Working together to achieve the Paris climate goals and sustainable development

International climate cooperation and the role of developing countries and emerging economies

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German Development Institute

NEW CLIMATE INSTITUTE

Working together to achieve the Paris climate goals and sustainable development:

International climate cooperation and the role of developing countries and emerging economies

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Abbreviations

A-S-I	Avoid-Shift-Improve
AAAA	Addis Ababa Action Agenda
ACT	Action towards Climate-friendly Transport initiative
AFOLU	Agriculture, Forestry and Land Use
BAU	Business-As-Usual
BECCS	Bioenergy Carbon Capture and Storage
BMZ	German Federal Ministry for Economic Cooperation and Development
BRT	Bus Rapid Transport
CAT	Climate Action Tracker
CBC	Community-based Conservation
CBD	Convention on Biological Diversity
CBDR	Common But Differential Responsibilities
CDR	Carbon Dioxide Removal
CDRFI	Climate and Disaster Risk Financing and Insurance
CFF	Climate Finance Facility
CH4	Methane
CO_2	Carbon Dioxide
COP	Conference of the Parties
CSA	Climate-Smart Agriculture
CVF	Climate Vulnerable Forum
DACCS	Direct Air Capture with Carbon Capture and Storage
EbA	Ecosystem-based Adaptation
ECAM	Energy Performance and Carbon Emissions Assessment and Monitoring
EU	European Union
EUR	Euro (currency)
FAO	Food and Agriculture Organization of the United Nations
FMU	Forest Management Units
FOLU	Forestry and Other Land-use
FORCLIME	Forest and Climate Change
FPIC	Free Prior and Informed Consent
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environmental Facility

Abbreviations

GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
Gt	Gigatons
GtC	Gigatons of Carbon
$GtCO_2e$	Gigatons of Carbon Dioxide equivalents
$GtCO_2e/y$	Gigatons of Carbon Dioxide equivalents/year
HDI	Human Development Index
HIC	High-Income Country
IAM	Integrated Assessment Model
ICMA	International Capital Markets Association
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IWA	International Water Association
IWRM	Integrated Water Resources Management
KfW	Kreditanstalt für Wiederaufbau
km	Kilometre
LAC	Latin America and the Caribbean
LAGREEN	Latin American Green Bond Fund
LCOE	Levelized Cost of Energy
LTS	Long-term Strategies
LUCI	Leadership for Urban Climate Investments
LULC	Land Use and Land Cover Change
LULUCF	Land Use, Land Use Change and Forestry
MoHE	Ministry of Higher Education
$MtCO_2e$	Million tonnes of Carbon Dioxide equivalents
MWDSEP	Ministry of Water Development, Sanitation and Environmental Protection
MWh	MegaWatt hour
N_2O	Nitrous Oxide
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
ND GAIN Index	Notre Dame Global Adaptation Index

Abbreviations

NUA	New Urban Agenda
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OECD DAC	OECD Development Assistance Committee
OECM	Other Effective Area-based Conservation Measure
OOF	Other Official Flow
PA	Protected Area
PBF	Policy Based Financing
PPP	Purchasing Power Parity
PrAda	Project “Adaptation of agricultural value chains to climate change”
PV	Photovoltaic
REDD(+)	Reducing Emissions from Deforestation and Forest Degradation
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RWS II	Reform of the Water Sector Phase II
SDG	Sustainable Development Goal
SSP2	Shared Socioeconomic Pathway 2
tC/ha	Ton of Carbon per hectare
tCO_2e	Metric tonnes of Carbon Dioxide equivalent
UMIC	Upper-middle-income Country
UN	United Nations
UNGA	United Nations General Assembly
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	United States Dollar (currency)
TUMI	Transformative Urban Mobility Initiative
WaCCliM	Water and Wastewater Companies for Climate Mitigation
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WTO	World Trade Organization

Executive Summary

Executive summary

Climate change alters the framework conditions for sustainable development

Climate change has become a threat to all countries and societies. Average global temperature increases currently stand at just above 1°C compared with pre-industrial levels, and while the mounting consequences of global warming are already visible today, this is set to rise further.

A temperature increase of just 1.5°C is likely to cause dramatic and irreversible changes in the Earth's climate system. An increase above this may turn climate change into an unmanageable risk for humankind. This is likely to significantly affect many people in developing countries and emerging economies, whose livelihoods would be most at risk.

Sustainable development requires that the climate system be stabilised between 1.5°C and 2°C of average global warming. This necessitates a drastic reduction in global greenhouse gas emissions. Developing countries and emerging economies are increasingly the focus here. These nations already account for two-thirds of global emissions, primarily due to their growing energy demands.

Failure to achieve the goals of the Paris Agreement would ultimately undermine the achievement of just and sustainable global development that leaves no one behind. A development-oriented strategy that achieves the necessary reduction in emissions requires both climate change mitigation and development cooperation across policy fields. Tackling the now unavoidable impacts of climate change must also include matters related to land use, marine conservation and global trade.

The Paris Agreement and the 2030 Agenda for Sustainable Development provide the necessary objectives and normative foundation for political action. Consistently implementing the objectives of both agendas is the key challenge for international policymakers, global corporations and for communities. In this context, it is necessary to keep all countries and population groups in view, aligning with the requirement of leaving no one behind.

This study shows how transformative change can bring about sustainable development, prevent climate change from spiralling out of control and address the unavoidable consequences of climate change in a development-friendly manner.

The Paris Agreement: where are we five years later?

The Paris Agreement requires all countries to make increasingly ambitious efforts to stabilise the climate well below 2°C of pre-industrial levels and preferably below 1.5°C. At the same time, it stresses the responsibility of every nation to achieve this goal through nationally determined contributions (NDCs) and requires them to develop adaptation plans to cope with the consequences of climate change. Equally, it underscores the need to gear global financial flows to these objectives and requests that wealthy nations assist poor and climate-vulnerable countries in realising their climate policies.

The leaders of COP21, the United Nations climate change conference, celebrate the adoption of the Paris Agreement on Climate Change on December 12, 2015. Photo by Alamy Stock.

In 2016, the Paris Agreement was ratified in record time and entered into force. As such, the first cycle of raising national ambitions began in 2020. Originally submitted in 2015, the NDCs still remain significantly lower than the ambition level of the Paris Agreement. Based on current climate policies and those relative to limiting global warming to 1.5°C, there is an emissions gap of 47-gigatonnes of carbon dioxide equivalents in regard to 2050 targets.

