultaneously reduce air pollution and of their impact on health and productivity.
- Co-creating and implementing sustainable policies and interventions that can have the greatest potential to reduce exposure to air pollution, taking into account social equity and the local political, cultural and socio-economic context.
- Continuing to build capacity and capability and promoting knowledge exchange locally, nationally and internationally, involving researchers, practitioners, policymakers and citizens.
- Engaging the civil society on the awareness and outreach initiatives as well as the planning and compliance implementation pathway triggered by regulatory developments.

Enabling Factors	Details
Blended & diversified funding	Combining municipal funds with national allocations and international donor support enabled action while building a path to long-term local financing.
Institutional capacity & knowledge transfer	Structured mentorship, succession planning and dedicated air quality teams preserved expertise and ensured continuity.
Multi-level political buy-in	Commitment from city, provincial and national leaders unlocked budgets and smoothed implementation.
Regional co-operation on transboundary pollution	Joint planning across Johannesburg, Ekurhuleni and Tshwane aligned measures with up-wind sources and recognised the shared airshed.
Air quality as a cross-sector lever	Positioning clean air as integral to health, equity and economic competitiveness attracted broader stakeholder support.

3 FINANCING INVESTMENT IN AIR QUALITY

3.1 The challenge: The need for finance

Addressing air quality challenges requires investment in several key areas such as air quality data monitoring, funding sectoral and multi-sectoral programmes, and adopting suitable technologies.

However, in 2018-2022, only 1% of international development funding went to clean air projects, according to Clean Air Fund's '*The State of Global Air Quality Funding*' (2024).

Blended finance is one innovative way to fund air quality action by attracting private investment to projects. Multilateral development banks (MDBs) provide guarantees or other de-risking tools to stimulate private sector investment through their specialised operations. To mobilise financing for air quality, one could start with addressing sectors that have clear revenue models and proven investment track records. The use of financial instruments like credit guarantees and blended finance can attract private capital (World Bank, 2025) and in doing so help governments to bridge the gap in the financing of their air quality management programmes.

3.1.1 Bangladesh and the World Bank Unlock Private Sector Capital Through Innovative Financing

Rapid population and economic growth have led to Bangladesh experiencing persistently high levels of air pollution. Industrial processes, construction and a fast-growing vehicle fleet push ambient PM2.5 well above national standards (Khatun et al., 2023). In 2015 air and water pollution were estimated to cause nearly 28 % of premature deaths, with economic losses of US $6.52 billion in urban Bangladesh and US $1.44 billion in Dhaka alone. By 2019 outdoor and indoor air pollution plus lead exposure still accounted for ≈ 22 % of all deaths (World Bank, 2022b).

Bangladesh has put in place the legal, policy and institutional frameworks needed for cleaner air, but financing remains a bottleneck. Between 2015 and 2021, US $2.4 billion in dedicated air quality finance was committed to the country (Clean Air Fund, 2023). To crowd in private investment, the Government launched the Bangladesh Environmental Sustainability and Transformation programme, backed by a US $170 million Green Credit Guarantee Fund financed by the World Bank, Agence Française de Développement and local banks. The pilot Green Credit Guarantee Scheme offers partial guarantees and technical assistance to bankers and high-emitting sectors (brick kilns, cookstoves, waste, power), unlocking loans for cleaner technologies (World Bank, 2022a).

Through the Green and Climate Resilient Development Credit, the World Bank is also helping Bangladesh embed air quality management in law. The Air Pollution Control Rules 2022 set national PM2.5 standards aligned with WHO interim targets, mandate sectoral emission caps and establish a National Committee for Air Pollution Control to coordinate implementation (World Bank, 2023). Five new private sector vehicle inspection centres and Bangladesh Bank's green brick kiln refinance window demonstrate how blended finance plus regulatory certainty can catalyse further private investment.

Enabling factors	Description
Blended finance unlocks scale	Credit enhancement guarantees leveraged large-scale private capital, supplementing public budgets and donor grants.
Targeted guarantees de-risk lenders	Partial guarantees for high-polluting sectors (brick kilns, waste management, vehicle inspection, power) reduce default risk, giving local banks confidence to build a track record in green lending.

Enabling factors	Description
Multi-sectoral collaboration	Finance, energy, environment ministries, Bangladesh Bank, development partners and private lenders coordinate policies and funds - illustrating that effective air-quality action relies on agencies well beyond the environment ministry.
Strong economic case	Health damage costs (US $6.5 bn in urban areas for 2015 alone) far outweigh required investments, helping government and partners justify bridging financing gaps and mobilising external support.

4 REGIONAL COOPERATION ON AIR POLLUTION

4.1 ASEAN's Agreement on Transboundary Haze Pollution and subsequent action

Air pollution in Southeast Asia routinely crosses national borders, with smoke from land and forest fires drifting hundreds of kilometres and raising fine particle (PM2.5) levels across the region. Many of these fires are set to clear land for agriculture and plantation development (Varkkey, 2014). Recognising the shared nature of the problem, the ten Association of Southeast Asian Nations (ASEAN) member states signed the ASEAN Agreement on Transboundary Haze Pollution (AATHP) in 2002, and it entered into force in 2003 with the vision of a haze-free ASEAN by 2030

The purpose of the agreement is to enhance the capacity of countries in the region to assess and respond to fires and the resulting haze both at the national level and through strengthened regional and international cooperation (ASEAN, 2021). To this end, the countries collaborate in developing and implementing measures to prevent and monitor transboundary haze pollution caused by land and/or forest fires. These efforts include mitigating fire impacts and controlling sources of fires through the identification of fire outbreaks, the development of monitoring, assessment, and early warning systems, the exchange of information and technology, and the provision of mutual assistance.

One of the key facets of the agreement is sharing information and data. The ASEAN Co-ordinating Centre for Transboundary Haze Pollution Control receives data from the different countries relating to fire-prone areas, land and/or forest fires, the environmental conditions conducive to such land and/or forest fires, and haze pollution arising from such land and/or forest fires and consolidates and analyses the data to provide each party to the agreement with an assessment of risks to human health or the environment.

In 2016, the ASEAN member states developed a Roadmap on the ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation that sets out the steps for collective action. The roadmap outlined collaborative actions ranging from sustainable peatland management to fire prevention, aimed at reducing associated health and environmental risks. A review of the roadmap conducted in 2022 found that it enhanced cooperation and information exchange among countries. It also noted progress in adopting regulations and incentives for zero-burning practices, as well as in reducing the extent of burned peatland areas. The review assessed progress as high, medium, or low, helping to identify actions where further efforts were needed to strengthen the collective response. Airshed modelling outcomes further indicated that there may

be significant air quality benefits for countries in the region from sharing experiences and collaborating on implementing air pollution solutions.

In 2023, the ministers adopted the Second Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control (2023-2030). The roadmap sets two headline targets: (i) a *significant and sustained reduction* in haze episodes, and (ii) attainment of the World Health Organization's PM2.5 Interim Target 3 for annual and 24-hour averages, supported by nine mutually reinforcing strategies ranging from sustainable peatland management to community-based fire prevention.

The regional framework and roadmaps provided strategic coherence for investment, as ASEAN developed and endorsed the Investment Framework for Haze-Free Sustainable Land Management (AIF-HFSLM). Running from 2023 to 2030, this investment framework aims to mobilise USD 1.5 billion in funding to strengthen multi-stakeholder partnerships and enhance the availability of resources to prevent large-scale burning of forests, peatlands, and agricultural residue. It will therefore be key to supporting the establishment of socially and economically viable alternatives to unsustainable land management practices.

Modelling undertaken for UNEP's *Clean Air & Climate Solutions for ASEAN* report shows that regional cooperation on a package of 15 priority measures could cut population-weighted PM2.5 exposure by up to 75 % by 2030, with benefits spread across all ten economies.

Enabling Factors	Description
Regional, airshed level cooperation	Transboundary haze demands regional solutions. The AATHP platform unlocks larger, cheaper health gains than isolated national action.
Legally binding framework	AATHP sets firm obligations and mobilises resources.
Shared data & early warning systems	ASEAN hotspot maps and daily haze outlook products guide swift national responses.
Science-driven targets & modelling	Second Haze Free Roadmap (2023-2030) aligns actions with WHO PM2.5 Interim Target 3.
Routine monitoring, reporting & evaluation	Biennial AATHP progress reviews track implementation, enable course corrections and sustain political commitment.
Strengthened regional institutions & partnerships	ASMC, sectoral working groups and cross sector collaborations drive delivery toward a haze-free ASEAN by 2030.

5 KEY LESSONS

The journey toward improved air quality is ongoing in the countries featured in the case studies above. These examples highlight that incremental steps are crucial in progressing toward air quality standards and in realising benefits for both public health and the economy. Success relies on leveraging a range of policy tools and approaches.

A common requirement for achieving incremental progress in air pollution management is adequate fiscal support and public financing for cleaner technology alternatives. The case studies show that countries often need help bridging financing gaps when domestic public funding falls short. Support from international donors can play a catalytic role but its impact is maximised when complemented by a coordinated, multi-sectoral approach within the countries themselves.

The air pollution challenges and associated responses across the case study areas discussed in this report - though differing in timing, actions, and implementation pathways - share common threads that highlight key elements for achieving effective outcomes. These include:

- Prioritising investment and action on addressable emission sources within key polluting sectors while progressively advancing toward the abatement of harder-to-treat sources through sustained long-term investments, cross-sectoral coordination, and policy integration
- Ensuring access to ambient air quality monitoring data enables informed decision-making
- Integrating the management approach to air quality across all levels of government – city, sub-national, national and international approaches work better when seamless across an airshed
- Strategically mobilising and blending diverse funding sources to support comprehensive air quality management initiatives
- Building and strengthening capacity at a city level is key to implementing localised solutions that are also evidence-based
- Demonstrating and communicating the health and economic benefits of achieving clean air targets facilitates buy-in across diverse stakeholder groups
- Developing multisectoral approaches leverages co-benefits across other sectors including climate, waste and energy

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SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

From Planning to Practice

Unlocking the Power of Biodiversity-Inclusive Marine Spatial Planning for Ocean Sustainability

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This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.

EXECUTIVE SUMMARY

The ocean is the planet's life-support system – and it is in trouble. Accelerating pressures from climate change, overexploitation, pollution, and habitat degradation are pushing marine ecosystems to the brink, threatening food security, livelihoods, and resilience worldwide. As custodians of nearly half of the world's coastlines and a fifth of its Exclusive Economic Zones, G20 countries are uniquely positioned to turn the tide.

This technical paper makes the case for biodiversity-inclusive Marine Spatial Planning (MSP) as a strategic lever to advance ocean sustainability and unlock the potential of the sustainable blue economy. MSP offers a transparent, cross-sectoral approach to coordinate competing and complementary uses of ocean space – balancing ecological, economic, and social goals – by recognising that thriving marine ecosystems provide the ecological infrastructure underpinning fisheries, tourism, carbon sequestration, and climate resilience, all central to sustainable blue economy strategies. When done well, it is inclusive, science-based, adaptive, and deeply aligned with global climate and biodiversity goals.

G20 cooperation and leadership is critical. Building on recent momentum under the Indian and Brazilian presidencies, South Africa has placed MSP at the heart of the 2025 Environment and Climate Sustainability Working Group's (ECSWG) deliberations on ocean sustainability. This paper draws on national experiences, global best practice, and practical lessons to provide a blueprint for scaling up equitable and biodiversity-inclusive MSP as part of sustainable ocean planning.

Key insights include:

MSP is no longer a niche tool – it is spreading fast across nations. Countries from Argentina to Indonesia, South Africa to Germany, are applying MSP to reduce user conflicts, restore ecosystems, and foster inclusive growth.

Integrating biodiversity into MSP generates synergies for nature, livelihoods, and long-term ocean health.

Ocean governance is breaking away from single sector management towards coordinated, integrated planning, enabling more holistic and resilient solutions for competing uses and biodiversity conservation.

Legal clarity, institutional coordination, and adequate financing are make-or-break factors for effective implementation.

Participation is not a checkbox. Inclusive governance that meaningfully engages Indigenous Peoples, small-scale fishers, and coastal communities is essential to legitimacy and impact.

MSP must go beyond a once-off plan or event – it must be continuous, adaptive and iterative process, with clear feedback loops, strong data systems, involvement of stakeholders, and alignment with national and international development, biodiversity and climate strategies.

Seven targeted recommendations to G20 policymakers:

- ***Promote holistic ocean management based on biodiversity-inclusive and climate-smart principles*** *by integrating MSP with other area-based approaches to benefit nature and society, in alignment with the Sustainable Development Goals (SDGs), Kunming-Montreal Global Biodiversity Framework (KMGBF), and Paris Agreement.*
- ***Strengthen national enabling frameworks*** *– laws, policies, and institutional mandates – to support cross-sectoral and multi-level marine governance.*
- ***Close capacity, data, and financing gaps*** *through domestic investment, international support, and open-access marine data infrastructure.*
- ***Promote equity and participation*** *in planning and decision-making and ensure that local and Indigenous knowledge is fully integrated.*
- ***Foster knowledge exchange, progress sharing and regional cooperation*** *by continuing dialogue and sharing best practices on developments in the sustainable blue economy and ocean governance.*
- ***Adapt global MSP guidance to national realities****, leveraging tools like MSPglobal and other guidelines through tailored technical support.*
- ***Elevate ocean governance on political agendas*** *to catalyse coordinated national planning approaches and regional cooperation and unlock the full potential of a sustainable blue economy.*

In conclusion, G20 countries are well-placed to demonstrate cooperation and leadership through partnership and shared learning, especially by supporting implementation in data- and capacity-constrained contexts. Through concerted action and shared commitment, MSP can help chart a sustainable and resilient course for our ocean – and our collective future.

1 INTRODUCTION

"If we save the sea, we save our world"

'Ocean with David Attenborough', May 2025

1.1 Ocean Sustainability - a Strategic Priority for the G20

As custodians of 45% of the world's coastlines and 21% of global Exclusive Economic Zones (EEZs), and accounting for the majority of the world's population, GDP, carbon emissions, and trade, G20 countries are uniquely positioned to lead the transition toward a sustainable blue economy (SBE) – demonstrating that ocean sustainability is not only an environmental and social imperative, but also an economic opportunity.

The ocean provides essential ecosystem services – from climate regulation and carbon storage to food security, jobs, and coastal protection. Yet growing pressures from pollution, climate change,

habitat degradation, and overexploitation are pushing marine systems beyond critical thresholds. Without urgent action, the degradation of ocean ecosystems will undermine global economic stability, equity, and resilience (Frazão Santos, C., *et al.*, 2024).

The G20 has a pivotal role to play in reversing this trend. As the primary forum for international economic cooperation, it can mainstream ocean sustainability into development, climate, and finance agendas. This includes promoting effective spatial governance and management initiatives, including Marine Spatial Planning (MSP), to coordinate uses of the ocean, reduce conflicts, and safeguard biodiversity. By advancing integrated and inclusive ocean governance, G20 members can provide guidance on how ocean sustainability and the development of SBEs can go hand in hand.