Global greenhouse gas emissions have continued to rise, reaching 55-gigatonnes in 2018 alone. Emissions from developed countries have been stagnating at elevated levels. Emissions from developing countries and emerging economies continue to rise and currently account for around two-thirds of annual global greenhouse gas emissions.

Upper-middle income countries are currently the main drivers of growth in global emissions. In the medium term, lower-middle income countries and poorer developing countries will also make a significant contribution to global emissions.

The atmosphere does not distinguish between North and South. It is therefore necessary to account for the importance of developing countries and emerging economies when it comes to successfully implementing the Paris Agreement. Historically, the main drivers of climate change are industrialised countries who bear a significant responsibility in tackling climate change. At the same time, it will not be possible to achieve the goals of the Paris Agreement without decisive action on the part of developing countries and emerging economies.

Despite the global economic downturn in the wake of the COVID-19 pandemic, global emissions continue to rise. At the same time, in many countries, the pandemic is slowing international climate action processes and delaying the formulation of new and more ambitious climate objectives. As of May 2021, the NDCs submitted by a total of 55 countries, including the European Union (EU), account for just under half of global greenhouse gas emissions.

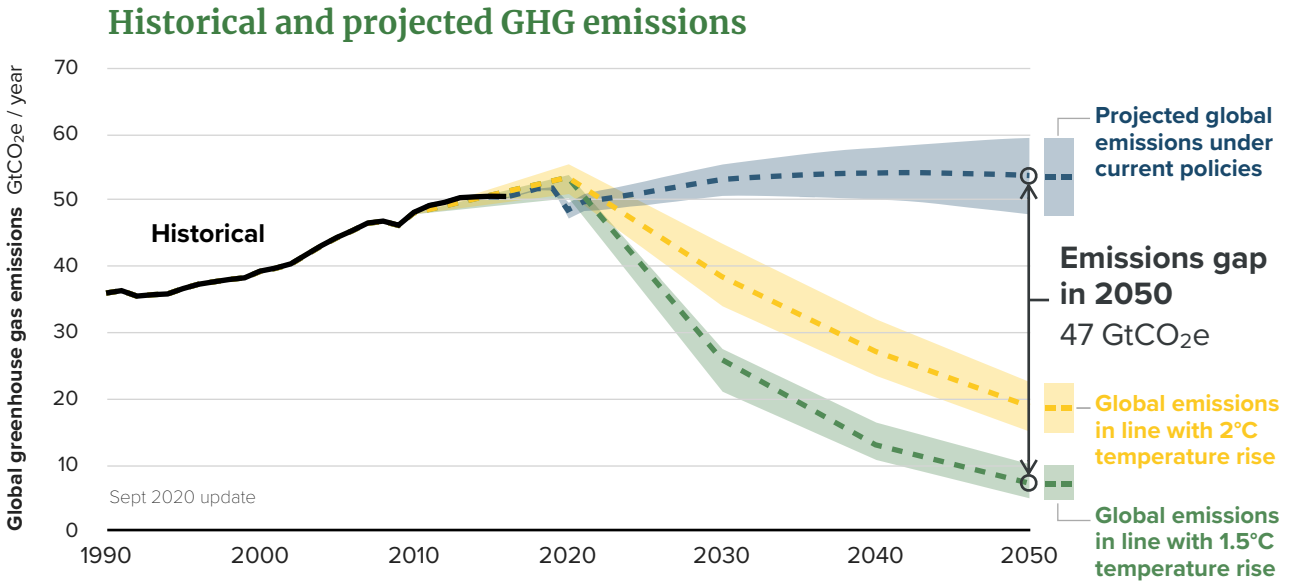


Figure A Historical and projected global GHG emissions, under current policies and different temperature pathways. Source: Climate Action Tracker 2020.

There is also a significant shortfall in achieving the Paris Agreement's goals for climate change adaptation. Only 20 countries have submitted detailed national adaptation plans (NAPs), and only one-fifth of global climate finance is invested in adaptation action. It is also conceivable that international climate finance will fall short of the USD 100 billion announced by industrialised nations for the period from 2020 onwards, despite substantial increases in recent years.

The period between now and 2030 is crucial if we are to achieve the goals of the Paris Agreement and developed countries must lead the way. At the same time, they must provide and support incentives for transformative policymaking in developing countries and emerging economies. This can be achieved by stepping up relevant policy dialogue, mobilising substantial financial resources, driving green technology transfer and supporting capacity development.

Raising the ambition levels of developing countries and emerging economies depends largely on the political will in those nations and on them having predictable and reliable support from their international partners. Even outside of a development cooperation setting, all international cooperation should be geared to the implementation of national climate policy. This should be in the context of the Sustainable Development Goals (SDGs) and the multilateral agreements on the conservation of biodiversity. Political priorities, general conditions and investments should be geared to these requirements, and corresponding adjustments are to be made in all countries and at all levels of action.

In this context, tackling the challenges of climate change and sustainable development in a decisive and credible way is as much an issue of national self-interest as it is an imperative of international solidarity.

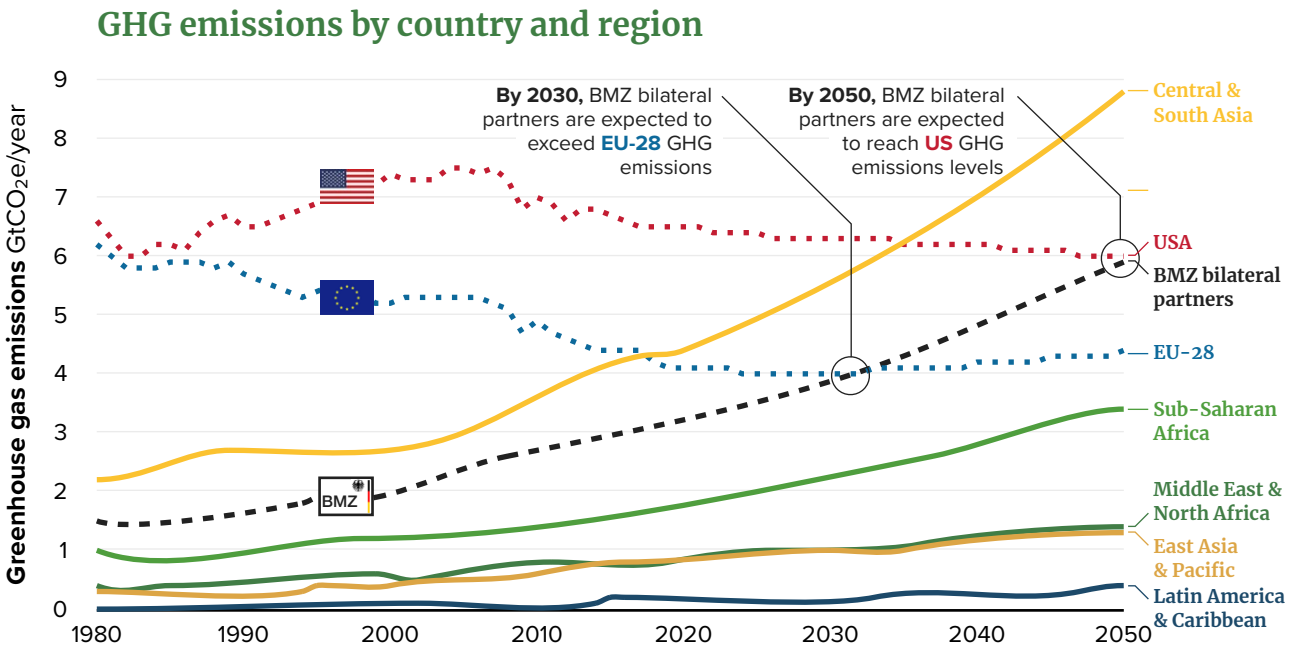


Figure B
Historical and expected greenhouse gas emissions from low and middle income countries per region and in comparison with bilateral partners of the BMZ, the EU-28 and the USA.
Source: Gütschow *et al.* 2020.

Why are current efforts still insufficient?

If implemented in full, current NDCs are expected to result in an average global temperature increase of 3°C or more by the end of this century. Worse still, the climate policy announcements of many countries are not being implemented consistently. In many places, translating the submitted NDCs into practical policy measures, national development plans, sufficient investment and regulatory framework conditions is a major challenge.

By international standards, many emerging economies with rapidly rising emissions still consider themselves to be developing countries. They view climate change mitigation as an additional burden and see themselves as entitled to continue emitting greenhouse gases. Consequently, they are reticent when it comes to raising their ambitions and supporting international commitments. Additionally, parts of their national commitments are conditional and subject to international support.

Many countries are acting inconsistently. On the one hand, they set themselves ambitious goals, for instance, by introducing carbon prices and climate risk insurance schemes. On the other hand, they still invest in the expansion of fossil-fuel-based energy systems and conventional urban development. This is where international cooperation needs to identify and support alternatives in order to reverse emission trends permanently.

In many developing countries and emerging economies, opportunities for using climate policy to enhance competitiveness and development go unnoticed. Given other pressing challenges right now, adaptation requirements and climate-related risks are rarely a priority for national governments. These governments are only slowly coming to recognise that climate-friendly investments would not only be more cost-efficient in the long term but can also create new prospects for innovation, growth and employment.

Most of the Parties to the Paris Agreement still have a long way to go in terms of achieving greenhouse gas neutrality. In summary, both the major emitters and many smaller developing countries and emerging economies must back up their commitments to the Paris Agreement with the corresponding action.

How can we build upon what has already been achieved?

A number of individual countries are already pursuing long-term strategies for decarbonising their economies. The EU and China point in this direction. The new EU climate target is at least a 55% reduction in emissions by 2030 compared with 1990 and climate neutrality by 2050. China announced a target of peak emissions before 2030 with carbon neutrality by 2060. The return of the United States to the Paris Agreement further raises hopes, as do the NDCs submitted by many developing countries and emerging economies since 2015 that also contain some promising approaches.

Declarations of intent by 127 countries on achieving net-zero carbon emissions currently account for around 63% of global emissions. Consistently implementing these declarations of intent would bring the international community closer to limiting global warming to 2°C. However, only a very small number of countries have enshrined their declaration of intent in national law or translated it into long-term strategies (LTSs) to date.

At subnational government levels, civil society and private-sector players, as well as global public administrations, are also making key contributions. They are increasing the pressure on the Parties to the Paris Agreement to act and make a practical contribution to raising ambition in many developing countries and emerging economies through their independent climate action.

The goals of the Paris Agreement are inextricably linked to the 2030 Agenda for Sustainable Development. The necessary dynamics for implementing the Paris Agreement can only further unfold if developing countries and emerging economies recognise that determined climate policy can promote their national development ambitions rather than hinder them. Many players are coming to realise that successful climate policy can only be achieved in accordance with the SDGs.

There is growing international recognition of the importance of sustainable land use and marine conservation. Ecosystems such as forests, wetlands, seagrass beds and mangroves currently capture around half of human carbon emissions from the atmosphere. These natural carbon sinks provide the basic conditions for sustainable development, climate change mitigation and ecosystem-based climate adaptation and warrant protection.

There is great potential in global efforts to combat the COVID-19 crisis. For instance, to overcome the economic and social consequences of the crisis, resources are being mobilised on a scale never seen before. This makes it possible to 'build forward better' by investing in climate change mitigation and climate-resilient and crisis-proof development.

To address these challenges effectively, it is necessary to leverage the potential and experience of international cooperation to pave the way for implementing the Paris Agreement and 2030 Agenda. Environmental or energy partnerships are limited in their sectoral scope. In contrast, development cooperation adopts a more comprehensive approach. This allows key players such as ministries of finance and planning to be brought on board for the implementation of transformative policies. Additionally, thanks to its alliance with multilateral financial institutions, development cooperation has the necessary leverage to influence general conditions at the international level, all in alignment with the goals of the Paris Agreement and the SDGs.

What needs to be done now?

Pursuing integrated approaches to climate policy and sustainable development

There are already many well-known cross-cutting solutions between development policy and climate policy. The expansion of renewable energies, for instance, can reduce greenhouse gas emissions. At the same time, they can support the achievement of different development goals in the areas of healthcare, education, domestic industrial development and job creation. Current solutions need to be integrated to a greater extent and leveraged for comprehensive systemic transformation that will facilitate the achievement of the goals of the Paris Agreement and the 2030 Agenda.