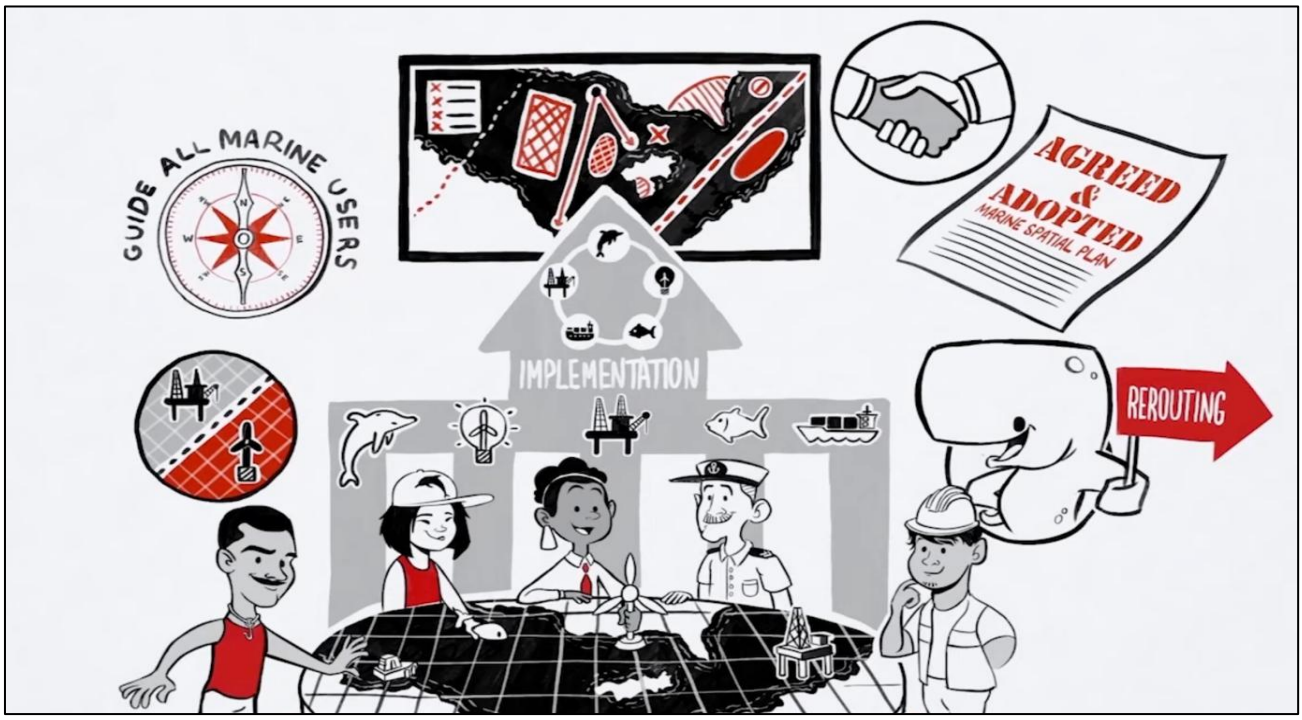


***Figure 1**: MSP is a participatory, strategic planning process that coordinates and guides the use of ocean space by different sectors. By balancing ecological, economic and social objectives, it is a key ingredient for developing a sustainable blue economy. ((Source: GIZ (2017) Marine Spatial Planning in a nutshell)*

1.2 Building a Sustainable Blue Economy through Marine Spatial Planning and Area-Based Management

MSP is a strategic and participatory process that guides where and how ocean space is used to balance ecological, economic and social objectives and build climate resilience. By coordinating marine activities across sectors such as shipping, mining, energy, fishing, and tourism, and integrating this with biodiversity protection, conservation and restoration. MSP provides a rational framework to reduce conflicts and enhance synergies (Ehler, C. & Douvere, F., 2009) (Figure 1). MSP is increasingly recognised as a useful tool to deliver a sustainable blue economy transition, helping governments to unlock ocean-based economic opportunities, including the creation of blue jobs, while safeguarding critical ecosystems. Within this context, Area-Based Management Tools (ABMTs) – including Marine Protected Areas (MPAs) and Other Effective Area-Based Conservation Measures

(OECMs) – play a vital role in conserving biodiversity and enhancing ecosystem resilience. These tools must be more effectively integrated in MSP frameworks to advance sustainable ocean planning and further promote an SBE as part of the solutions for an accelerated transition towards a climate resilient and healthy ocean.

Biodiversity-inclusive MSP integrates biodiversity into spatial planning from the outset, ensuring that critical habitats, ecological connectivity, and vulnerable species are sustained and enhanced/restored (Grantham, *et.al*, 2024). This approach positions biodiversity not as a competing sector, but as essential infrastructure for a resilient and productive ocean. Embedding climate-smart principles further enables marine plans to anticipate and respond to shifting conditions, strengthening ecosystem and with this community resilience.

The implementation of MSP that is informed by an ecosystem-based management approach, adaptive and participatory can be considered a global best practice (IOC-UNESCO & EC, 2021). When biodiversity is treated as a central pillar of planning, MSP can align environmental stewardship with inclusive economic growth and social well-being. Biodiversity-inclusive and climate-smart MSP is prominent among a suite of governance approaches promoted by a range of global initiatives – including the Intergovernmental Oceanographic Commission (IOC-UNESCO), the Convention on Biological Diversity (CBD), the United Nations Environment Programme (UNEP) and the High-Level Panel for a Sustainable Ocean Economy – as essential for meeting Sustainable Development Goal (SDG) 14 and the objectives of the Kunming-Montreal Global Biodiversity Framework (KMGBF) (IOC-UNESCO & EC, 2025). Regional agreements, including Regional Seas Conventions and Action Plans and collaborations around Large Marine ecosystems (LMEs), play a critical role in supporting these efforts by providing strategic guidance, fostering coordination among member states, and promoting coherent transboundary marine governance[1] (UNEP-Nairobi Convention, 2022; UNEP/MAP Decision IG.26/10; UNEP/MAP-SPA/RAC, 2021). These approaches also ensure that spatial planning not only protects habitats and species but also addresses climate resilience, sustainable livelihoods, and social equity.

To truly align with emerging global priorities, biodiversity-inclusive MSP needs to embrace concepts that can assist with identifying and quantifying ecological value, prioritising actions, and delivering co-benefits for people and ecosystems. Examples include natural capital assessment and accounting, systematic conservation planning, and nature-based solutions. Integrating these approaches can enable MSP to more effectively address cumulative human impacts, climate vulnerabilities, and ecosystem risks across marine and coastal landscapes. Recognising land–sea interactions is equally important, as many pressures originate on land and shape marine biodiversity outcomes, making integrated planning across coastal and marine systems critical for safeguarding connectivity and resilience. Furthermore, embedding circular economy principles into ocean planning can promote resource efficiency, reduce pollution, and support innovation in

[1] This is exemplified by the Barcelona Convention and its 2023 decision on the implementation of MSP in the Mediterranean and its Post-2020 Strategic Action Programme for the Conservation of Biodiversity and Sustainable Management of Natural Resources in the Mediterranean Region, including a specific activity to support countries in the development of systematic conservation planning, taking into account ICZM, land use/ marine use planning and management aspects in the context of MSP.

ocean-based sectors, ensuring that the blue economy contributes to both ecological integrity and long-term socio-economic resilience. In this light, biodiversity-inclusive MSP should be viewed not only as a conservation tool, but as a central pillar of sustainable ocean planning and management that can help to achieve national development priorities, climate adaptation strategies, and the transition to an SBE. By applying spatial planning to implement policy frameworks, governments can foster policy coherence and unlock synergies between ecological stewardship, economic innovation, and social equity. Guidance on enabling a practical transition to sustainable, regenerative and equitable blue economies using MSP and other area-based management tools is available in UNEP (2025) (UNEP/MAP-SPA/RAC, 2021).

Emerging research highlights challenges in ensuring inclusive participation, addressing multiple values and spatial data gaps, and achieving effective enforcement across jurisdictional and institutional boundaries (UNEP, 2025). However, it also documents practical, evidence-based solutions such as adaptive zoning, participatory mapping, and integrated monitoring systems (World Bank, 2022). Key ongoing debates centre on how best to mainstream climate mitigation and adaptation into MSP (DFFE, 2021), strengthen institutional capacity and learning, promote equity, and ensure that the voices of small-scale fishers, Indigenous Peoples, and local communities are meaningfully included. These challenges – and the solutions being piloted – underscore the importance of G20 collaboration to scale up successful practices and address capacity disparities across member states.

1.3 Anticipated Outcomes of South Africa's G20 Presidency

Building on the foundational achievements of previous G20 presidencies, the South African G20 Presidency has identified biodiversity-inclusive MSP as a key priority for the sustainable management of oceans and coasts. The following expected outcomes have been proposed: (1) Best practices on the development of comprehensive biodiversity-inclusive MSP processes; (2) Identified capacity gaps or needs and interventions to improve implementation of biodiversity-inclusive MSP; and, (3) Development of a guidance tool for the approach to marine areas planning. Together, these outcomes are intended to make a significant contribution to shaping a coherent G20 position on ocean sustainability. They are offered as flexible, non-prescriptive options that countries may adopt or adapt in line with their national priorities and institutional contexts.

This technical paper is intended to contribute meaningfully to the G20 Oceans and Coasts agenda and its expected outcomes. G20 member states were invited to contribute written inputs, drawing on their national experiences and expertise in biodiversity-inclusive MSP and other area-based management initiatives as tools for sustainable ocean governance. The South African Presidency was leading this collaborative effort and engaging with all feedback received from G20 members and the broader ocean community. The content of this technical paper remains the sole responsibility of the South African government.

2 SUMMARY OF PAST G20 DELIBERATIONS AND COUNTRY POSITIONS

2.1 The Role of MSP in the G20 and its Member Countries and Regions

Sustainable ocean governance and MSP have become central topics within the G20 ECSWG in recent years. Under the Indian G20 Presidency in 2023, the "Chennai High-Level Principles for a Sustainable and Resilient Blue/Ocean-based Economy" were adopted, explicitly recognising MSP as a key strategy to balance economic development with marine conservation; address marine pollution; integrate Indigenous knowledge; and support climate resilience (Queirós, A.M., *et al.*, 2025). Building on this, the Brazilian G20 Presidency in 2024 specifically called for advancing MSP, promoting ocean-based climate actions, and supporting the ratification and implementation of the High Seas Treaty (BBNJ) by its Parties (G20, 2023). It promoted MSP as a vital tool for managing marine resources equitably, reduce user conflicts and foster synergies among sectors (G20 2024). These efforts have been complemented by technical workshops and capacity-building initiatives, such as the UNESCO-G20 Workshop on MSP in Rio de Janeiro, which emphasised integrating MSP into broader climate and biodiversity frameworks, including the KMGBF and the Paris Agreement (G20 2024). While MSP has prominently featured in technical working group discussions and outputs, its visibility in high-level political tracks remains comparatively limited.

G20 deliberations have consistently underscored the need for participatory, ecosystem-based, and inclusive MSP, with a strong emphasis on involving Indigenous Peoples, small-scale fishers, and local communities to ensure equitable benefit sharing. The basic premise of all MSP approaches is an evidence-based approach to resolve user conflicts and coordinate across borders. However, MSP systems and priorities may vary among different countries, shaped by national and regional contexts, and strategic policy goals. While MSP typically seeks to balance ecological, social, and economic objectives, different countries may prioritise different strategic goals—some championing biodiversity and ecosystem-based approaches, while others place greater emphasis on economic development and blue growth, fisheries management, or climate resilience and adaptation. These diverse priorities (as illustrated in Table A1; Annex 1), highlight the flexibility of MSP as a governance tool (as long as fundamental goals like biodiversity conservation and equitable benefit sharing are met) and reinforce the value of the G20 platform for peer learning, collaboration, and exchange of good practices to mainstream biodiversity-inclusive, climate-smart, and socially equitable MSP across member states.

2.2 Status of MSP Implementation in G20 Member Countries and Regions

As the demand for ocean space and resources continues to rise, G20 countries face growing pressure to manage their marine estate more effectively and equitably. Recognising the urgent need for action-oriented ocean governance, many countries around the world have adopted MSP to address competing ocean uses, safeguard biodiversity, promote SBEs, and enhance climate resilience.

Different countries have taken varied approaches to MSP, shaped by national contexts, governance systems, technical and data capacities, and policy priorities. For example, Germany has pursued legally binding MSP with strong ecological objectives, while Indonesia has focused on cross-sectoral coordination and socio-economic inclusion in data-limited environments. These differences extend to the pace and stage of implementation. While some countries have approved and are actively implementing marine spatial plans, others remain in earlier stages of pre-planning or stakeholder consultations (Figure 2, Table A2, Annex 2). The diversity of MSP progress across G20 nations highlights both achievements and opportunities for mutual learning, advancing MSP practice and capacity-building through international platforms like the G20.

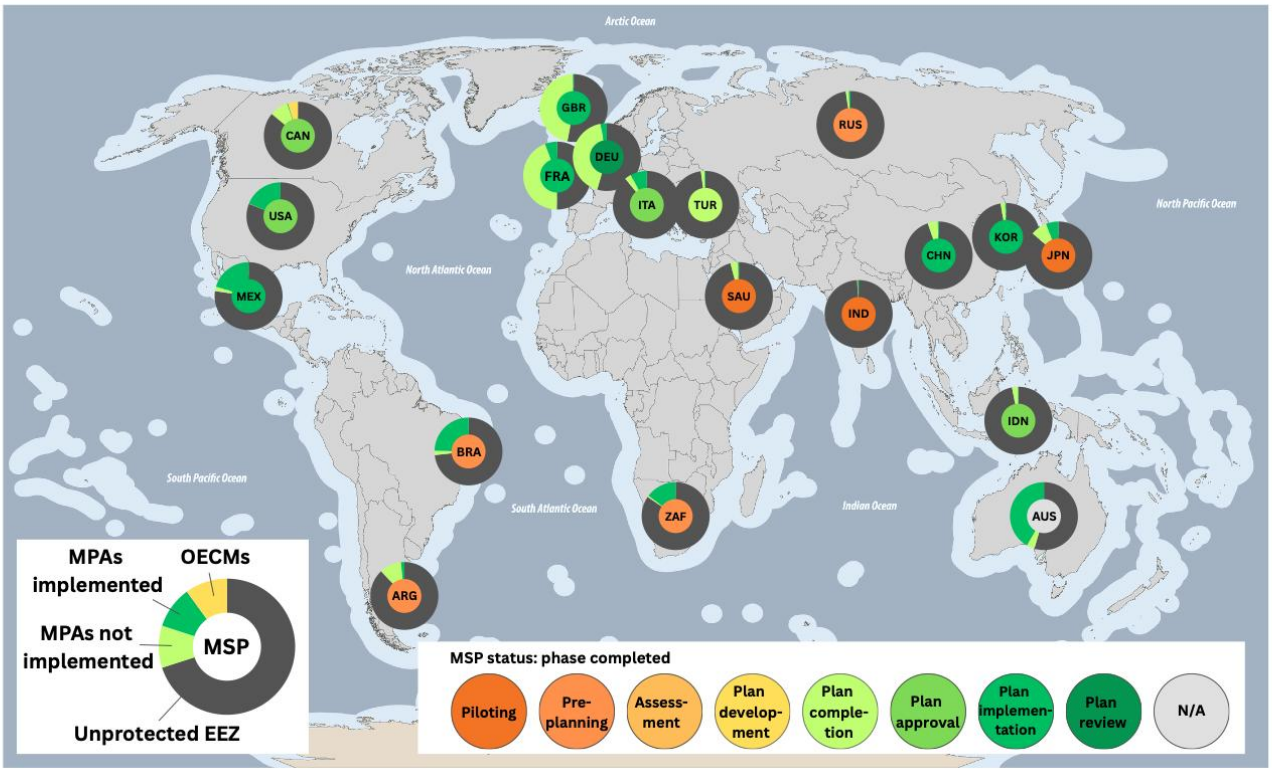


***Figure 2**: G20 members are at different stages in their MSP process (colour of inner circle). MPA coverage also varies (green portion of outer circles). In some instances, MPAs are proclaimed but not implemented (lighter green). Thus far, only Canada has recognised marine OECMs (included in MPAs not implemented).*

2.3 Status of Marine Conservation of the G20 Exclusive Economic Zones

With the adoption of the KMGBF in 2022, the global community has renewed its commitment to halt biodiversity loss, particularly through area-based conservation. Action Targets 1–3 of the KMGBF underscore the importance of spatial planning and the protection of ecosystems, with Target 3 ("30x30") calling for the effective conservation of at least 30% of marine and coastal areas by 2030 (MSPGlobal, 2024). The G20, collectively governing nearly 45% of the world's Exclusive Economic Zones (EEZs), has a pivotal role in advancing this agenda. Two principal tools underpin progress: MPAs and OECMs. While OECMs offer new opportunities, particularly for recognising diverse governance models and conserving areas beyond formal MPAs, implementation faces challenges –

including unclear legal recognition, limited guidance on marine application, and capacity constraints (CBD, 2022; IUCN-WCPA Task Force on OECMs, 2019).

As shown in Figure 2 (and Table 3, Annex 3), most G20 countries remain below the 30% threshold, with many reporting lower actual implementation than formal designations suggest. Low coverage of fully or highly protected areas further highlights the need to improve conservation effectiveness and quality (UNEP-WCMC & IUCN, 2024).

As marine conservation efforts scale up to meet global targets, biodiversity-inclusive MSP can help ensure that the expansion of the conservation estate and its management is both ecologically effective and socially equitable. Integrated MSP practices that embed biodiversity from the outset can help coordinate ocean uses, reduce conflicts, and drive the transformative change needed in ocean governance to meet sustainability goals.