This will only succeed if effective incentives are provided for a significant course correction in developing countries and emerging economies, too. This, of course, runs alongside the transformation efforts in industrialised nations. In addition to policy dialogue and finance, these include the transfer of relevant technology and capacity development. In order to ensure consistent external action, corresponding measures, primarily those which are development-related, must be supported by other international cooperation instruments. These include trade issues and export promotion.

The formulation of increasingly ambitious NDCs is instrumental for this kind of course correction and for achieving the goals of the Paris Agreement. Within the ambition cycle of the Paris Agreement, supporting developing countries and emerging economies in developing goals in line with their national development agendas is just as important as identifying financing and decisively implementing corresponding measures.

Links between NDCs and SDGs

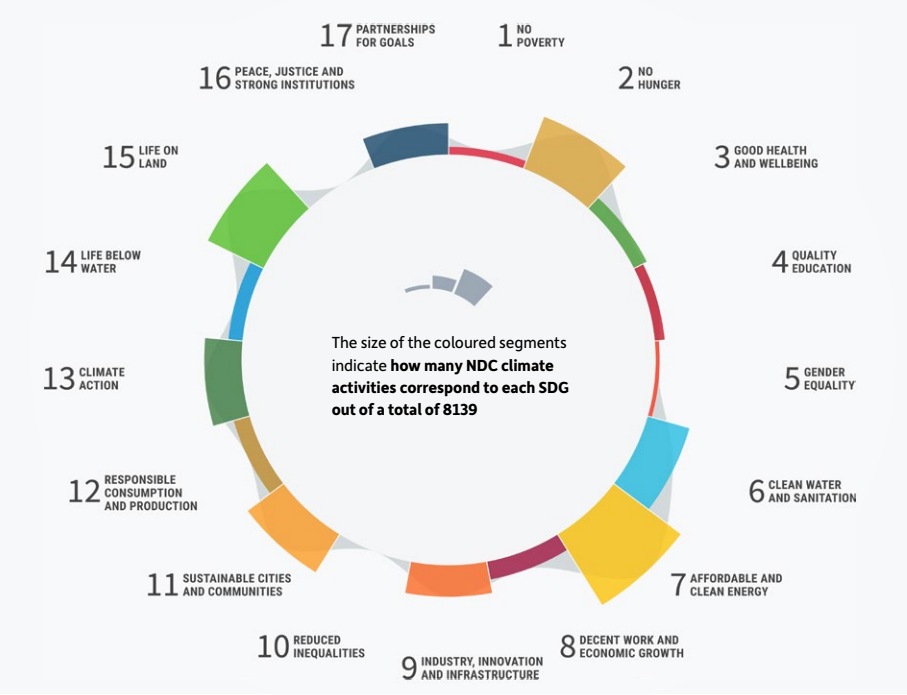


Figure C
Climate activities included in NDCs and their link to the SDGs at the global level. The bars indicate the share of NDC activities relevant to the SDG targets (adapted from NDC-SDG Connections tool, www.ndc-sdg.info).

Setting a course at the international level

Concluding negotiations on market mechanisms swiftly and in the interests of a robust interpretation of Article 6 of the Paris Agreement would indicate a decisive step in terms of a multilateral climate policy. A corresponding outcome from the forthcoming UN climate change conference COP26 in November 2021 would be the mobilisation of substantial additional finance to support developing countries and emerging economies.

An upward trend in international climate finance would send a confidence-building signal to the international community and is likely to create a greater openness to transformation on the part of developing countries and emerging economies. This trend could, for instance, involve the achievement of the USD 100 billion per annum from 2020, as promised by industrialised nations. As a result, increased scope for financing conditional action in the context of developing countries' NDCs could be achieved.

Systematically incorporating climate risks

When it comes to implementing national climate policy in the interests of sustainable development, it is also necessary to take systematic account of climate risks. This applies to development planning and corresponding investments at all levels of political action and in all sectors. It requires robust and forward-looking risk analyses, early-warning systems and climate-risk insurance, for which the necessary capacity must be built. This includes within multilateral development banks and in the partner countries themselves. These are the key requirements for comprehensively addressing climate and disaster risks and for the resilience of the development efforts in the face of the unavoidable consequences of climate change.

Creating frameworks for strong national engagement

Creating the right frameworks locally in order to strengthen a sense of ownership and capacity to take action on the part of developing countries and emerging economies is the top priority. In this way, structures and institutions could be established in the long term for successful and independent national climate policy. This would be supported technically and financially through development cooperation, though it requires ownership within the countries to yield a sustainable impact.

Global energy consumption is pivotal for securing a stable climate. In order to achieve a rapid transition to a carbon-neutral global economy, it is necessary to reduce the supply of and demand for emission-intensive energy systems. This could be promoted through regulatory frameworks and price signals as well as through targeted linking of international financial conditions to export credit guarantees and the abolition of subsidies for fossil fuels. Given the dynamic growth in energy demand in developing countries and emerging economies, a great deal of action is required.

The roll-out of effective carbon pricing has a crucial role to play, most likely being the biggest political lever for efficient global emissions reduction. Development cooperation can play a key supporting role in introducing corresponding instruments in developing countries and emerging economies and for the design of international emissions trading.

Identifying and prioritising promising action areas

In addition to these overarching approaches, individual action areas at the interface between climate policy and sustainable development are highly relevant. The most notable of these action areas are global energy production, the political design of urbanisation, sustainable agriculture, forest and ecosystem conservation, and the management of global freshwater resources.

In order to develop the greatest possible impact in the short and medium-term and boost impetus for comprehensive change towards climate-friendly sustainable development, they should be afforded particular attention and prioritised accordingly. International cooperation can provide incentives in this context and assist developing countries and emerging economies initiate and support these kinds of systemic transformations locally.

There are already many vantage points for international climate cooperation with developing and emerging countries. Their central role in achieving the goals of the Paris Agreement can therefore be strengthened in a sustainable manner. Provided the political will is there on the part of the partner countries and the respective national frameworks are created, these action areas offer numerous options for intervention. This could effectively leverage the potential and experience of agents of international cooperation. The following recommendations serve as examples and are spelled out in detail in this study.

Modernising energy production around the world

A reliable supply of and affordable access to clean energy are crucial requirements for achieving sustainable socio-economic development, combating poverty and reducing societal inequality. At the same time, global energy consumption accounts for around 70% of global carbon emissions, with 25% coming from electricity generation alone. Growth in energy demand is dynamic, especially in developing countries and emerging economies.

Priorities for action

- **Supporting the leapfrogging of technical development steps in favour of renewable energy systems** in order to displace fossil fuels, particularly through decentralised solutions in rural areas and mobilisation of the private sector.
- **Identifying local alternatives to fossil fuel energy production** and promoting new technologies (such as green hydrogen production), adapted supply chains and regional energy corridors to exploit the potential for renewable energy.
- **Establishing and strengthening inclusive institutions** in order to shape local and national system change in the energy sector to moderate conflicts of interest for the benefit of all.
- **Consistently gearing international cooperation projects in the energy sector** to climate neutrality.

Wind and solar power generation. Photograph: Mel Stoutsenberger

Making urbanisation climate-friendly

Urban areas already account for three-quarters of global energy-related carbon emissions. By 2050, around two-thirds of the world's population will live in cities, driven by rapid urbanisation in Africa and Asia in particular. As these cities grow, so too does their climate-policy relevance.

Priorities for action

- **Promoting low-emission urban mobility** through electrified local public transport powered by renewable energy and improved transport infrastructure for pedestrians and cyclists. For example, through integrated spatial planning.
- **Investing in climate-friendly and climate-resilient urban infrastructure and buildings** that prevent emission-intensive path dependencies in urban development, take account of climate risks and also afford marginalised groups access to relevant infrastructure. For example, through the upgrading of informal settlements and slums.
- **Promoting inclusively planned adaptation measures** in order to boost the urban population's resilience to climate-related risks and foster social cohesion. For example, via participatory elements such as citizens' councils and the use of social media.
- Providing targeted support to help urban stakeholders **identify and exploit the potential of their cities as centres of sub-national climate policy.** For example, through twinning agreements.

Solar panels for supplying own necessity of electricity in the city. Photograph: BrazilPhotos

Safeguarding global food security with low emissions

Agriculture is the key sector in many developing countries and emerging economies and is crucial to the food security of an ever-growing global population. At the same time, around 80% of the world's total agriculture-based greenhouse gas emissions originate from developing countries and emerging economies. Increasing agricultural production in order to safeguard global food security while also reducing agricultural emissions is one of the key challenges in sustainable development.

Priorities for action

- **Promoting the acceptance and dissemination of climate-friendly and climate-safe technologies and practices** in agricultural production in order to increase yields in a way that allows emissions intensity to be reduced and resilience boosted.
- **Improving access for smallholders to loans and insurance** in order to mobilise sustainable investment and safeguard value chains.
- **Combining supply- and demand-side measures** to reduce emissions from meat and dairy production, primarily through sustainably intensifying livestock farming in developing countries and switching to plant-based alternatives and deforestation-free and climate-neutral products in industrialised nations.
- **Stepping up efforts to prevent harvest losses and waste,** primarily through improved, low-emission cooling and storage options in developing countries and through greater consumer awareness among the urban middle classes.

Everyday life for farmer with cows in the countryside. Photograph: DCPhoto

Conserving forests and ecosystems

Unspoilt ecosystems are the natural foundation for human development. In addition to numerous vital ecosystem services, forests, wetlands and oceans also serve as carbon sinks, capturing around half of human carbon emissions from the atmosphere. By implication, the destruction of ecosystems leads to a higher concentration of greenhouse gases in the atmosphere. Key natural carbon reservoirs are found within the territories of developing countries. Around 7% of global carbon emissions can be traced back to deforestation in the tropics alone.

Priorities for action

- **Improving the integration of species protection, ecosystem conservation and climate policy,** most notably through consistent mutual consideration of species protection issues in climate finance and climate-change impacts in biodiversity finance.
- **Minimising deforestation of tropical rainforests** by regulating global markets for relevant primary goods and creating incentives for **deforestation-free supply chains**. For example, by promoting remote sensing systems and industry standards for supply chains.
- **Clarifying and safeguarding local communities' land rights** in order to strengthen their sense of responsibility for protecting their forest resources, especially in conservation areas.
- **Taking greater account of indigenous and local knowledge** to improve the conservation and sustainable use of natural resources and increase the involvement of indigenous and local communities in environmental policy in the interests of sustainable land use.

Logging in lowland rainforest in Sabah Borneo. Photograph: Mint Images

Taking account of sustainable water use

Water is the basis for all life on planet Earth and a prerequisite for human development. Four billion people, primarily in developing countries, have no safe access to clean water and therefore have limited development prospects. Climate change threatens to exacerbate this situation further. At the same time, many forms of human water use are energy-intensive and generate additional greenhouse gas emissions.

Priorities for action

- **Promoting more efficient water use,** in particular by introducing and disseminating water-saving technologies in water-intensive sectors such as agriculture and urban development.
- **Strengthening integrated water resources management (IWRM),** in particular through developing capacity for monitoring water resources and infrastructure.
- **Reducing greenhouse gas emissions from wastewater and sludge,** in particular by promoting technical and institutional solutions for reducing, processing and reusing wastewater. For example, by using newly established wetlands.
- **Supporting governance reforms in the water sector** designed to overcome institutional fragmentation and opposing interests in the multi-level system and strengthening water security for marginalised groups.

Woman filling up canisters with clean water. Photograph: SOPA Images Limited

Introduction

Climate change has become a ubiquitous challenge. Its impact threatens lives and livelihoods in all countries around the globe. Likewise, it affects all sectors of a globalised economy and all levels of governance. As for societies, the poorest communities are typically the most vulnerable to the environmental, economic and social impacts of climate change, especially in developing countries. To strive for sustainable development inevitably means to deal with the causes as well as the consequences of anthropogenic global warming. At the same time, the fight against global warming will only be successful if development is ecologically sustainable and socially inclusive. In essence, "climate change is a development issue, and only sustainable development can confront the challenge" (Parry 2009).

Accordingly, development policy is essential for helping countries and communities to cope with climate change. Global development pathways should seek to avoid the unmanageable and manage the unavoidable consequences of climate change through inclusive policy responses and sustainable investments.

Avoiding the unmanageable, "dangerous climate change" in the words of the 1992 United Nations Framework Convention on Climate Change (UNFCCC), means radically reducing global greenhouse gas (GHG) emissions ('mitigation'). Scientific evidence indicates the possibility of irreversible changes to natural systems beyond a global temperature increase of 1.5°C. Staying within the critical threshold of 1.5°C to 2°C by the end of the century requires reaching net-zero emissions globally by around 2050.