3 CURRENT POLICY OR POLICY-RELEVANT INITIATIVES AND DEBATES

3.1 Core Principles for Biodiversity-Inclusive MSP

A suite of global guidance – including the MSPglobal International Guides (IOC-UNESCO & EC, 2021 & 2025), IUCN WCPA's participatory, integrated and biodiversity-inclusive spatial planning framework (Grantham, H., et al., 2024), and FAO's sectoral guidelines – offer practical, science-based approaches to integrate biodiversity into MSP. These frameworks share core principles: ecosystem-based management, participatory governance, data-driven decision-making, and adaptive implementation. The accompanying table (Table A4, Annex 4) provides an overview of available guidance, highlighting their respective relevance for G20 policy and practice. However, applying these globally informed tools requires contextual adaptation – accounting for national legal systems, governance structures, data capacities, and socio-economic realities. Tailored uptake of these resources can help overcome implementation bottlenecks and align MSP processes with national development priorities. In complement, regional cooperation can support the process by promoting exchange of best practices, institutional and capacity building measures and stakeholders' awareness and engagement.

G20 example: Brazil collaborated with MSPglobal to pilot its national MSP roadmap, adapting global guidance to strengthen institutional coordination, stakeholder engagement, and spatial data integration in priority marine areas, including in the Northeast and South regions. This partnership provided technical support and helped operationalise early planning steps within Brazil's federal governance context.

The following core principles have been distilled from global guidance as particularly relevant for the G20 context:

3.1.1 Planning with Nature: Ecosystem-based, Biodiversity-inclusive MSP

Securing the long-term health of marine ecosystems – and the livelihoods they support – requires that biodiversity considerations are fully integrated into MSP from the outset. Best practice involves

identifying priority areas for conservation through structured planning processes (e.g. systematic conservation planning) and expert input to inform zoning decisions and sea-use guidelines. Platforms such as the Global Biodiversity Information Facility (GBIF) and ecological atlases provide essential data, especially for data-poor regions. Embedding biodiversity also requires the meaningful participation of stakeholders, ensuring that Indigenous and local knowledge is integrated alongside scientific data.

G20 example: South Africa's MSP process exemplifies biodiversity-inclusive planning by enabling transparent, ecologically grounded zoning that integrates biodiversity priorities into national ocean use strategies (see Box 1).

3.1.2 Strong Legal Anchors and Institutional Coherence

Robust legal and strategic foundations are critical for delivering long-term and integrated outcomes through MSP and ABMTs. National legislation and policy strategies should be aligned with global commitments (e.g. KMGBF) and embed ecosystem-based, adaptive, and inclusive principles (IOC-UNESCO & EC, 2025). In parallel, strategic policy instruments that complement legislation play a critical role in enabling coordination across sectors and levels of government, fostering adaptive and transparent decision-making, and linking MSP to wider environmental and development priorities.

G20 example: Within the European Union, G20 member states such as Germany, France, and Italy are signatories to the *EU Ocean Pact* (COM 2025 281 final), which aims to integrate different maritime policies and ensure ocean health. Within this framework, the EU has specifically announced updates to key directives, including the MSP Directive, to strengthen integration and better incorporate biodiversity-related target. Other legally binding instruments, such as the EU Nature Restoration Regulation (2024/1991/EU), are supported and enabled by the cross-sectoral coordination provided through MSP. These legal instruments ensure coherence between national priorities and international obligations.

3.1.3 Meaningful Participation and Inclusion of Local Actors

Effective stakeholder participation is a cornerstone of comprehensive MSP and other ABMTs. Best practices ensure that all relevant actors – including Indigenous Peoples and local communities – are involved from the outset and throughout the planning process. Transparent engagement builds trust, enhances legitimacy, and leads to decisions that are socially and ecologically robust. Equitable participation also helps surface local knowledge that complements scientific data, enabling planners to identify spatial priorities that reflect diverse values and dependencies on marine ecosystems.

G20 example: Mexico's national MSP process includes targeted stakeholder consultations and participatory mapping, actively incorporating the voices of small-scale fishers and coastal communities to inform zoning decisions and improve marine governance outcomes.

Box 1: South Africa's path towards biodiversity-inclusive MSP

South Africa's approach to MSP showcases that biodiversity conservation and a sustainable blue economy are mutually reinforcing. It stands out as a leading example of biodiversity-inclusive MSP, grounded in robust legislation, long-term investment in science, and iterative stakeholder engagement. This approach Key milestones include:

- **Operation Phakisa (2014–2019):** A national initiative that fast-tracked ocean governance reforms and catalysed the proclamation of **20 new offshore MPAs**, expanding protection from 0.4% to 5.4% of the EEZ.
- **Development of MSP Act, 2018 (Act No. 16 of 2018):** Provides a legal framework for marine spatial planning in South Africa, governing the use of the ocean by multiple sectors.
- **National Biodiversity Assessments (NBA):** Iterative science-based assessments (2004, 2011, 2018) underpin Systematic Conservation Planning with up-to-date spatial ecological data.
- **Regional EBSA process:** Identified, described and revised 22 national and transboundary Ecologically or Biologically Significant Areas (EBSAs) to inform spatial priorities for biodiversity-inclusive MSP.
- **National Coastal and Marine Spatial Biodiversity Plan:** Includes a Critical Biodiversity Area (CBA) Map that integrates EBSAs and other priorities to identify the most important areas for meeting biodiversity targets, accompanied by sea-use guidelines.
- **Marine Biodiversity Sector Plan (2024):** Uses CBA Map and sea-use guidelines to propose biodiversity-inclusive zoning under MSP.
- **Forward-looking use of MSP zoning:** Supports future **MPA expansion and recognition of OECMs**, aligning with GBF Targets 1 & 3.

South Africa's experience demonstrates how science-based tools and inclusive planning can operationalise biodiversity priorities in marine governance. Throughout, Systematic Conservation Planning and broad stakeholder engagement have been vital, enabling transparent, adaptive, and biodiversity-inclusive MSP that balances conservation with sustainable ocean use for South Africa's future. This process benefited from regional agreements and technical guidance through the Benguela Current Convention (MARISMA project) and the Nairobi Convention (regional MSP strategy).

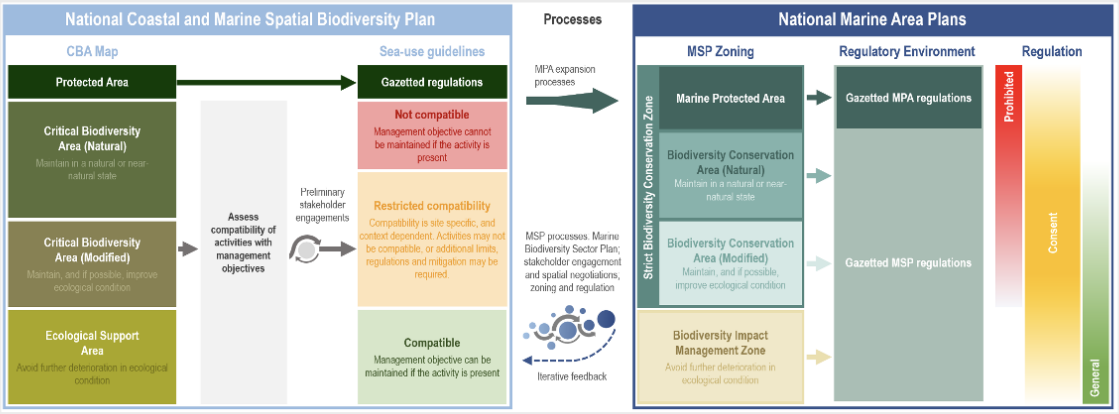


Figure 3. In South Africa, a science-driven approach (CBA map, left panels) and sea-use guidelines inform the Biodiversity Sector Plan and proposed regulations for sea-use zones.

3.1.4 Evidence Based, Transparent and Adaptive Decision Making

MSP processes benefit significantly from being informed by the best available science-based evidence in form of ecological, socio-economic, and governance data. Transparent decision making – grounded in spatial assessments, scenario planning, and participatory inputs – can help balance conservation and development objectives. Open access data platforms, regular monitoring frameworks, and tools for mapping biodiversity values support more robust and defensible plans. Many G20 countries have found that embedding adaptive management cycles, including periodic reviews and flexible feedback mechanisms, enables MSP to remain responsive to new information and changing ocean conditions.

G20 example: Australia's bioregional planning process integrates ecological, economic, and cultural data to inform zoning and management measures within marine parks. Long-term monitoring and review cycles allow updates based on new science and stakeholder input, helping ensure continued relevance and effectiveness of marine spatial plans.

3.1.5 Mainstreaming Biodiversity Across Sectors and Scales

Mainstreaming biodiversity into MSP and other ABMTs requires deliberate integration across marine sectors – including fisheries and aquaculture, energy, transport, and conservation – as well as across governance levels. This approach ensures that biodiversity is not treated as an isolated objective but is embedded into decision making systems that govern ocean uses. Coordination mechanisms such as inter-ministerial committees and inclusive stakeholder platforms can align sectoral interests and foster co-benefits for nature and people. At the same time, aligning local, national, and regional planning scales helps maintain ecological connectivity, accommodate diverse knowledge systems, and support coherent implementation. Well-designed spatial data infrastructures and participatory planning processes are critical enablers of this integrative approach. Embedding biodiversity targets across planning instruments and ensuring consistency with national development strategies, climate commitments, and sustainable blue economy agendas enhances policy coherence. Joint planning frameworks and adaptive governance mechanisms are essential to align objectives across institutions, reduce fragmentation, and maximise synergies. Enhancing institutional capacity, fostering cross-sectoral dialogue to enhance collaboration, and conducting comprehensive framework reviews are effective approaches to advance integrated governance and policy alignment. The KMGBF also underlines the importance of policy coherence by setting objectives to integrate biodiversity into all policies and reform detrimental incentives. Programmatic approaches are necessary for monitoring these changes. Tools like UNEP's Sustainable Blue Economy Transition Framework and Rapid Readiness Assessment method (UNEP, 2025) are practical tools to develop, embed and deliver cohesive policy and SBE transition pathways via biodiversity-inclusive MSP and sustainable oceans plans.

G20 example: Japan integrates biodiversity into national ocean governance through its *Basic Plan on Ocean Policy*, which promotes coordination across fisheries, environment, and infrastructure sectors. Marine conservation priorities are reflected in spatial policies for fisheries, coastal protection, and disaster risk reduction, demonstrating multi-sectoral and multi-scale alignment.

3.2 Capacity Gaps and Needs for the Implementation of MSP

3.2.1 Enhancing Coordination Across Agencies and Levels

One of the most persistent barriers to effective MSP is the lack of coordination across sectors, institutions, and levels of government. Overlapping mandates, siloed systems or decision-making, and limited communication among agencies often lead to fragmented marine governance. Addressing this requires clearly defined institutional roles, formalised coordination mechanisms, and whole-of-government approaches. National inter-ministerial committees, cross-sectoral working groups, and dedicated MSP coordination units can facilitate dialogue, align priorities, and ensure policy coherence. Vertical coordination between national and sub-national authorities is equally critical to integrate local knowledge, address place-based challenges, and ensure implementation aligns with regional and community-level needs. Moreover, it is crucial that MSP is embedded within a broader strategic approach to sustainable ocean governance. This includes aligning MSP with complementary spatial and non-spatial tools including (but not limited to) MPA and OECM management, coastal zone planning, local fisheries governance, and marine pollution control. Cross-border coordination with neighbouring states is also essential to address shared marine ecosystems and transboundary pressures. By situating MSP within a wider governance architecture, countries can enhance the effectiveness, legitimacy, and durability of planning outcomes.

G20 example: Argentina has strengthened coordination for MSP through its Interministerial Coordination Table for MSP, involving agencies from the environment, fisheries, defence, and transport sectors. This institutional mechanism promotes integrated decision-making, clarifies mandates, and ensures that MSP implementation reflects both national development priorities and environmental commitments.

3.2.2 Institutional and Human Capacity Needs

Institutional and human capacity are fundamental to the successful implementation of MSP and other ABMTs, yet many countries face challenges such as limited dedicated personnel, insufficient technical expertise in spatial planning methodologies (e.g. systematic conservation planning), and unclear institutional mandates. These gaps are often compounded by high staff turnover and fragmented responsibilities across agencies, undermining institutional memory and continuity. Building and retaining capacity requires long-term strategies, including the creation of specialised MSP units, sustained training and mentoring programmes, and investment in supportive administrative environments. Success also depends on political leadership and buy-in from senior authorities, since planners are only as effective as their institutional mandates and the support from ministries or ministers allow them to be. Capacity development must also extend to local and subnational levels to ensure that MSP is grounded in real-world contexts and supported by diverse knowledge systems.

G20 example: The Republic of Korea has invested in institutional and human capacity for MSP through the establishment of the MSP Centre within the Korea Maritime Institute and the

development of specialised training programmes for planners and local stakeholders. These initiatives support cross-sectoral collaboration and the integration of ecosystem-based and climate-resilient approaches in national marine planning.

3.2.3 Data, Modelling, and Monitoring Gaps

Access to reliable, up-to-date, and spatially explicit marine data is a cornerstone of effective MSP. However, many countries face significant data limitations, including fragmented databases, limited spatially extensive monitoring systems, and inadequate integration of socio-economic and biodiversity data. Addressing these challenges requires coordinated national data management strategies, open access platforms, and standardised methodologies for data curation and analysis. Investing in modelling tools to bridge data gaps or simulate different management scenarios may enhance evidence-based decision-making.

G20 example: Germany has developed a centralised marine data infrastructure (MDI-DE) that integrates environmental, economic, and spatial datasets from multiple agencies. This platform supports ecosystem-based MSP by enabling consistent data access, scenario modelling, and performance tracking, helping planners align maritime uses with conservation objectives under the EU MSP Directive.

3.2.4 Financing and Resource Mobilisation

Ocean governance through MSP requires sustained financial investment to support data collection, stakeholder engagement, institutional coordination, capacity development, implementation, monitoring and evaluation. However, many countries struggle with limited public funding and fragmented resource mobilisation, which can delay or compromise the quality of planning and implementation. Blended finance models, including public-private partnerships and climate or biodiversity funds, can help bridge resource gaps. Incorporating MSP into national development plans and climate adaptation strategies can also unlock financing from development banks and multilateral environmental funds.[2] Biodiversity-inclusive MSP provides a comprehensive framework for attracting finance by reducing investment risks and increasing investor certainty. It also helps balance the needs of various sectors, promoting sustainable use of marine biodiversity and resources and attracting investment for both economic development and conservation.

The UNEP Sustainable Blue Economy Finance Principles[3] are a global guiding framework for banks, insurers and investors to finance an SBE transition and associated activities, such as biodiversity-inclusive MSP, to protect natural assets. They promote *inter alia* systemic and precautionary objectives in SBE investments. These principles are primarily directed towards private financial institutions (banks, investors and insurers) but are also supportive of public finance. Public finance is particularly important and influential to the development of an SBE as many enabling activities –

[2] To catalyse this potential, G20 countries are encouraged to engage actively with ready and willing development partners, including organisations such as the World Bank, UNESCO/IOC, and regional cooperation frameworks like the UNEP Regional Seas Conventions.

[3] https://www.unepfi.org/blue-finance/the-principles/

such as biodiversity inclusive MSP – are determined during the planning stage and well before private financial institutions are involved with financing. Relevant guidance on the application of the SBE Finance Principles includes UNEP FI (2021) and UNEP FI (2022). Moreover, UNEP FI (2024) supports financial institutions in setting targets for an SBE.

G20 example: Indonesia has mainstreamed MSP within its national development strategy and secured funding through its Maritime Affairs and Fisheries Ministry, while also leveraging international support through initiatives like the Coral Triangle Initiative and the World Bank's PROBLUE programme. This approach has enabled continued investment in MSP and associated conservation measures.

3.2.5 Need for Peer Learning and Regional Collaboration

Peer learning and regional collaboration are powerful mechanisms for building capacity, harmonising approaches, and accelerating MSP and ABMT implementation. Many countries face knowledge gaps around spatial planning (e.g. systematic conservation planning), stakeholder engagement, or technical tools that could be addressed through structured exchange with more experienced peers. Regional platforms, multilateral dialogues, and technical partnership arrangements foster learning-by-doing, policy coherence, and the sharing of context-appropriate innovations. They also help build trust and alignment in transboundary planning efforts, which are essential where marine ecosystems span multiple jurisdictions.[4]

G20 example: India has actively engaged in South-South and regional learning exchanges, notably through its participation in the MSPglobal Initiative and partnerships with neighbouring countries under the Indian Ocean Rim Association (IORA), fostering knowledge transfer on inclusive and ecosystem-based marine planning.

On a regional scale, the 2023 decision of the Contracting Parties of the Barcelona Convention and its Protocols on the implementation of MSP in the Mediterranean is supported through a regional MSP Working Group of national experts. The Mediterranean Strategy for Sustainable Development 2026-2035 furthermore promotes the deployment of MSP to tackle biodiversity loss, effectively implement MPAs, and accelerate the achievement of SDG 14 through an SBE.

3.3 From Planning to Practice: Strategic Levers for MSP Implementation

3.3.1 Addressing Political Will and Policy Coherence

Some of the challenges in implementing MSP include limited political will and championship as well as a lack of coherence across sectoral policies. Without high-level commitment, endorsement and strategic guidance, MSP processes often remain fragmented, underfunded, or disconnected from

[4] Such efforts align with the G20 presidency's call to foster knowledge exchange, progress sharing, and regional cooperation, and can be exemplified by initiatives in regions like the Western Indian Ocean, where MSP is being positioned - through international partnerships such as with the World Bank and enabled by the Nairobi Convention - as a foundational element for sustainable and equitable Blue Economy development.

broader development, climate, and conservation agendas. Political will is essential not only to legitimise marine planning efforts but also to integrate them into national strategies for sustainable development, the SBE, and biodiversity protection. Coherent policy frameworks help align mandates between ministries, reduce regulatory conflict, and provide a clear institutional home for MSP. Embedding MSP within long-term development or ocean governance strategies can catalyse progress and unlock resources.

G20 example: The United Kingdom embedded MSP into its broader marine governance framework through the Marine and Coastal Access Act (2009), linking planning with fisheries, conservation, and marine licensing. Strong political support ensured cross-departmental coherence and led to the successful implementation of marine plans for all English inshore and offshore regions.

3.3.2 Enabling Adaptive, Participatory Implementation Frameworks

Adaptive and participatory implementation frameworks are fundamental to effective MSP. While most MSP processes are designed as cyclical rather than static, it is essential that plan revision is needs-based and responsive to dynamic ocean conditions, emerging industries, and shifting conservation and political priorities. Embedding monitoring, evaluation, and learning mechanisms enables timely updates and continuous improvement. Equally important is ensuring meaningful stakeholder participation beyond plan development—engaging communities, sectors, and Indigenous Peoples throughout implementation strengthens legitimacy, equity, and knowledge integration and building lasting communities of practice. Institutionalising inclusive governance structures and feedback loops fosters iterative learning, enhances compliance, and increases the durability and impact of MSP over time.

G20 example: Canada's MSP approach includes regional planning bodies that incorporate Indigenous and stakeholder representatives throughout implementation. These bodies review progress, adjust planning priorities, and ensure transparency, supporting adaptive management and reinforcing trust in the process. This participatory governance model underpins Canada's MSP Framework (2019).

3.3.3 Embedding Climate Resilience and Social Equity

To be effective and future-proof, MSP must also explicitly address climate resilience and social equity. Ocean warming, acidification, sea-level rise, and shifting species distributions are already undermining the integrity of marine ecosystems and the livelihoods that depend on them. Embedding climate-smart principles – such as scenario planning, ecosystem-based adaptation, and blue carbon protection – enables MSP to support mitigation and adaptation efforts that are socially equitable or even transformative. Equally, integrating social equity ensures that planning reflects the needs of vulnerable coastal communities, small-scale fishers, and Indigenous Peoples. Holistic alignment of MSP with the Paris Agreement and KMGBF targets helps secure both ecological sustainability and social equity. As emerging marine climate interventions (e.g. ocean fertilisation and geoengineering experiments) are explored, MSP should also be informed by related international frameworks such as the London Convention and Protocol, which provide

environmental safeguards. G20 cooperation can help ensure these instruments evolve in step with scientific advances and equity considerations.

G20 example: The United States integrates climate resilience into MSP through regional ocean partnerships, such as the Northeast Regional Ocean Plan, which uses climate projections and socio-economic vulnerability mapping to guide spatial decisions that protect habitats and coastal communities under future change scenarios.

3.4 Synthesis: a Roadmap to Guide G20 Biodiversity Inclusive MSP Practice

This technical paper supports the delivery of the Chennai High-Level Principles for a Sustainable and Resilient Blue/Ocean-based Economy (G20, 2023), endorsed during India's G20 presidency, by operationalising key principles such as inclusivity, sustainability, and ecosystem-based approaches through the lens of biodiversity-inclusive MSP. It also reflects priorities raised under Brazil's G20 presidency, particularly the emphasis on regional cooperation, nature-based solutions, and the integration of MSP into broader development planning and climate adaptation strategies. Together, these elements underscore the paper's relevance to ongoing G20 dialogues and its contribution toward coherent and forward-looking ocean governance.

A proposed roadmap (Figure 3) jointly developed through discussions of the G20 ECSWG distils global best practice into actionable guidance. It supports the notion of biodiversity-inclusive MSP, e.g. through integration of area-based conservation tools and practices, with the aim to balance ecological resilience with SBE goals. Common challenges are highlighted and solutions provided, specifically considering developing country contexts.

To ensure enduring impact beyond South Africa's presidency, the G20 ECSWG is encouraged to institutionalise a platform for continued collaboration on integrated ocean governance.

Biodiversity-inclusive, climate-smart MSP, alongside more effective MPAs and scaling of marine OECMs, requires long-term commitment, strategic alignment, and international cooperation. Embedding these tools within national and regional planning frameworks—and aligning them with the SDGs, KMGBF, and the Paris Agreement—will enable G20 countries to lead a transformation in ocean governance. Establishing continuity through a structured five-year engagement framework (Figure 4; Annex 6) will foster institutional memory, support shared learning, and catalyse innovation across countries. Sustained G20 engagement is vital to advancing ocean sustainability, enhancing climate resilience, and delivering equitable benefits for coastal communities around the world

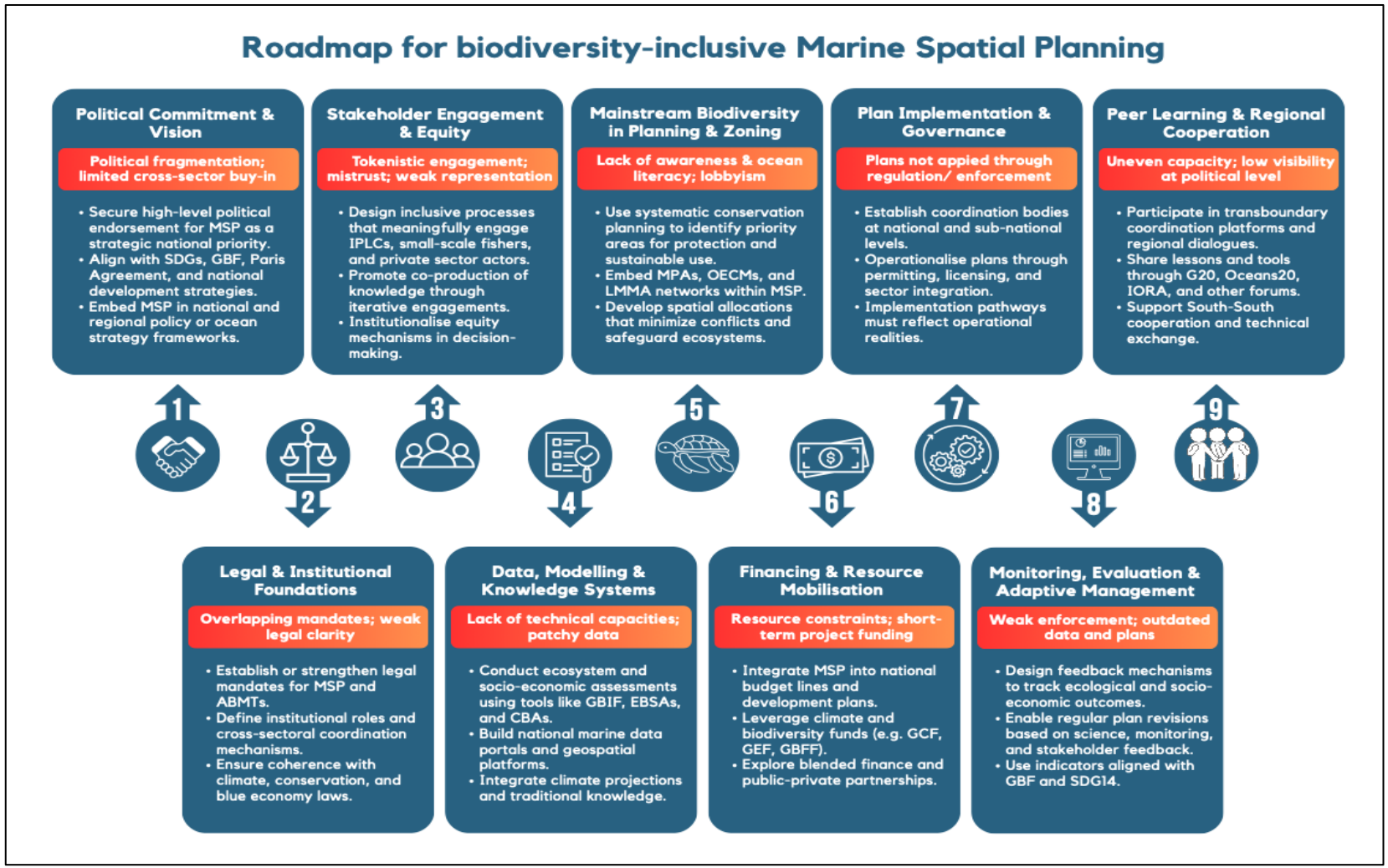


***Figure 4**: Roadmap for biodiversity-inclusive MSP in G20 countries. For each step of the MSP process, common challenges are shown (in red boxes) as well as international best practice. (An editable version in table format is provided in Annex 5, Table A5)*

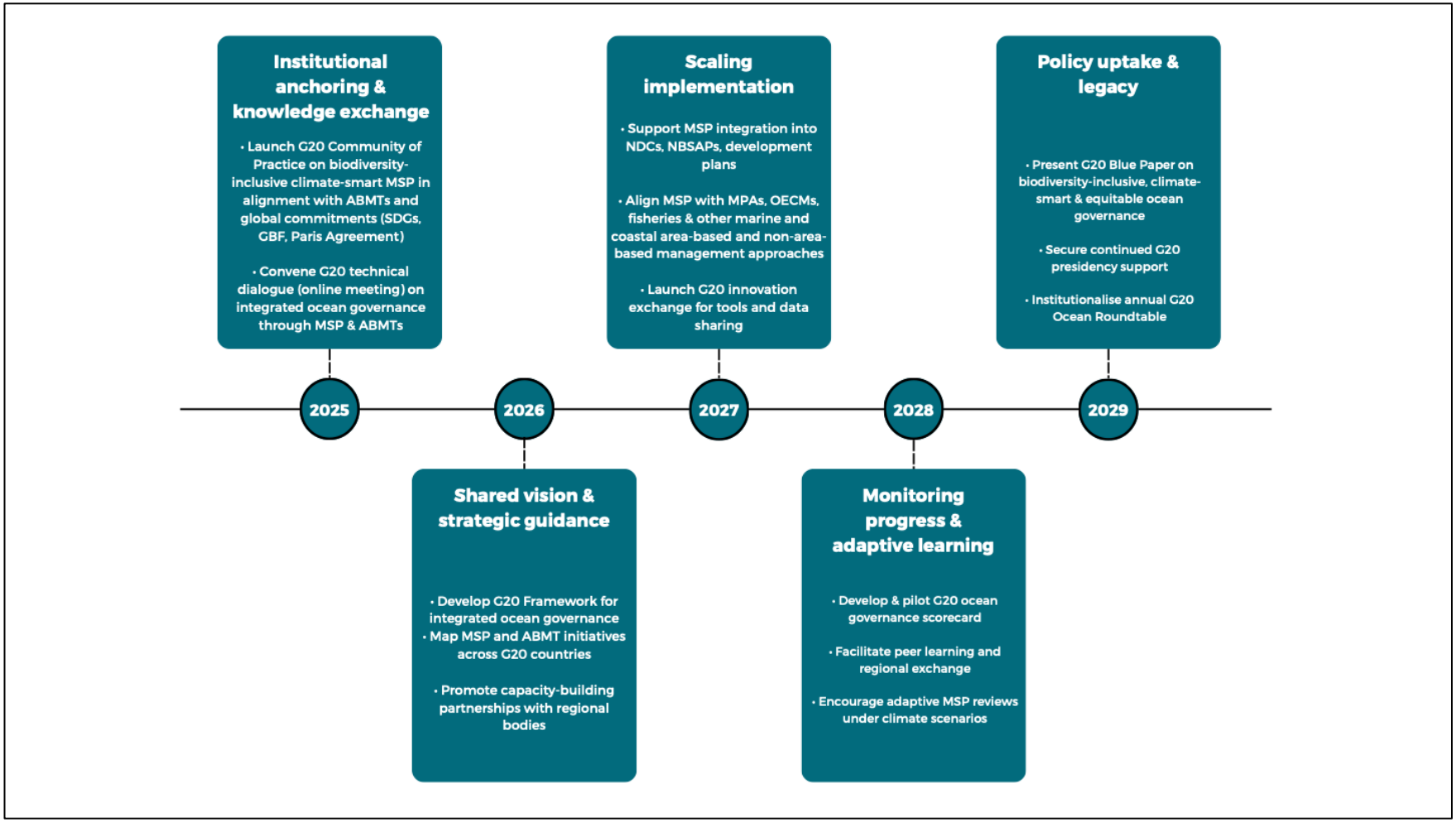


***Figure 5**: Proposed 5-year engagement framework for fostering a platform to strengthen integrated ocean governance through an ongoing G20 ECSWG platform. (An editable version in table format is provided in Annex 6, Table A6)*

4 PROPOSED G20 PRESIDENCY RECOMMENDATIONS AND CONSIDERATIONS

To accelerate progress toward ocean sustainability and a resilient blue economy, the G20 ECSWG is well-positioned to champion the mainstreaming of biodiversity-inclusive and climate-smart MSP and other ABMTs. Based on the findings of this paper, the following recommendations are proposed:

7.1 Promote holistic ocean management based on biodiversity-inclusive and climate-smart principles

To be effective, MSP must evolve beyond a narrow technical exercise into a catalyst for holistic ocean management that brings together conservation, climate resilience, and sustainable development. Embedding biodiversity-inclusive and climate-smart principles across MSP and other area-based approaches, such as MPAs and OECMs, creates synergies that strengthen ecosystems while supporting equitable benefits for people. By positioning MSP within broader national and regional strategies aligned with the SDGs, KMGBF, and the Paris Agreement, G20 members can demonstrate how spatial planning can be harnessed as a transformative governance tool for sustainability, rather than a stand-alone process.

7.2 Strengthen legal, institutional, and strategic frameworks

Clear legal mandates and institutional roles can provide an important foundation for coherent MSP implementation. Where appropriate, countries are advised to review or adapt legislation and strategic policies in ways that support cross-sector coordination, stakeholder inclusion, and the integration of biodiversity and climate objectives.

7.3 Close capacity, data, and financing gaps

Investment is needed to enhance institutional and human capacity, particularly in spatial planning, stakeholder engagement, and data integration. G20 countries can catalyse progress by mobilising finance by supporting investments, through domestic budgets and multilateral climate and biodiversity funds, and by promoting open-access marine data platforms and modelling tools.

7.4 Promote inclusive and participatory governance

MSP and ABMTs must include the knowledge, rights, and priorities of Indigenous Peoples, small-scale fishers, and local communities. Participatory mapping, co-design and co-management approaches, and community representation in planning bodies can ensure that MSP delivers equitable outcomes. Global and regional cooperation and stakeholder engagement platforms should provide frequent opportunities to amplify local voices, facilitate knowledge exchange, and promote inclusive governance practices across marine planning processes.

7.5 Foster knowledge exchange, progress sharing and regional cooperation

The G20 ECSWG has a unique opportunity to champion a global Community of Practice for ocean and coastal sustainability to help bridge implementation gaps, promote policy coherence, and build trust through the sharing of good practices, collaborative learning, and technical support across diverse contexts. Continued robust dialogue on new developments and progress in the sustainable blue economy and ocean governance – including tools such as MSP – is encouraged among G20 members. Voluntary progress-sharing, for example through an annual G20 update on ocean sustainability indicators such as those presented in this paper (e.g. Figure 2; Annexes) could further enhance continuity and transparency.