Managing the unavoidable impacts of climate change means boosting social and economic resilience to climate-related risks. It aims to enable communities to adapt to climate-induced changes in the human environment ('adaptation'). Since climate-related risks will remain even as adaptation and risk reduction efforts are ramped up ('residual risk'), managing the unavoidable impacts of climate change extends to finding ways to respond to the losses and damages that may result.

Mitigating global warming, adapting to climate change and responding to the risks of climate-related losses and damages have all been anchored as distinct goals in the 2015 Paris Agreement on Climate Change (UNFCCC, 2015b, articles 6, 7 & 8). Moreover, the Paris Agreement's objectives are consistently framed in the context of sustainable development and poverty eradication. This underscores the development dimension of all climate policy. It also mirrors the transformative objective of the 2030 Agenda for Sustainable Development which was adopted by the United Nations (UN) General Assembly in September 2015 (UN, 2015b). Accordingly, climate-compatible development cooperation is key to handling the diverse set of challenges related to both mitigation of and adaptation to climate change.

The objectives of both the Paris Agreement and the 2030 Agenda are universal in scope. Developed countries (often referred to as 'global North') and developing countries and emerging economies (often referred to as 'global South') will need to join forces to achieve the objectives of both agendas. This signals a substantive departure from previous approaches, such as the Kyoto Protocol or the Millennium Development Goals, which both followed a distinct North-South dichotomy. Notwithstanding the historical emissions and subsequent responsibilities of developed countries, both agreements acknowledge the significance of current emissions contributed by developing countries and emerging economies as well as their projected future increases in both relative and absolute terms.

Achieving the goals of the Paris Agreement and 2030 Agenda hence requires ratcheted up ambition and determined action in both the North and South, especially when it comes to limiting the average global temperature rise to 1.5°C. Scientific evidence to that end is compelling (IPCC, 2018a) and, as of now, the world is far from being 'on track' (UNEP, 2019b). Similarly, the world is far behind schedule in reaching the Sustainable Development Goals (SDGs) within the envisioned 2030 timeframe (UN, 2020). While progress has been made in some areas, the international community is still lagging behind in achieving key targets

that cut across the range of SDGs, notably the issues of rising inequality, climate change, biodiversity loss and increased waste production (Independent Group of Scientists appointed by the Secretary-General, 2019). Synergies between the climate and sustainable development agendas offer hope on both counts.

Even the current COVID-19 pandemic bears promise as a crisis response. Despite the overwhelming harm it inflicts, particularly on the poor and most vulnerable, it has facilitated systemic corrections that would hardly be considered possible in a 'business as usual' setting. Indeed, "systemic change is often only possible through a crisis of the magnitude of COVID-19" (Patterson, 2020). A multidimensional approach to recovery would allow economies and societies to respond to compound risks more adequately and, crucially, "to break free from carbon-intensive production and consumption" (UNDP, 2020a).

Accordingly, the window of opportunity to recover from the pandemic by building forward in better, more sustainable ways bears great promise. This requires the alignment and coherent implementation of development objectives as spelled out in the SDGs and the imperatives of climate policy in a manner that leaves no one behind. While advancing climate-compatible development pathways, such alignment and coherence promise to simultaneously reduce poverty and hunger, create sustainable jobs and livelihoods and preserve natural resources and ecosystem functions. This thereby strengthens the crisis resilience of countries, economies and vulnerable populations, and seeks to diminish inequalities.

The socio-economic opportunities of climate-compatible development have been well established, for example by the World Bank Outlook 2050 (Mukhi *et al*., 2020), the Global Commission on the Economy and Climate (NCE, 2018) and by a recent COVID-19-focused special edition of the Human Development Report (UNDP, 2020b). Likewise, the Global Commission on Adaptation has made a compelling case for up-front adaptation investments to increase resilience and cost-efficiency (GCA, 2019). Scenario- and data-based analyses also illustrate the evident interlinkages between the objectives of sustainable development and climate policy (McCollum et al., 2018; Roy *et al*., 2018; Janetschek *et al*., 2020). At the same time, development trade-offs that may result from climate action will also need to be considered and carefully addressed (von Stechow *et al*., 2016; Shawoo *et al*., 2020).

Development cooperation has a major role to play in aligning development and climate policies and in ensuring coherence between both. In that sense, all development policy should be climate proof if it is to avoid undermining the goals of the Paris Agreement and yield environmentally sustainable and socially inclusive results. Likewise, climate policy, especially by developed countries that simultaneously act as donor countries in bi- and multilateral cooperation, invariably has an external dimension. As a case in point, more than 80% of Germany's international climate finance expenditure is disbursed through the German Ministry of Economic Cooperation and Development (BMZ) (BMZ, 2019a).

The potential of international cooperation at the nexus of development and climate policy needs to be recognised. This must then be leveraged in order to trigger transformative change on a larger scale towards sustainable development. For

instance, the European Union's (EU) Green Deal must not be seen as a European agenda that is only implemented domestically but should also guide the EU's external cooperation with partner countries in Asia, Latin America, the Caribbean and, in particular, Africa (Iacobuta *et al*., 2019; SDSN/IEEP, 2020).

Not least, the global financial system needs to allow for consistency on climate and sustainable development policy objectives. Indeed, "making finance flows consistent with a pathway to low GHG emissions and climate-resilient development" is explicitly called for in the Paris Agreement (UNFCCC, 2015b, article 2.1 (c)). Even though it speaks directly to the nexus of development pathways and climate action, this points well beyond the realm of development policy. It is essential to consider "all finance (public and private, domestic and international) and ensure it is supportive of, and not undermining the transition to a low-GHG emissions, climate-resilient world" (Whitley *et al.*, 2018) while also contributing to the implementation of the 2030 Agenda.

On balance, the numerous links between the objectives of the 2030 Agenda and the imperatives of the Paris Agreement call for a systemic perspective that reaches across sectors and encompasses all levels of governance. The pervasive relevance of global finance is one case in point, which is also reflected in the Addis Ababa Action Agenda (AAAA). The AAAA recognises multiple sources of finance – public and private, domestic and international – and calls for the strengthening of the financial systems to contribute to global stability, equitable and sustainable growth and sustainable development (UN, 2015a, article 105). Crucially, a coherent and integrated approach to climate-compatible and sustainable development policy can be expected to deliver 'triple win' effects through advancing equitable sustainable development around the globe, mitigating global warming ('avoiding the unmanageable') and boosting resilience towards climate change impacts ('managing the unavoidable').