7.6 Adapt global guidance into national action

G20 countries are encouraged to translate existing guidance on biodiversity-inclusive MSP to their national contexts. Technical support and cross-sectoral alignment are essential for turning these tools into practice on the ground.

7.7 Elevate ocean governance and the sustainable blue economy on political agendas

Ocean governance is key for unlocking the potential of the SBE and achieve development, biodiversity, and climate goals, while accelerating efforts towards SDG progression. G20 leaders are well positioned to champion this agenda by promoting evidence-based spatial governance and management approaches (incl. MSP and ABMTs) and help catalyse coordinated national action. The ECSWG may also explore the option of a shared Action Agenda to articulate common principles, milestones, and priorities for advancing integrated and inclusive ocean governance.

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ANNEX 1: STRATEGIC PRIORITIES FOR MSP IN DIFFERENT COUNTRIES

***Table A1**: Various strategic priorities guide Marine Spatial Planning (MSP). G20 members were invited to contribute examples reflecting their county contexts and priorities.*

Priority	Rationale	Example
Sustainable Blue Economy	Balance economic development (e.g. fisheries, tourism, energy) with long-term ocean health and job creation	The European Union's Sustainable Blue Economy Strategy aligns blue growth with the European Green Deal.
Biodiversity & Ecosystem Approach	Protect critical habitats, species, and ecosystem services, ensuring resilience and sustainability	South Africa and Mexico integrate EBSAs and CBAs in MSP approach; area-based conservation measures (MPAs/OECMs) are prioritised to meet CBD targets (e.g. Target 1 "biodiversity-inclusive MSP; Target 3 "30x30")
Economic development	Optimise space for offshore energy, ports, aquaculture and reduce spatial conflicts	China's MSP supports blue economy growth by zoning industrial and aquaculture zones
Fisheries management	Incorporate small-scale and commercial fisheries into spatial plans to reduce conflict	Indonesia includes exclusive community fishing zones in provincial MSP plans
Climate resilience & adaptation	Integrate climate change adaptation and mitigation into MSP and management	Japan's MSP incorporates coastal hazard mapping and resilience planning into zoning
Conflict resolution among sectors	Minimise spatial conflicts between competing sectors (e.g. fishing, shipping, energy, conservation)	Germany's EEZ plan balances shipping, energy, and conservation zones
Regional / transboundary coordination	Manage shared marine resources and address cross-border issues (e.g. migratory species, pollution)	Good and long-standing transboundary coordination in the Baltic Sea Region through HELCOM-VASAB MSP WG UNEP/MAP newly established WG on MSP offers new opportunity for advancing MSP in the Mediterranean region
Stakeholder inclusion & transparency	Ensure buy-in, equity and legitimacy by involving all relevant stakeholders, incl. Indigenous Peoples and local communities	Canada co-develops Pacific MSP with First Nations
Data integration & science-based planning	Inform decisions with best available science, spatial data, and environmental assessments	USA's NOAA MSP framework utilizes spatial data portals and risk assessments

ANNEX 2: STATUS OF MSP IMPLEMENTATION IN G20 MEMBER STATES

***Table A2**: Information gathered by the MSPGlobal initiative (Available on: https://www.mspglobal2030.org/msp-roadmap/msp-around-the-world/), a joint effort by UNESCO's Intergovernmental Oceanographic Commission (IOC-UNESCO) and the European Commission. Not all information is up to date (see column "Last update"). G20 members were invited to update information relating to their respective MSP status in this table.*

Country	Scale of the plan	Pre-planning	Assess-ments for planning	Plan develop-ment	Plan completion	Plan approval	Plan implement-ation	Plan review	Last update
Argentina	National	Complete	Underway	Underway	N/A	Underway	Underway	Underway	Apr 2025
Australia	Commonweal th marine jurisdiction (offshore, not coastal zone)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Aug 2018
Brazil	National, Southern Region (pilot)	Complete	Underway	N/A	N/A	N/A	N/A	N/A	Feb 2025
Canada	Sub-national	Complete	Complete	Complete	Complete	Complete	Underway	N/A	Feb 2025
China	National, Sub-national, Local	Complete	Complete	Complete	Complete	Complete	Complete	Underway	Jun 2020
France	National	Complete	Complete	Complete	Complete	Complete	Underway	The various plans are revised every 6 years, i.e. 2030 for the SNML and 2031 for the DSF.	Mar 2025
Germany	National	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Jun 2022
India	No data	No data	No data	No data	No data	No data	No data	No data	No data

Country	Scale of the plan	Pre-planning	Assess-ments for planning	Plan develop-ment	Plan completion	Plan approval	Plan implement-ation	Plan review	Last update
Indonesia	National	Complete	Complete	Complete	Complete	Complete (through a Government Regulation)	Underway	Review/revision every five years or other timeframe when necessary (e.g. due to natural disasters or other national urgent matters)	Feb 2025
Italy	National	Complete	Complete	Complete	Complete	Complete	Underway	Possible mid-term revisions	Aug 2025[a]
Japan	No data	No data	No data	No data	No data	No data	No data	No data	No data
Mexico	Sub-national	Complete	Complete	Complete	Complete	Complete	Complete	N/A	Feb 2025
Russia	No data	No data	No data	No data	No data	No data	No data	No data	No data
Republic of Korea	National	Complete	Complete	Complete	Complete	Complete	Complete	Open to revision at the five-year term	May 2020
Saudi Arabia	N/A	Underway	Underway	Underway	N/A	N/A	N/A	N/A	Apr 2025
South Africa	National	Complete	Underway	N/A	N/A	Ministerial Committee on MSP will approve Marine Area Plans	N/A	Every 5 years or per need	Jun 2022
Turkey	National	Complete	Complete	Complete	Complete	Underway	Underway	N/A	Jun 2025

[a] This row was updated through direct feedback from Italy. The MSPGlobal was last updated in July 2022.

Country	Scale of the plan	Pre-planning	Assess-ments for planning	Plan develop-ment	Plan completion	Plan approval	Plan implement-ation	Plan review	Last update
UK: England	Sub-national	Complete	Complete	Complete	Complete	Complete	Complete	Underway	Apr 2025
UK: Northern Ireland	Sub-national	Complete	Complete	Complete	Complete	Underway	Underway	N/A	Apr 2025
UK: Scotland	Sub-national	Complete	Complete	Complete	Complete	Complete	Complete	Revision of the management plan: Every three years	Jun 2020
UK: Wales	Sub-national	The WNMP has been prepared and adopted under the Marine and Coastal Access Act (2009)	N/A	The plan has been adopted with the agreement of the UK Government Secretary of State for Environment, Food and Rural Affairs for non-devolved matters.	Now the Plan is in place, relevant public authorities must take account of it in their decision making.	Adopted with the agreement of the UK Government Secretary of State for Environment, Food and Rural Affairs for non-devolved matters.	Stakeholders have been engaged throughout the Marine Planning process through the Marine Planning Stakeholder Reference Group and with decision makers through the Marine Planning Decision Makers Group.	A review and reporting will take place at least every three years on the effects of policies in the WNMP.	Jun 2020
USA	Sub-national	Complete	Complete	Complete	Complete	Complete	Underway	N/A	Feb 2025

ANNEX 3: STATUS OF MARINE CONSERVATION OF THE G20 EEZ

***Table A3**: Protection coverage of Marine Protected Areas (MPAs) and marine OECMs, as officially reported on the World Databases for Protected Areas (WDPA) / OECM (WD-OECM). However, only much lower percentages of MPAs have been implemented and considered fully / highly protected (MPA Atlas; last two columns). Note that to date very few countries have officially reported marine OECMs. Data represent the status quo in June 2025.*

G20 member country	Total marine and coastal area / EEZ (WDPA)[a] (km2)	Percentage MPA coverage (WDPA) (UNEP-WCMC & IUCN, 2025)	Percentage Marine OECM coverage (WDOECM)[b] Error! Bookmark not defined.	Percentage fully / highly protected marine area (MPA Atlas)	Percentage protected & implemented marine area (MPA Atlas)
Argentina	1,071,039	12.0%	0%	0.7%	1.6%
Australia	7,351,434	45.4%	0%	11.0%	41.6%
Brazil	3,682,336	26.7%	0%	3.2%	24.6%
Canada	5,733,482	9.2%	4.72[c]	0.2%	0.4%
China	957,646	4.8%	0%	0%	0%
France	347,760	49.8%	0%	0%	5.8%
Germany	56,560	45.4%	0%	0%	3.0%
India	2,325,759	0.3%	No data	0%	0%
Indonesia	6,021,765	3.%	0%	0.1%	0.2%
Italy	536,463	11.%	0%	0%	7.8%
Japan	4,066,374	13.8%	Not specified[d]	0%	5.9%
Mexico	3,186,357	22.6%	0%	4.8%	20.5%
Russia	No data	2.2%	0%	0.8%	0.8%
Republic of Korea	346,807	2.2%	0%	0%	0%
Saudi Arabia	224,039	3.6%	0%	0%	0%
South Africa	1,547,395	15.4%	0%	4.3%	14.7%
Turkey	262,125	1.7%	0%	0%	0%
UK	727,745	46.8%	0%	0%	0%
USA	8,610,701	19.%	0%	17.5%	18.9%

[a]. UNEP-WCMC and IUCN (2025) Protected Planet: The World Database on Protected Areas (WDPA). June 2025. Cambridge, UK: UNEP-WCMC and IUCN. Available at: <www.protectedplanet.net>.

[b] Data were sourced from the World Database on OECMs (www.protectedplanet.net) unless otherwise stated in recent peer-reviewed literature (superscript numbers). Many countries have identified candidate marine OECMs, but to date few have been officially recognised and reported.

[c.] Jonas, H.D., Bingham, H.C., Bennett, N.J., Woodley, S., Zlatanova, R., Howland, E., Belle, E., Upton, J., Gottlieb, B., Kamath, V. and Lessmann, J. (2024) Global status and emerging contribution of other effective area-based conservation measures (OECMs) towards the '30x30' biodiversity Target 3. *Frontiers in Conservation Science*, 5, p.1447434.

[d] As of March 2025, 328 sites have been nationally certified as OECMs, with 159 registered on WD-OECM, but marine/terrestrial split is not detailed (www.env.go.jp/nature/biodiversity/OECM.html)

ANNEX 4: INTERNATIONAL GUIDANCE ON MSP

***Table A4**: Overview of international guidance on biodiversity-inclusive MSP. Years in brackets indicate planned products that have not been published yet (see full references under References).*

Guidance / Source	Year	Key Objectives	Main Features	Approach	Reference
MSPglobal International Guide on MSP	2021	Support countries to develop marine/maritime spatial plans aligned with ecosystem-based, participatory principles	Step-by-step, practical guidance for national, regional, and transboundary MSP	Emphasizes EBSA integration, ecosystem approach, and alignment with KMGBF	IOC-UNESCO and European Commission (2021)
MSPglobal International Guide on MSP (Vol 2) – Biodiversity-inclusive Principle	2025	Support countries with KMGBF Target 1 implementation (bio-diversity-inclusive MSP)	Stepwise recommendations for each MSP phase; ecosystem-based, knowledge-driven, inclusive, adaptive, and integrates science and Indigenous knowledge	Flexible, non-prescriptive, participatory guidance; complements existing MSP tools; applicable to diverse national and regional contexts	IOC-UNESCO and European Commission (2025)
IUCN WCPA Guidance on Participatory, Integrated, and Biodiversity-Inclusive Spatial Planning (PI-BISP)	2024	Guide countries to implement Target 1 of the KMGBF: all areas under participatory, integrated, biodiversity-inclusive spatial planning by 2030	Holistic, systematic, integrates terrestrial, freshwater, and marine; clear biodiversity goals; participatory; outcome-driven; adaptive management; equity and Indigenous rights	Systematic, policy-linked, whole-of-society, data-driven, with monitoring and evaluation	Grantham et al. (2024)
World Bank PROBLUE Guidance on MSP for a resilient and	2022	Enhance ocean governance through integrated MSP	Two-volume toolkit: (1) Formulate & implement MSP; (2) Integrate	Stepwise process: (a) make the case; (b) enable conditions; (c) plan	World Bank, (2022)

Guidance / Source	Year	Key Objectives	Main Features	Approach	Reference
inclusive Sustainable Blue Economy		frameworks & balance ecological, social, and investment priorities to support sustainable blue economies	cross-cutting themes (climate, gender, biodiversity, economy)	formulation; (d) implementation ; with integrated cross-cutting considerations	
CBD Guidance Notes for Target 1 (Biodiversity-Inclusive Spatial Planning)	2023	Help countries implement KMGBF Target 1 on spatial planning	Outlines principles for biodiversity-inclusive planning, incl. terrestrial & marine applications	Focuses on ecological representativity, connectivity, inclusion of IPLCs and EBSAs	CBD Secretariat: https://www.cbd.int/gbf/targets/1
IPBES Assessment on Integrated Biodiversity-Inclusive Spatial Planning and Ecological Connectivity	(2027)	Provide methodological assessment and best practice for integrating biodiversity and connectivity into spatial planning across land, inland waters, and sea	Methods, tools, scenarios, lessons learned, focus on connectivity, cross-sectoral, multi-scale	Science-policy assessment, practical recommendations for policymakers and practitioners	N/A – not yet published

ANNEX 5: ROADMAP FOR BIODIVERSITY-INCLUSIVE MSP – EDITABLE FORMAT

***Table A5**: Roadmap to guide effective MSP processes (herewith as editable table format). Each step highlights international best practice for overcoming common challenges (in red boxes).*

Step	Common challenges	Best practice
1. Political Commitment & Vision	Political fragmentation, limited cross-sector buy-in	• Secure high-level political endorsement for MSP as a strategic national priority. • Align with SDGs, KMGBF, Paris Agreement, and national development strategies. • Embed MSP in national and regional policy or ocean strategy frameworks.
2.Legal & Institutional Foundations	Overlapping mandates; weak legal clarity	• Establish or strengthen legal mandates for MSP and ABMTs. • Define institutional roles and cross-sectoral coordination mechanisms. • Ensure coherence with climate, conservation, and blue economy laws.
3. Stakeholder Engagement & Equity	Tokenistic engagement; mistrust; weak representation	• Design inclusive processes that meaningfully engage IPLCs, small-scale fishers, and private sector actors. • Promote co-production of knowledge through iterative dialogue. • Institutionalise equity mechanisms in decision-making.
4. Data, Modelling & Knowledge Systems	Lack of technical capacities; patchy data	• Conduct ecosystem and socio-economic assessments using tools like GBIF, EBSAs, and CBAs. • Build national marine data portals and geospatial platforms. • Integrate climate projections and traditional knowledge.
5. Mainstream Biodiversity in Planning & Zoning	Lack of awareness & ocean literacy; lobbyism	• Use systematic conservation planning to identify priority areas for protection and sustainable use. • Embed MPAs, OECMs, and LMMA networks within MSP. • Develop spatial allocations that minimize conflicts and safeguard ecosystems.
6. Financing & Resource Mobilisation	Resource constraints; short-term project funding	• Integrate MSP into national budget lines and development plans. • Leverage climate and biodiversity funds (e.g. GCF, GEF, GBFF). • Explore blended finance and public-private partnerships.
7. Plan Implementation & Governance	Plans not applied through regulation / enforcement	• Establish coordination bodies at national and sub-national levels. • Operationalise plans through permitting, licensing, and sector integration. • Implementation pathways must reflect operational realities.
8. Monitoring, Evaluation & Adaptive Management	Weak enforcement; outdated data and plans	• Design feedback mechanisms to track ecological and socio-economic outcomes. • Enable regular plan revisions based on science, monitoring, and stakeholder feedback. • Use indicators aligned with KMGBF and SDG 14.
9. Peer Learning & Regional Cooperation	Uneven capacity; low visibility at political level	• Participate in transboundary coordination platforms and regional dialogues. • Share lessons and tools through G20, Oceans20, IORA, and other forums. • Support South-South cooperation and technical exchange.

ANNEX 6: VISION AND 5-YEAR ENGAGEMENT FRAMEWORK FOR AN ONGOING PLATFORM TO STRENGTHEN INTEGRATED OCEAN GOVERNANCE UNDER G20

***Table A6**: Proposed 5-year engagement framework to facilitate ingoing dialogue to advance ocean sustainability through the G20 ECSWG.*

Year	Theme	Key actions
2025	Institutional anchoring & knowledge exchange	• Launch G20 Community of Practice on biodiversity-inclusive climate-smart MSP in alignment with ABMTs and global commitments (SDGs, KMGBF, Paris Agreement) • Convene G20 technical dialogue (online meeting) on integrated ocean governance through MSP & ABMTs
2026	Shared vision & strategic guidance	• Develop G20 Framework for integrated ocean governance[e] • Map MSP and ABMT initiatives across G20 countries • Promote capacity-building partnerships with regional bodies
2027	Scaling implementation	• Support MSP integration into NDCs, NBSAPs, development plans • Align MSP with MPAs, OECMs, fisheries & other marine and coastal area-based and non-area-based management approaches • Launch G20 innovation exchange for tools and data sharing
2028	Monitoring progress & adaptive learning	• Develop & pilot G20 ocean governance scorecard • Facilitate peer learning and regional exchange • Encourage adaptive MSP reviews under climate scenarios
2029	Policy uptake & legacy	• Present G20 Blue Paper on biodiversity-inclusive, climate-smart & equitable ocean governance • Secure continued G20 presidency support • Institutionalise annual G20 Ocean Roundtable

[e] Such a framework should provide strategic guidance, common principles, and voluntary best practices for G20 members to coordinate MSP, as well as MPA, OECMs and other ocean governance tools. It should promote cross-sectoral integration, ecosystem-based planning, and coherence across national and regional scales, while respecting countries' legal and institutional contexts.

G20 2025 Report on Actions against Marine Plastic Litter

Seventh Information Sharing based on the G20 Implementation Framework

The seventh compilation of policies and measures undertaken by countries and international organisations worldwide to tackle marine plastic litter titled the "G20 2025 Report on Actions against Marine Plastic Litter" is a stand-alone report whose previous editions have been successfully published over the last six years. As the report will continue to be updated with new data to December 2025, it is published separately but will be available on various websites including https://www.dffe.gov.za/g20ecswg. The 2025 report aims to identify the most recent trends in policies tackling marine plastic litter among G20 countries and regions that share the Osaka Blue Ocean Vision, as well as international organisations.

SHERPA TRACK

Environment and Climate Sustainability Work Group (ECSWG)

Current impacts of and mitigation measures for Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG) in the Marine Environment

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[a] *This paper is a Technical Paper commissioned by the South African Department of Forestry, Fisheries, and the Environment (DFFE) to enrich and inform the discussion and deliberations of the 2025 G20 Environment and Climate Sustainability Working Group (ECSWG) during South Africa's G20 Presidency. Although the paper was subjected to various reviews by G20 Members, invited Guest Countries, and International Partners, the views, opinions, findings, and conclusions or recommendations expressed in these papers are those of the author(s) and do not necessarily reflect those of the G20 or the DFFE.*

EXECUTIVE SUMMARY

Abandoned, lost, or otherwise discarded fishing gear (ALDFG), or "ghost gear," is a persistent form of marine plastic pollution with severe environmental and socio-economic consequences, continuing to trap marine life and degrade habitats long after use. Small-scale fisheries in developing regions are disproportionately affected by limited infrastructure and oversight. This paper outlines the current response to ALDFG, examining multilateral frameworks and emerging best practices.

Key mitigation debates include gear marking, Extended Producer Responsibility (EPR), retrieval schemes, and liability mechanisms. These must be context-sensitive to avoid disproportionate impacts on small-scale fishers. ALDFG's environmental impacts include ghost fishing, entanglement, and multi-scale plastic pollution (micro, meso, and macro), alongside habitat destruction; socio-economic impacts range from reduced fish stocks and livelihoods to vessel safety risks and public cleanup burdens. Nets and lines also pose hazards to shipping, where entanglement of propellers or rudders can damage vessels, increase fuel use, and threaten crew safety. Root causes include operational challenges, economic pressures, weak regulation, and behavioural norms. Addressing these challenges requires inclusive policy frameworks with effective enforcement, investment in harbour reception and waste management infrastructure, community engagement and capacity-building, sustainable financing tools, regional cooperation, and continued innovation in fishing gear. In Africa, small-scale fisheries dominate, facing infrastructure gaps and high retrieval costs, but also presenting opportunities for innovation and regionally coordinated responses through continental and regional governance frameworks.

The report concludes with G20-oriented recommendations: supporting pilot projects for gear marking and traceability, advancing EPR studies, developing national and regional action plans, and promoting global data standards with digital monitoring. It also calls for incentivising innovation, scaling recovery, and integrating ALDFG into sustainable 'blue' finance. Equity and inclusion are cross-cutting themes, with particular attention to small-scale, Indigenous Peoples, and under-represented stakeholders. The paper urges the G20 to lead in forging inclusive, innovative, and enforceable responses to this global challenge.

1 INTRODUCTION

Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG), also known as "ghost gear," represents one of the most damaging yet under-recognised forms of marine plastic pollution. Unlike general marine plastic pollution, ALDFG continues to harm marine life long after its initial use through entangling wildlife, damaging sensitive habitats like coral reefs, and contributing to the growing volume of ocean debris (Gilardi, et al., 2020; FAO, 2024). ALDFG was one of the earliest drivers of recognition of plastic pollution, owing to its direct and visible impacts on marine life and fisheries. While overall plastic pollution is now widely acknowledged, international momentum around ALDFG-specific responses has increased in recent years.

Globally, ALDFG is estimated to make up a significant share of large plastic debris in the world's oceans (Kuczenski, et al., 2021; Richardson, et al., 2022; Richardson, et al., 2019). For example, studies in the North Pacific Gyre region ("North Pacific Garbage Patch") have shown fishing gear to account for most of the macro-plastic mass (Lebreton, et al., 2022; Lebreton, et al., 2018). In the Global South[b], this issue is compounded by the dominance of small-scale fisheries with an overall lack of vessel and gear registries and related management regimes, limited port waste reception facilities, and poor and inequitable access to training on gear handling (Gifford, et al., 2024). Fishing gear losses often result from a wide variety of causes, including storms, spatial conflicts, and lack of disposal options, while the lack of management, regulatory oversight and collection infrastructure further exacerbates the problem (UNEP, 2021; Macfadyen, et al., 2009).

Mitigation strategies, including gear marking, retrieval schemes, biodegradable designs, and producer responsibility models are being piloted, although success remains uneven. Regional approaches emphasise context-sensitive solutions grounded in collaboration across sectors (e.g., fisheries, maritime, environment, waste management) (Gifford, et al., 2024; GGGI, 2021). This paper investigates ALDFG impacts and reviews mitigation efforts, highlighting scalable interventions that balance ecological integrity with social equity. Its goal is to inform decision-makers and support collective action to reduce ALDFG and its consequences.

2 ONGOING MULTILATERAL DELIBERATIONS AND POLICY DEVELOPMENTS

Global concern around ALDFG has intensified over the past decade, prompting coordinated multilateral action at the highest levels of international governance. This section focuses on ongoing deliberations under the Intergovernmental Negotiating Committee (INC) and the International Maritime Organization (IMO), while briefly referencing historic efforts to provide

[b] Countries in Africa, Asia, Latin America, and Oceania that have historically been economically and politically marginalized by colonial powers and capitalist globalization with lower levels of development, income, and access to resources compared to the Global North. It is not a precise geographical term.

context. The UNEA Resolution 5/14 (2022) initiated negotiations for a legally binding global treaty to end plastic pollution. These negotiations, undertaken through the INC process, remain ongoing, following the inconclusive results of INC-5.2. Fishing gear has emerged as a subject of debate within these negotiations. Positions vary among Member States, from opposing explicit reference to gear, to advocating for dedicated provisions. Notably, the most recent Chair's Text from INC-5.2 included a dedicated provision on abandoned, lost or otherwise discarded fishing and aquaculture gear containing plastic, underscoring the strong level of support for measures addressing fishing-related plastic pollution, while also reflecting the diversity of Member State positions (UNEP, 2025). Momentum around ALDFG has also been reflected in G7 and OECD processes, including the OECD's Towards G7 Action to Combat Ghost Fishing Gear, which reviewed policy options and best practices for prevention and recovery (OECD, 2021).

Simultaneously, discussions at IMO's Marine Environment Protection Committee (MEPC) and the Pollution Prevention and Response (PPR) Sub-Committee continue to shape amendments to MARPOL (International Convention for the Prevention of Pollution from Ships) Annex V. These include proposals to mandate gear marking and strengthen gear loss reporting requirements. The current timeline anticipates submission of amendment proposals to PPR 13 (2026), with potential adoption at MEPC in 2028 and entry into force in 2029 (UNEP, 2021). The UN Food and Agricultural Organization (FAO) has contributed as an observer, providing input on challenges for developing countries and advocating for coordination with national fisheries authorities (Drinkwin, 2022). These deliberations build on the FAO's Committee on Fisheries (COFI), which endorsed the Voluntary Guidelines on the Marking of Fishing Gear (VGMFG) and continues to highlight ALDFG as a priority issue. At COFI-36 in 2024, Members reaffirmed the importance of addressing ALDFG, applauding FAO's technical work and encouraging further collaboration with IMO and regional bodies (FAO, 2024).

Regional efforts have also advanced, particularly in Africa, where the Abidjan and Nairobi Conventions have supported regional frameworks and action plans on marine plastic pollution and ALDFG (Nairobi Convention, 2021; Abidjan Convention, 2022). Platforms like the African Ministerial Conference on the Environment (AMCEN) have further endorsed regional approaches (Drinkwin, 2022; AMCEN, 2019). Additionally, Regional Fisheries Management Organizations (RFMOs) such as the Indian Ocean Tuna Commission (IOTC) and the General Fisheries Commission for the Mediterranean (GFCM) are implementing measures related to gear marking and loss reporting, particularly in relation to drifting Fish Aggregating Devices (FAD) (FAO, 2024; Gilman, 2015). In the North-East Atlantic, the OSPAR Convention has adopted and is implementing its second Regional Action Plan on Marine Litter (2022–2030), which includes specific actions to prevent and reduce ALDFG. As one of 15 Contracting Parties, the UK, along with other members, is supporting measures such as improved gear marking, retrieval programmes, and enhanced port reception facilities under this framework (OSPAR Commission, 2022).

While multilateral momentum has grown, challenges persist, particularly around capacity, enforcement, and equitable implementation in small-scale fisheries. These deliberations nonetheless represent a foundational step toward strengthening global governance frameworks to prevent and mitigate ALDFG. African representatives emphasise that global responses must account for regional disparities in capacity and governance. Regional frameworks provide policy pathways that reflect the realities of African fisheries, thereby strengthening inclusivity and equity in governance. African-led responses such as the African Union's Blue Economy Strategy, alongside community-based initiatives, further demonstrate proactive leadership in reducing ALDFG. At the same time, African voices stress that while globally binding frameworks are essential, flexible treaty mechanisms and country-driven models are equally important to accommodate diverse national capacities and contexts.

3 CURRENT INITIATIVES AND DEBATES

3.1 Global and Regional Initiatives

This section highlights multi-stakeholder programmes and technical initiatives, focusing on operational initiatives at global, regional, and national levels to address the reduction of ALDFG. The Global Ghost Gear Initiative (GGGI), established in 2015, is a dedicated alliance focused exclusively on ALDFG. GGGI convenes governments, fisheries, industry actors, and civil society to deliver practical solutions across the fishing gear lifecycle. Its resources include the Best Practice Frameworks for the Management of Fishing Gear (C-BPF) and Aquaculture Gear (A-BPF), which guide efforts on prevention, retrieval, and circular design (GGGI, 2021). In 2023, GGGI reported expanding global recovery operations and partnership-driven initiatives, with Australia joining in 2024 and committing AUD 1.4 million to retrieval and beach-clean-up activities in the Arafura and Timor Seas in partnership with Indigenous ranger groups.

The IMO–FAO OceanLitter Programme, supports developing countries in reducing marine plastic pollution from fisheries and maritime sectors and houses projects such as GloLitter Partnerships that promote MARPOL Annex V implementation, FAO's VGMFG uptake, and capacity-building for ALDFG reporting, gear retrieval, and port reception facilities (FAO, 2024). While the GPML supports knowledge exchange, innovation scaling, and voluntary reporting frameworks (UNEP, n.d.). Its Global Plastics Hub includes data and tools on ALDFG and sea-based marine plastic pollution (Global Plastics Hub, n.d.). GESAMP Working Group 43 focuses on sea-based sources of marine plastic pollution, including ALDFG, and contributes scientific guidance to global assessments and technical reports (GESAMP, 2024).

At a regional level, African institutions are generating their own frameworks and solutions. The African Union's Blue Economy Strategy provides a continental policy framework, while Sustainable Seas Trust's ALDFG Best Practice Guide supports community cleanups, gear

traceability pilots, and advocacy on behalf of small-scale fisheries (Gifford, et al., 2024). Regional frameworks addressing ALDFG in Africa are further detailed in section 7.2 under policy-based mitigation strategies, where ongoing initiatives and regional coordination efforts are discussed in greater depth, outlining how African-led approaches are shaping policy responses and practical interventions tailored to the continent's diverse fisheries contexts.

3.2 Policy and Regulatory Debates

3.2.1 Voluntary versus Mandatory Gear Marking

A central debate in ALDFG mitigation is whether gear marking should be mandatory under frameworks like MARPOL Annex V, or remain a flexible, context-specific measure guided by FAO's Voluntary Guidelines. Supporters of mandatory marking argue it enhances traceability, compliance, and retrieval efforts through enforceable systems (FAO, 2019), and generate critical data for retrieval (UNEP, 2021; GGGI, 2021). They note that inconsistent adoption hampers global monitoring and complicates transboundary enforcement, especially for industrial fleets (Gilardi, et al., 2020; Macfadyen, et al., 2009). Recent international developments have added momentum to this debate. Momentum is building, in June 2022, the IMO's MEPC agreed to develop a mandatory goal-based requirement under MARPOL Annex V. However, no formal proposals have been submitted yet, and mandatory marking is unlikely before 2029, pending a multi-stage approval process and a 16-month ratification period (MEPC, 2022).

Meanwhile, critics caution that imposing universal standards without support may disproportionately burden small-scale and artisanal fisheries, particularly in low-income countries. In regions with limited infrastructure and oversight, gear may not be available or affordable, and compliance systems may be impractical. These concerns have been echoed in recent COFI discussions (GESAMP, 2024), which call for phased implementation alongside training, subsidies, and enabling policies (Gifford, et al., 2024; GIZ, 2025). FAO and partners have also advocated for alignment with Regional Fisheries Management Organisations (RFMOs), recommending that the IMO PPR Sub-Committee evaluate existing RFMO reporting systems to avoid duplication and inefficiencies (FAO, 2024; PPR, 2025).

Emerging middle-ground models favour a gradual rollout, starting with high-risk gear types or geographic hotspots, supported by national systems and international funding to ensure equity and capacity-building (UNEP, 2021; FAO, 2024). Continued collaboration between FAO, IMO, and RFMOs remains key to harmonising standards and scaling practical, inclusive solutions. Globally, donor-supported pilot projects are testing phased gear marking approaches in developing countries; however, similar initiatives in Africa are still in earlier stages or emerging. Supporting pilot programmes in African small-scale fisheries would help produce context-sensitive implementation lessons and build capacity.

3.2.2 Extended Producer Responsibility (EPR) for Fishing Gear

Extended Producer Responsibility (EPR) shifts the cost and responsibility for end-of-life product management from the public sector to private actors, including manufacturers, importers, and retailers. Applied to fishing gear, mandatory EPR would require those involved in the production and sale of gear to contribute to its collection, recycling, or safe disposal at end-of-life (UNEP, 2021; GIZ, 2025). While EPR can help ensure gear is responsibly managed before it becomes abandoned, lost, or discarded, most ALDFG is heavily contaminated and not suitable for recycling, and retrieval costs may exceed what EPR schemes can realistically cover. Therefore, EPR and related schemes should be understood primarily as tools to improve sound waste management and reduce the likelihood of gear loss, rather than comprehensive mechanisms for funding ALDFG retrieval. However, without complementary enforcement, the distinction between loss and disposal can be blurred, with the risk that a no-penalty system incentivises deliberate discard under the guise of accidental loss. This underlines the importance of effective monitoring, reporting, and enforcement mechanisms to complement financial instruments. However, implementation in small-scale fisheries and harbours is challenging. Informal, decentralised gear value chains, where fishers assemble gear from multiple unregistered sources, make it difficult to define and regulate a single "producer" responsible under EPR frameworks. Furthermore, local gear repairers and sellers frequently operate without formal registration, complicating traceability and compliance mechanisms (Macfadyen, et al., 2009; Sala & Richardson, 2023).