To substantiate this case, in Chapter 1 this report first explores where we stand five years after the adoption of the Paris Agreement. It takes stock of current and projected GHG emissions and the status of global carbon sinks. It also explores the state of knowledge on expected climate risks in the context of sustainable development, with a focus on the role of developing countries and emerging economies. On this basis, it sketches out the implications for international cooperation, especially with a view to sector-wide approaches for climate neutral, resilient and sustainable development. Subsequently, the report turns to specific climate and development interlinkages in Chapter 2, with a focus on challenges and opportunities for cooperation in five key action areas — Electricity Supply, Cities, Agriculture, Forestry and Ecosystems, and Water. In Chapter 3, the report concludes with recommendations for forward-looking policy options to strengthen sustainable development in line with the Paris Agreement.

The road from Paris: 5 years later

1

Half a decade has passed since countries adopted the Paris Agreement at the UNFCCC's historic 21st Conference of the Parties (COP21). While the Agreement's objective of keeping global temperature increase to well below 2°C and striving for a 1.5°C limit is formulated at the global level, its success depends critically on action taken at a national level. For that purpose, all countries are requested to submit Nationally Determined Contributions (NDCs). These include pledges to mitigate GHG emissions and often formulate adaption goals, as well. Countries are asked to update these NDCs every five years, with the first update due in 2020.

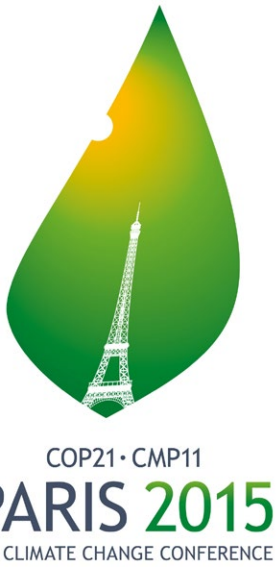
Box I
The Paris Agreement as a milestone and benchmark for international cooperation

The Paris Agreement on Climate Change

When the 21st Conference of the Parties to the UNFCCC finally adopted the Paris Agreement on 12 December 2015, it marked a historic moment. It sealed a protracted intergovernmental negotiation process that was widely considered an overdue response to a major challenge for international cooperation — finding effective and fair responses to anthropogenic climate change.

The Paris Agreement also proved historic by legally entering into force on 4 November 2016. This was within a year, and demonstrated an unprecedented pace of national ratifications as well as political resolve and momentum.

Five years after its adoption, it remains to be seen how the Paris Agreement will be effectively implemented around the world to deliver on its promises.



Core objectives of the Paris Agreement

- First and foremost, the Paris Agreement enshrines the **international commitment to limit global warming** to "well below 2°C above pre-industrial levels" and to pursue "efforts to limit the temperature increase to 1.5°C" (Art. 2.1 (a)). It signals the political will to decarbonise the world economy and end the era of fossil fuels.
- Second, the international commitment to this long-term goal is underpinned by **a universal political foundation that builds on national action** as spelled out in NDCs and acknowledges the need for all countries to take ambitious action. This signals a deliberate departure from the explicit dichotomy between developed and developing countries that previously hampered multilateral climate governance. The Paris Agreement also requests that each Party's successive NDC present a progression of ambition "in the light of different national circumstances" (Art. 4.3).
- Third, the Paris Agreement anchors the **need to adapt to climate change, strengthen resilience, and reduce vulnerability** as a distinct global goal (Art. 7). In this context, each Party is urged to engage in adaptation planning and implementation as appropriate, including through national adaptation plans (Art. 7.9 (b)). Furthermore, the Paris Agreement requires that enhanced financial resources aim to achieve a balance between adaptation and mitigation, taking into account the priorities and needs of developing country Parties (Art. 9.4). It also stipulates the need to avert, minimise and address "loss and damage associated with the adverse effects of climate change" (Art. 8).
- Fourth, the Paris Agreement calls for the **alignment of global financial flows** with the imperatives of climate policy and sustainable development (Art. 2.1 (c)). It thus backs the burgeoning post-fossil turnaround in the world of finance ('divestment') and signals reliable long-term expectations to business actors and investors. Moreover, developed country Parties "shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation" (Art. 9.1).

The leaders of COP21, the United Nations climate change conference, celebrate the adoption of the Paris Agreement on Climate Change on December 12, 2015 in France.

Sources: UNFCCC, 2015; Bauer and Pegels, 2016; Kinley, 2017; Bauer, 2018.
Photo: Alamy Stock

195 countries have submitted a first NDC, submissions of second NDCs are underway

To date, 195 Parties to the UNFCCC have submitted a first NDC, covering more than 95% of global GHG emissions. The ambition level of NDCs regarding their prospective GHG emissions reductions thereby widely differs across countries and is, on aggregate, projected to be insufficient to meet the Paris Agreement's goals (CAT, 2020e). Moreover, 136 out of all submitted NDCs are partially or wholly conditional on receiving international support, either in the form of financial assistance, technology transfer or capacity building. While most developing countries include both a conditional and an unconditional component in their NDC, there is a significant gap between what developing countries pledged to achieve unconditionally and what they indicate as additionally possible conditional on support. For example, Indonesia set an unconditional target of reducing its emissions by 29% by 2030 compared to a business-as-usual (BAU) scenario. The conditional target is to reduce emissions by 41% in the same period (Pickering *et al.*, 2019). Hence, the mobilisation of international support for the conditional components in developing countries' NDCs is key to meet the Paris Agreement's goals.

As of May 2021, 55 countries have submitted new NDC targets as part of the 2020 NDC update, covering 47.5% of global emissions. Several Parties have submitted a stronger mitigation target, while other countries submitted a second NDC without increasing their emissions reduction ambition.[1] A third group of countries indicated their intent to not update their NDC in 2020, which defaults from the decisions that give effect to the Paris Agreement (CAT, 2020b).