Some jurisdictions are advancing tailored EPR models. The EU's Directive 2019/904 mandates producer contributions for plastic-containing fishing gear. France and Norway have piloted schemes with financial and traceability requirements (European Commission, 2022). Recent OECD analysis explores how EPR could be extended to fishing gear, outlining design considerations and lifecycle challenges relevant to ALDFG (Brown, et al., 2023). Despite these advancements, implementation remains uneven. Still, many low- and middle-income countries face barriers: weak regulation, limited recycling infrastructure, low gear volumes, and technical constraints in handling complex, contaminated materials. Scaling EPR for fishing gear will require multilateral funding, regional collaboration, and context-specific pilots that reflect informal market dynamics. To succeed globally, schemes must distribute responsibility across the value chain and invest in enabling conditions like infrastructure, training, and institutional coordination (Sala & Richardson, 2023).

3.2.3 Financing Mechanisms

One of the central issues in ALDFG mitigation is identifying who bears the costs associated with addressing issue, including retrieval, monitoring, and infrastructure development. Financing models range from deposit-refund systems, gear levies, and 'no-special-fee' systems for port reception facilities (such as those established under the EU Port Reception Facilities Directive), to public-private partnerships and development aid. Multilateral donors,

like the World Bank and the Global Environment Facility (GEF), have supported pilot initiatives, while some national governments fund clean-up operations through maritime agencies or environmental levies (FAO, 2024; UNEP, 2021). However, concerns persist about sustainability and equity. Taxpayer-funded approaches may be politically sensitive, while gear levies could disproportionately affect low-income fishers. Therefore, blended finance models combining donor funds, government investment, and private sector contributions are being explored. These models aim to ensure reliable funding while promoting cost-sharing and accountability. The development of international financial mechanisms specific to ALDFG, such as a global fund for ghost gear, has also been proposed as a longer-term solution (GGGI, 2021; GIZ, 2025).

3.2.4 Gear Recovery and Liability

The question of legal liability for lost fishing gear has become increasingly contentious. Some jurisdictions and stakeholders propose holding fishers accountable for recovering ALDFG, arguing that this promotes responsible behaviour and reduces long-term ecological damage. This includes penalties for unreported losses and incentives for voluntary retrieval or participation in clean-up initiatives (UNEP, 2021; GGGI, 2021). However, critics argue that assigning liability in cases of unintentional loss, such as during storms or gear conflict, may unfairly penalise small-scale fishers, particularly in low-capacity contexts. The risk of criminalising poverty or deterring voluntary disclosure must be carefully considered (Gifford, et al., 2024; UNEP, 2021). For liability models to work, they must be accompanied by accessible reporting mechanisms, financial assistance, and educational programmes that promote understanding of recovery responsibilities without fear of reprisal.

3.2.5 Circular Economy Integration

Integrating circular economy principles into fishing gear management offers one of the most impactful pathways for reducing ALDFG. Central to this approach is the prioritisation of gear that is designed for longevity, repairability, and traceability across its life cycle. Innovations in gear durability, modular component replacement, and end-of-life take-back schemes reduce the likelihood of gear loss and maximise the reuse or repurposing potential of materials. Circular strategies also include investment in localised infrastructure for gear recovery, refurbishment, and recycling, such as port reception facilities linked to waste processing hubs or community-led gear repurposing cooperatives. In West Africa and parts of East Africa, pilot projects have shown how repurposed nets can be transformed into marketable goods such as hammocks or roofing material, providing both environmental and livelihood benefits. Policy tools such as EPR (see section 3.2.2), incentives for returning gear, and mandatory gear inventories can support circularity by assigning responsibility for the full life cycle of fishing gear, from design through to disposal or reintegration into productive use (Gifford, et al., 2024; GGGI, 2021).

3.2.6 Rethinking Biodegradable Plastic Fishing Gear Solutions

While biodegradable plastic fishing gear, often made from materials like polylactic acid (PLA) or polybutylene succinate (PBS), has attracted attention for its potential to reduce long-term environmental persistence, its real-world performance remains highly inconsistent and debatable. It bears noting that biodegradability aligns with a linear economy model and is fundamentally not circular in intent or design. Moreso, these biodegradable plastic materials often degrade too slowly or fragment into microplastics under oceanic conditions, undermining their ecological value (Gilardi, et al., 2020; UNEP, 2021). Exposure to cold, saline, or high-pressure environments can also make them brittle and unreliable, prompting hesitancy among fishers who depend on strong, durable gear. These limitations are particularly problematic for small-scale fisheries, which can often lack the resources to evaluate or replace underperforming alternatives. Despite their promise, many current biodegradable plastic options are not a dependable, circular, or equitable solution to ALDFG. Instead, practical and scalable progress lies in enhancing gear durability, improving traceability, providing adequate reception facilities for end-of-life fishing gears and investing in ALDFG reporting and recovery infrastructure, approaches that offer immediate and proven contributions to circularity (Gifford, et al., 2024). Until truly marine-degradable, non-toxic plastic materials with verified field performance are available, these strategies remain the most effective path forward.

Biodegradable options using natural materials such as cotton, sisal or jute twines and wood, among others, are proven and available however often in the form of gear modifications to reduce ghost fishing. For example, natural twines such as cotton twines are used in many pot and trap fisheries around the world to attach and enable pot and trap escape openings; if the gear becomes ALDFG the natural twine will degrade in the marine environment enabling the pot or trap escape opening and thus stopping the potential for the gear to continue to catch target and non-target species (Araya-Schmidt & Queirolo, 2019; Norris, et al., 2012; Winger, et al., 2015). Similarly, some fisheries use degradable wood to cover trap openings so that, if a trap is lost, the wood will naturally break down over time, allowing trapped organisms to escape and preventing the trap from continuing to fish (Macfadyen, et al., 2009). The integration of such natural biodegradable materials to gear modifications offers a natural, more affordable, and accessible alternative, including for small-scale fisheries, to the biodegradable plastic alternatives still under development with variable results. Given these uncertainties, biodegradable plastic gear and components should be considered experimental and supplementary at this stage, rather than primary solutions for ALDFG mitigation.

3.2.7 Equity and Inclusion

Equity and inclusion are increasingly recognised as essential components of successful ALDFG mitigation. Small-scale and artisanal fisheries, predominant in Africa, Asia, and parts of Latin America, face unique challenges, including limited access to marked gear, financial

constraints, and lack of formal representation in policymaking (Gifford, et al., 2024; Macfadyen, et al., 2009). Top-down solutions that ignore these realities risk failing in practice and exacerbating inequality. To address this, participatory approaches are gaining traction. Programmes such as the SST's African Best Practice Guide stress the need to co-design interventions with fishing communities, build local capacity, and embed ALDFG efforts within broader development goals (Gifford, et al., 2024). Inclusion also means ensuring that women, youth, and indigenous fishers, who often play crucial but under-recognised roles in fisheries, are involved in decision-making. Equity-driven strategies not only improve compliance but also enhance resilience and legitimacy in ALDFG governance (UNEP, 2021). These efforts align with regional and global gender and social inclusion frameworks, such as the AU Gender Strategy (African Union Commission, 2018) and FAO's SSF Guidelines (FAO, 2015), underscoring the importance of integrating women, youth, and indigenous voices in ALDFG policy responses.

4 IMPACTS OF ALDFG

4.1 Environmental Impacts

ALDFG disrupts marine ecosystems through ghost fishing and entanglement. Ghost fishing refers to the continued capture and mortality of marine life by lost gear, contributing to unaccounted fishing pressure on both commercial and non-commercial species (GIZ, 2025; Macfadyen, et al., 2009; Barnardo, et al., 2024). Entanglement with ALDFG also kills an estimated 136,000 marine mammals, turtles, birds, and fish annually (Macfadyen, et al., 2009; GIZ, 2025).

Beyond direct impacts, ALDFG degrades ecosystems by shedding microplastics and toxic additives as it breaks down, affecting the marine food web and potentially human health (Gilardi, et al., 2020; UNEP, 2021; Barnardo, et al., 2024). Dragged by currents, heavy gear can also damage benthic habitats like coral reefs and seagrass beds through abrasion and crushing (Gifford, et al., 2024; Barnardo, et al., 2024). ALDFG also presents growing biosecurity risks. Drifting gear serves as a vector for invasive species, pathogens, and fouling organisms, transporting them across national boundaries (Gilman, et al., 2021). These introductions can threaten biodiversity, alter ecosystem functions, and increase management costs, disproportionately affecting small island and coastal states with limited capacity to respond.

4.2 Socio-Economic Impacts

ALDFG has major socio-economic impacts, particularly for fisheries-dependent coastal communities. Continued ghost fishing depletes commercially important stocks, reducing harvest efficiency and income (Macfadyen, et al., 2009; Glassom & Wallace, 2024). Gear loss imposes financial strain, especially in small-scale fisheries, where replacing gear or

retrieving lost equipment is costly and time-consuming (Gifford, et al., 2024). Limited access to insurance, credit, and safety nets heightens vulnerability to economic shocks (GGGI, 2021).

The economic damage extends beyond fisheries. ALDFG accumulates on beaches, reefs, and marine parks, harming eco-tourism and recreation sectors that depend on clean coastal environments (UNEP, 2021; GIZ, 2025; Glassom & Wallace, 2024). It also poses safety risks, injuring swimmers and damaging vessels, with operational and financial consequences (GIZ, 2025; Glassom & Wallace, 2024). For the shipping sector, nets and lines fouled on propellers or rudders can cause costly repairs, increased fuel consumption, and operational delays, in addition to serious safety risks for crews (Macfadyen, et al., 2009). Its gradual breakdown contributes to microplastic contamination in seafood, raising long-term public health and economic concerns (Gilardi, et al., 2020; Glassom & Wallace, 2024). Finally, the burden of retrieval and cleanup often falls to governments, NGOs, and volunteers, diverting resources from other priorities, especially in remote or ecologically sensitive areas (Gifford, et al., 2024; GGGI, 2021).

4.3 Cultural Impacts

Beyond ecological and economic consequences, ALDFG threatens cultural identity and heritage (Bok, et al., 2024). For many Indigenous Peoples and coastal communities, marine ecosystems are deeply intertwined with culture, spirituality, and livelihoods. When culturally significant species, sacred sites, or customary fishing grounds are damaged by abandoned gear, these communities experience loss that extends beyond material impacts. ALDFG disrupts traditional food systems, erodes intergenerational knowledge transfer, and undermines cultural continuity, with direct implications for food sovereignty and wellbeing (Bennett, et al., 2018; FAO, 2015). Comparable impacts are reported globally, where marine ecosystems provide not only subsistence but also underpin cultural practices, values, and social cohesion.

5 SOURCES AND DRIVERS OF ALDFG

ALDFG results from a complex interplay of operational, environmental, economic, regulatory, and behavioural drivers. Understanding these is essential for effective mitigation. Gear is often lost in high-traffic or complex seabed areas, or during storms, particularly in artisanal fisheries with limited anchoring capacity. In industrial tuna fisheries, large numbers of drifting FADs are deployed annually, many of which become abandoned or lost. Their widespread use adds substantially to ALDFG inputs, creating specific challenges for monitoring, retrieval, and accountability (Gilman, 2015). In deep or remote waters, high retrieval costs can deter recovery (Gilardi, et al., 2020; Macfadyen, et al., 2009; Gifford, et al., 2024; UNEP, 2021). Economic pressures also drive gear abandonment. Low-cost, poor-quality gear is more prone to be discarded or lost and less likely to be recovered. Without affordable disposal options, end-of-life gear is often discarded, especially in countries

lacking port reception or recycling facilities (GIZ, 2025; Gilardi, et al., 2020; UNEP, 2021). A persistent difficulty is distinguishing genuine gear losses from deliberate disposal. In contexts where disposal infrastructure is lacking, or where no penalties or incentives exist, some operators may misclassify discarded gear as 'lost' to avoid costs. Regulatory gaps and weak enforcement exacerbate the problem. Absence of gear marking, loss reporting, or retrieval requirements, particularly in small-scale fisheries, allows ALDFG to accumulate. Non-compliance is fuelled by limited capacity, fear of penalties, and competing enforcement priorities (Gifford, et al., 2024; GGGI, 2021).

Behavioural and social factors play a role as well. Fishers may lack awareness, incentives, or a sense of accountability, especially in communal waters. In some communities, discarding gear has become routine, shaped by norms and a lack of alternatives (UNEP, 2021; Macfadyen, et al., 2009). Finally, weak fisheries governance and enforcement, including illegal, unreported, and unregulated (IUU) fishing, overexploitation, and poor zoning, intensifies gear conflict and loss (Richardson, et al., 2019). Tackling these human and systemic drivers is key to building inclusive, locally grounded solutions that promote stewardship.

6 POSSIBLE MITIGATION MEASURES

Efforts to address ALDFG must combine prevention, reporting, traceability, mitigation, and recovery strategies that are both ecologically effective and socio-economically feasible. The most promising measures are often multi-faceted, engaging multiple stakeholders including fishers, governments, managers, and innovators from the outset.

6.1 Gear Design and Innovation

Improving fishing gear design is among the most effective ways to reduce ALDFG's environmental impact. Innovations aim to enhance durability, degradability, and selectivity to minimise harm to marine ecosystems. A range of technologies and modifications are being developed to reduce ghost fishing. For example, biodegradable escape panels in lobster and crab traps allow animals to exit after a set period (Gilardi, et al., 2020). As noted in Section 3.2.6, while biodegradable plastics offer promise, challenges around durability and premature degradation highlight the need for careful, context-specific use (Macfadyen, et al., 2009; UNEP, 2021). Weak links and escape mechanisms can prevent entanglement of larger species, while modular gear and reinforced connections reduce fragmentation and support partial recovery (Gifford, et al., 2024; GGGI, 2021). As discussed in Section 3.2.5, gear recycling, particularly of synthetic nets, advances circular economy goals and supports responsible end-of-life management. These programmes reduce informal disposal and recover material value (GGGI, 2021; Sala & Richardson, 2023). However, adoption remains inconsistent due to excessive costs, limited infrastructure, material standardisation issues, and business model challenges, especially in small-scale fisheries (Gifford, et al., 2024).

6.2 Gear Marking and Traceability

As discussed in Section 5, gear traceability refers to the ability to identify, monitor, and record the ownership, movement, and fate of fishing gear throughout its lifecycle. It is important to note that fisheries-specific gear marking and traceability requirements are distinct from global product labelling standards governed by the WTO TBT Committee. The latter deals with trade-related technical regulations, whereas gear marking in the fisheries context is an operational management tool intended to reduce ALDFG by improving accountability, monitoring, and recovery.

Within this framework, gear marking is a critical element of ALDFG mitigation. The FAO's Voluntary Guidelines on the Marking of Fishing Gear (FAO, 2019) promote integrated gear marking systems, including owner-linked gear registers, reporting mechanisms for lost and found gear, ALDFG recovery protocols, environmentally sound disposal, and robust monitoring, control, and surveillance systems. Passive marking techniques include etched ID numbers, colour codes, or barcodes affixed to buoys and lines. Electronic tracking, such as GPS buoys, RFID tags, and sonar-reflective materials, supports active monitoring in industrial fisheries (FAO, 2019).

Gear traceability systems, piloted in regions like the EU and East Africa, integrate registries with reporting platforms to alert authorities and fishers to losses. While adoption remains limited in artisanal fleets due to infrastructure and enforcement gaps, pilot programmes show improved recovery rates and reduced intentional discard (GGGI, 2021; GIZ, 2025). Going forward, the G20's role lies in supporting pilot projects, financing, and capacity-building to ensure these systems are equitable and feasible for all fisheries, particularly small-scale and artisanal operators.

6.3 Recovery and Cleanup Technologies

When prevention fails, effective recovery becomes essential. However, recovery operations can have their own environmental risks, including seabed disturbance, bycatch during retrieval, and carbon costs of vessel operations (Gilardi, et al., 2020; Macfadyen, et al., 2009). Further monitoring and assessment are needed to balance the impacts of recovery against the potential ecological risks of leaving ALDFG in situ. A range of technologies are in use or development, including Remotely Operated Vehicles (ROVs), underwater drones, sonar mapping, and draggling/grappling methods to identify and recover submerged ALDFG (Gilardi, et al., 2020). Recovery operations may include hoisting gear aboard vessels or manual removal by divers. Incentive-based retrieval schemes, gear buy-backs, deposit-refund systems, and gear bounties, encourage reporting and return (UNEP, 2021). Community- and citizen-led efforts, such as beach and dive clean-ups coordinated by Sustainable Seas Trust in South Africa and HubNets in Nigeria, raise awareness and restore habitats. Sustainable recovery depends on long-term financing, port reception infrastructure (Gilardi, et al., 2020), and robust monitoring systems.

6.4 Management, Best Practices and Regulations

Effective fisheries management is vital for ALDFG prevention and mitigation. Best practices include gear zoning, effort limits, and the enforcement of gear reporting requirements (Gilardi, et al., 2020; Gifford, et al., 2024). National legislation should mandate gear disposal procedures and port reception facilities, with enforcement supported by Monitoring, Control and Surveillance (MCS) systems (FAO, 2019; FAO, 2024).

7 POLICY-BASED MITIGATION STRATEGIES

Policy interventions play a vital role in the mitigation of ALDFG. Coherent national frameworks, regional cooperation, and adherence to international governance frameworks and guidelines are essential to drive implementation, ensure accountability, and align stakeholders around common objectives.

7.1 National Policies

Many countries are incorporating ALDFG-specific measures into broader marine plastic and fisheries management frameworks, though approaches and enforcement vary. National policies often align with international agreements, such as MARPOL Annex V and the FAO's Voluntary Guidelines (see Section 7.3). National Action Plans frequently prioritise gear marking, port reception facilities, fisher education, and derelict gear removal (UNEP, 2021). Fisheries Management Plans are also integrating ALDFG mitigation through licensing, reporting, and spatial tools like marine protected areas and seasonal closures. In countries like Kenya and South Africa, these efforts are embedded in ecosystem-based management (Gifford, et al., 2024; GIZ, 2025). Improving port waste reception facilities is key for MARPOL compliance, yet infrastructure gaps persist, particularly in many African and Small Island Developing States (SIDS) contexts. Weak port reception infrastructure and limited disposal options remain key contributors to ALDFG in Africa. Strengthening these systems should be prioritised within broader blue infrastructure development, with the G20 well positioned to catalyse investment and technical support as part of inclusive global responses. Given ALDFG's cross-sectoral nature, national policy must be grounded in coordinated planning across fisheries, maritime, ports, waste, and environmental sectors.

7.2 Regional Frameworks

Regional governance frameworks across Africa and beyond are gradually addressing ALDFG. The Nairobi Convention's Marine Litter Action Plan (2021–2025) and the Abidjan Convention's Regional Strategy on Plastic Pollution both recognise ALDFG as a critical concern, calling for harmonised tracking, retrieval programmes, and standards (Abidjan Convention, 2022; Nairobi Convention, 2021). The Benguela Current Commission supports implementation through on-ground projects in key hotspots. The GloLitter Partnerships Project under the IMO OceanLitter Programme facilitates joint planning, peer exchange, and

regional capacity-building, with African regional task force meetings convened to build consensus on shared priorities. However, practical enforcement, funding, and inclusion of small-scale fisheries remain ongoing challenges. Together, these regional governance frameworks, supported by AMCEN and aligned with continental priorities, form the backbone of Africa's policy response to ALDFG, ensuring mitigation strategies are tailored to diverse fisheries contexts while promoting coherence across coastal states

7.3 International Agreements and Voluntary Guidelines

As noted in Section 2, international frameworks underpin domestic regulation and voluntary action on ALDFG. MARPOL Annex V, led by the IMO, prohibits discharge of plastics, including fishing gear, and requires States to provide port reception facilities and gear loss reporting. The IMO's 2018 Action Plan on Marine Plastic Litter and its 2025 update support these obligations, with current discussions focused on strengthening Annex V through mandatory gear marking and enforcement. FAO contributes as a technical advisor and observer, reporting annually to IMO and supporting amendment development (Drinkwin, 2022). The FAO's Voluntary Guidelines on the Marking of Fishing Gear (2019) remain a key non-binding tool, especially for small-scale fisheries lacking formal registration systems. Several RFMOs have referenced or adopted these guidelines, implementing gear marking and biodegradable materials, notably in tuna fisheries using drifting FADs (Gilman, 2015; IOTC, 2019). The OECD Review of Fisheries 2025 further highlights emerging best practices in fisheries that create enabling conditions for circular economy approaches and improved monitoring in fisheries management, which can in turn support ALDFG mitigation (OECD, 2025). Additional frameworks such as the FAO Code of Conduct for Responsible Fisheries (1995), the Honolulu Strategy (2011), and UNEA Resolution 5/14 (2022), support best practices and lay groundwork for future alignment through the global plastics treaty. The Basel, Rotterdam and Stockholm (BRS) Conventions provide complementary frameworks by addressing plastic waste through provisions on minimisation, transboundary movements, and environmentally sound management. While not focused on fishing gear specifically, its 2019 amendments on plastic waste and related capacity-building projects are relevant for the recycling and disposal of recovered ALDFG. Ultimately, the effectiveness of these frameworks will depend on how they are adapted to national and regional contexts. Implementation must reflect differences in fisheries structures, institutional capacity, and socio-economic conditions to ensure measures are both practical and equitable.

8 DATA GAPS AND MONITORING FRAMEWORKS

Efforts to address ALDFG are constrained by persistent data gaps and the lack of a unified global monitoring framework. Information on its scale, sources, and distribution remains fragmented, particularly in small-scale and developing country fisheries with limited monitoring capacity (Gilardi, et al., 2020; FAO, 2024). Underreporting is common due to weak systems, low awareness, and limited incentives. A lack of standardised metrics and

integration into national frameworks further impedes trend analysis, hotspot identification, and intervention assessment. To close these gaps, FAO launched the voluntary Global ALDFG Survey, inviting input from governments, industry, and civil society to strengthen data-driven decision-making (FAO, 2024). Parallel discussions at IMO aim to amend MARPOL Annex V, including proposals for mandatory gear loss reporting to improve consistency (PPR, 2025). Effective monitoring requires cross-sectoral collaboration, with fishers playing a key role. Their reporting must be supported by gear marking, port reception systems, and gear tracking at end-of-life. (FAO, 2019; Gifford, et al., 2024).

Digital tools are expanding reporting reach. GGGI's Data Portal is the largest open-access ALDFG repository, fed by inputs from governments, NGOs, and the private sector (GGGI, 2021). The Ghost Gear Reporter App enables real-time submissions from ocean users, while mobile-based gear marking and e-reporting tools offer traceability in some regions. Though NetTag has seen limited uptake, remote sensing and AI tools show promise for detecting gear aggregations and monitoring high-risk zones (UNEP, 2021). Community-based monitoring also plays a critical role. Programmes that train local fishers and residents to log ALDFG, like those led by Sustainable Seas Trust, help address data gaps while fostering grassroots stewardship (Gifford, et al., 2024). Ultimately, dependable, standardised, and regularly updated data is essential for scaling and evaluating effective ALDFG solutions.

9 G20 CONSIDERATIONS AND RECOMMENDATIONS

ALDFG is a rising transboundary threat to ecosystems, fisheries, and coastal communities. As major maritime and fishing nations, the G20 is well placed to lead a coordinated response. The table below highlights priority actions based on global best practices, balancing ecological, social, and economic considerations.

***Table 1**: Key recommendations and considerations*

Recommendation Area	G20 Action	Details
Port-based monitoring and gear return	Support pilot programmes at ports to evaluate fisher responsiveness to gear return and enable gear loss tracking	Fund and assess pilot initiatives at key ports that evaluate fisher response to the return of retrieved ALDFG. Explore how ports can serve as hubs for monitoring, incentivising disposal of end-of-life gear and/or recovery and integrating enforcement (e.g. loss reporting or gear traceability audits). Findings could inform scalable retrieval schemes and strengthen gear circularity.
Gear Marking & Traceability	Support pilot projects around gear marking systems and gradual standardisation	Build on the FAO VGMFG and related IMO processes to advance effective and verifiable systems, including gear registers, ALDFG loss and recovery reporting, and robust monitoring, control, and surveillance (MCS). It is important to note that fisheries-specific gear marking requirements are distinct from product labelling standards governed by the WTO TBT Committee. The latter addresses trade-related technical regulations, whereas gear marking serves as a sector-specific

Recommendation Area	G20 Action	Details
		management tool for accountability, traceability, and recovery in fisheries. G20 support should focus on financing pilots, developing enabling infrastructure, and providing capacity support to small-scale and artisanal fisheries to ensure equitable implementation.
Extended Producer Responsibility (EPR)	Facilitate policy dialogue and fund feasibility and end-use studies	Explore context-appropriate EPR models for fishing gear, including for informal and small-scale sectors; support producer responsibility schemes that promote durability, recovery, and end-of-life solutions.
ALDFG Action Plans	Support development and financing of National Action Plans (NAPs) and Regional Frameworks	Align with the SDG 14.1, UNEA Res. 5/14, IMO Action Plan to Address Plastic Litter from Ships; promote adoption of FAO/IMO/UNEP technical guidance documents (e.g. GloLitter tools); acknowledge and support existing NAPs such as Senegal's ALDFG NAP and other sea-based marine plastic litter (SBMPL) action plans.
Data Harmonisation & Monitoring	Promote global ALDFG data standards and open-access digital tools	Invest in mobile apps, satellite tools, at-sea vessel and port reception reporting; promote fisher-led and community-based monitoring; encourage engagement in global/regional platforms (e.g. GGGI Data Portal, GPML, NetTag, SafeSeaNet); support IMO efforts to update MARPOL Annex V on gear loss reporting.
Knowledge Sharing Platform	Establish a dedicated, regularly updated database or platform to record country-level initiatives on marine debris and ALDFG.	Create a knowledge-sharing mechanism where G20 members can document national policies, regulations, monitoring programmes, and innovations related to marine debris and ALDFG. This platform would facilitate peer learning, highlight best practices, and support alignment across national, regional, and global frameworks. It would also ensure that progress at the national level is visible and accessible.
Technological Innovation	Fund research, innovation challenges, and certification mechanisms	Support design and uptake of alternative gear (e.g., biodegradable components, reinforced connections); fund durability and life-cycle analysis; support local manufacturing and equitable access.
Community-Led Solutions	Co-finance and scale up grassroots ALDFG prevention, recovery, and awareness initiatives	Highlight community-led models (e.g., SST South Africa, HubNets Nigeria); link ALDFG recovery to livelihoods and stewardship; engage Regional Seas and Regional Fisheries Bodies to strengthen collaboration.
Sustainable Financing	Mainstream ALDFG interventions into blue economy funding streams	Promote blue bonds, blended finance, and ALDFG insurance coverage; incentivise gear return and recovery via deposit-refund and extended responsibility schemes.
Cross-Cutting: Inclusion & Equity	Ensure inclusive participation in all interventions	Engage small-scale, Indigenous, and under-represented groups in decision-making, support equitable access to funding, gear innovations, and monitoring systems.

Recommendation Area	G20 Action	Details
		Approaches should also be tailored to country-specific contexts, recognising that the balance between enforcement, incentives, and community-driven solutions will vary across fisheries and governance systems.

These priorities reflect a holistic approach to ALDFG by advancing scalable, inclusive solutions, the G20 can combat marine plastic pollution. This is a pivotal opportunity to drive a global shift toward more accountable, circular, and equitable fisheries systems.

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APPENDIX 1: DEFINITIONS AND TECHNICAL TERMS

Term	Definition
Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG)	Fishing gear that has been abandoned, lost, or otherwise discarded at sea, including nets, lines, traps, and other equipment no longer under a fisher's control. In practice, distinguishing between genuine gear loss and intentional disposal remains a challenge, with important implications for monitoring, enforcement, and financing schemes.
Biodegradable Gear	Fishing gear manufactured from natural or synthetic materials designed to degrade through biological processes in the marine environment.
Blue Economy	A sustainable ocean-based economy that harnesses marine resources for economic growth while preserving the health of ocean ecosystems.
Blue Finance / Blue Bonds	Financial instruments and funding mechanisms that support sustainable ocean-based economic activities, including ALDFG prevention and recovery.
Bycatch	Non-target species that are unintentionally captured during fishing operations, often resulting in ecological and economic consequences.
Circular Economy	An economic system that prioritizes resource efficiency by reusing, repairing, refurbishing, and recycling existing materials and products, including fishing gear, to extend their lifecycle where technically and economically feasible. Fishing gear is increasingly addressed in circular economy policy and projects (e.g. INdIGO in the UK, Blue Circular Economy project in Northern Europe), especially in relation to end-of-life gear reuse, component recycling, and gear redesign.
Ghost Fishing	The capture and mortality of marine life by fishing gear that continues to function after being abandoned, lost, or discarded.
Ghost Gear	A commonly used term for ALDFG when it continues to fish or pose hazards after being abandoned, lost, or discarded.
Gear Marking	As defined by the FAO Voluntary Guidelines on the Marking of Fishing Gear, "Mark" means – (i) an identifier that allows the relevant authority to discern the person or entity ultimately responsible for the use of the fishing gear; and/or (ii) a means of providing an understanding of the presence, scale, and nature of fishing gear in the water.
Gear Traceability	The ability to track and trace fishing gear at various points of its lifecycle. This includes: (i) Locational traceability: for gear visibility and recovery during use. (ii) Ownership traceability: to identify responsible parties. (iii) Commercial traceability: encompassing production, use, and end-of-life management.
Ghost Gear Reporter App / NetTag	Digital mobile applications designed to report and track lost fishing gear, supporting recovery and improving ALDFG monitoring.
Honolulu Strategy	A global framework adopted in 2011 that outlines goals and recommended actions for the prevention, reduction, and management of marine debris.
Marine Plastic Litter	Any persistent, manufactured or processed solid plastic material discarded, disposed of, or abandoned in the marine and coastal environment.
Microplastics	Plastic particles smaller than 5 mm, often resulting from the degradation of larger plastic items, including ALDFG.
Port Reception Facility	As per MARPOL Annex V, a designated facility at a port for the safe and legal discharge of ship-generated waste, including used or damaged fishing gear.

Term	Definition
Small-Scale Fisheries (SSFs)	Fisheries involving fishing households or small businesses that use small vessels or operate from the shore, often with low technology and within informal or traditional systems.
Stakeholders	Individuals, communities, organisations, or institutions, such as fishers, government agencies, port authorities, and NGOs, which are directly or indirectly affected by fishing activities and ALDFG.

APPENDIX 2: ABBREVIATIONS

Abbreviation	Description
AMCEN	African Ministerial Conference on the Environment.
COFI	Committee on Fisheries – FAO's global fisheries governance body.
C-BPF / A-BPF	Catch-based and Aquaculture Best Practice Frameworks (from GGGI).
dFADs	Drifting Fish Aggregating Devices – Floating, often non-biodegradable structures deployed to attract pelagic fish species, which can become ALDFG when lost.
EEZ	Exclusive Economic Zone – A sea zone over which a state has special rights regarding exploration and marine resource use.
EPR	Extended Producer Responsibility – A policy approach where producers are responsible for the full life cycle of their products, including post-consumer waste collection, recycling, and end-of-life disposal.
FAO	Food and Agriculture Organization of the United Nations.
GEF	Global Environment Facility – A multilateral fund supporting environmental initiatives.
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection.
GGGI	Global Ghost Gear Initiative.
GPML	Global Partnership on Plastic Pollution and Marine Litter.
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit – German development agency involved in environmental and policy work.
IAEA	International Atomic Energy Agency.
IMO	International Maritime Organization.
INC	Intergovernmental Negotiating Committee – Leading the global treaty negotiations on plastic pollution under UNEA.
IOTC	Indian Ocean Tuna Commission – A regional fisheries management organisation.
ISA	International Seabed Authority.
MEPC	Marine Environment Protection Committee – A body of the IMO responsible for environmental issues.
MARPOL	International Convention for the Prevention of Pollution from Ships.
MCS	Monitoring, Control and Surveillance – A set of tools and systems to support fisheries enforcement and compliance.
NAP	National Action Plan – A country-level strategy or plan addressing ALDFG or marine litter.
NFIFO	FAO's Fishing Technology and Operations Team.
PPR	Pollution Prevention and Response Sub-Committee – Technical sub-body under IMO.
PROs	Producer Responsibility Organisations – Entities that support the implementation of EPR by coordinating producer compliance, including collection, recycling, and data reporting.
RFMOs	Regional Fisheries Management Organizations.
SDG 14	Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
SIDS	Small Island Developing States.
SST	Sustainable Seas Trust.

Abbreviation	Description
UN Clean Seas Campaign	UNEP-led awareness campaign to combat marine plastic pollution.
UNDP	United Nations Development Programme.
UNEA	United Nations Environment Assembly.
UNEP	United Nations Environment Programme.
UNIDO	United Nations Industrial Development Organization.
VGMFG	Voluntary Guidelines on the Marking of Fishing Gear.