Current policies lead to an emissions gap of 47 $GtCO_2e$

A recent study took stock of current national climate actions[2] and compared them against the global objectives of the Paris Agreement. It demonstrates that current climate-related policies are highly insufficient to limit global warming to 1.5°C (IPCC, 2018a; Höhne *et al.*, 2020). When translating these current policies into GHG emissions, global emissions in 2050 are projected to be ~47 gigatons of carbon dioxide equivalents ($GtCO_2e$) above GHG emissions levels that would be in line with global warming of maximum 1.5°C above pre-industrial levels (Figure 1). In other words, there will be an 'emissions gap' of ~47 $GtCO_2e$ in 2050 if no additional climate action is taken to augment current policies.

Recent submissions of net-zero targets point in the right direction

Although current policies, as well as policies and targets set forward in the first round of NDCs, are highly insufficient to close the emissions gap, a recent wave of net-zero pledges has put the objectives of the Paris Agreement within reach (CAT, 2020d).[3] An analysis of these recent announcements shows that global warming could be limited to between 2.1°C and 2.6°C as a result of all net-zero pledges. This includes carbon neutrality announcements from major emitters such as Canada, China, the EU, Japan, Mexico, South Africa, South Korea and, under its new administration, the United States (US) (CAT, 2020d; UNEP, 2020). In total, 127 countries are considering adopting or have adopted net-zero targets that together cover 63% of the global GHG emissions in

1 Countries analysed in the CAT that submitted a stronger NDC target include: Argentina, Chile, Colombia, Costa Rica, Ethiopia, the EU, Kenya, Nepal, Norway, Peru, the United Arab Emirates, the United Kingdom, the US. Countries analysed in the CAT that proposed a stronger NDC target include: Canada, China, Japan, South Africa and Ukraine. Countries that submitted a new NDC but did not increase their ambition include: Australia, Brazil, Mexico, New Zealand, the Russian Federation, Singapore, South Korea, Switzerland and Viet Nam (CAT, 2020a).

2 The analysis presented here considers current policies but not necessarily NDC targets. For some countries, the policies considered are in line with the NDC target (e.g., EU), while for others, current policies are not aligned with NDC targets (e.g., Australia).

3 When a country adopts a net-zero target, it aims to achieve a balance of greenhouse gas emissions and removals — using either natural sinks, such as reforesting land or a technological solution, such as carbon capture and storage. Closely related, a country would aim for net-zero carbon dioxide emissions under a "carbon neutrality" target, whereas all greenhouse gases are considered under a "climate neutrality" target (NewClimate Institute and Data-Driven EnviroLab, 2020).

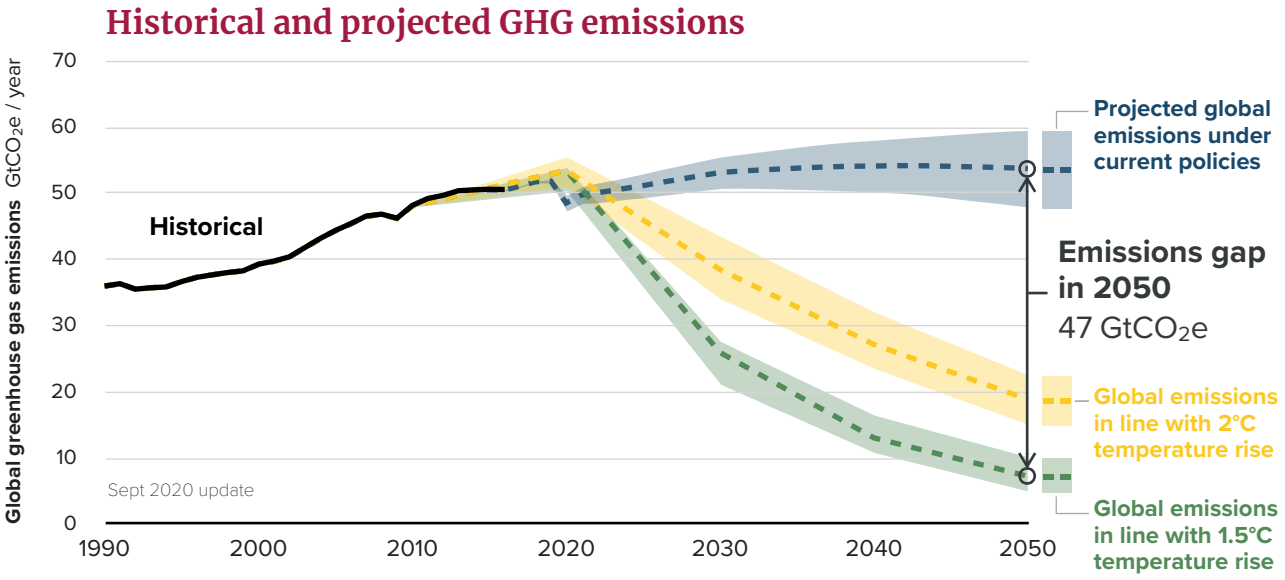


Figure 1 Historical and projected global GHG emissions, under current policies and different temperature pathways. The solid black line represents historical emissions. The shaded areas indicate maximum and minimum projected emissions. The dotted lines represent the mid-range projection (adapted from CAT, 2020e).

2017 (CAT, 2020d; UNEP, 2020). However, governments must translate their respective announcements into effective climate policies and realistic short-term targets, which are accompanied by solid implementation plans and long-term strategies. Only with stronger policies and targets towards 2030 will the net-zero target by mid-century be kept in reach (CAT, 2020d).

Global emissions are still rising and are projected to increase further, especially in developing countries and emerging economies

Despite global advances in climate policy, including the recent wave of net-zero targets, global GHG emissions have been growing steadily at 1.3 to 1.5% per year since 2009. This reached a record high of 55.3 $GtCO_2e$ in 2018, including emissions from land-use change (UNEP, 2019b). The top four emitters are China, the EU-28, India and the US, which together contributed over 55% of total GHG emissions (excluding emissions from land-use change). The Group of 77 and China, representing a coalition of 134 developing countries in the UN, together accounted for 60% of total GHG emissions in 2016 (ClimateWatch, 2020b).

A comparison of member countries of the Organisation for Economic Cooperation and Development (OECD) and non-OECD countries shows that in total, carbon dioxide (CO_2) emissions have declined in OECD countries by 0.4% per year since 2009, starting from a high per capita level. On the other hand, emissions have risen in non-OECD economies by nearly 3% per year, while remaining at a lower per capita level (UNEP, 2019b). This difference can be explained by higher growth in economic activity and energy use in non-OECD countries without equal reductions in energy and carbon intensity (Figure 2).

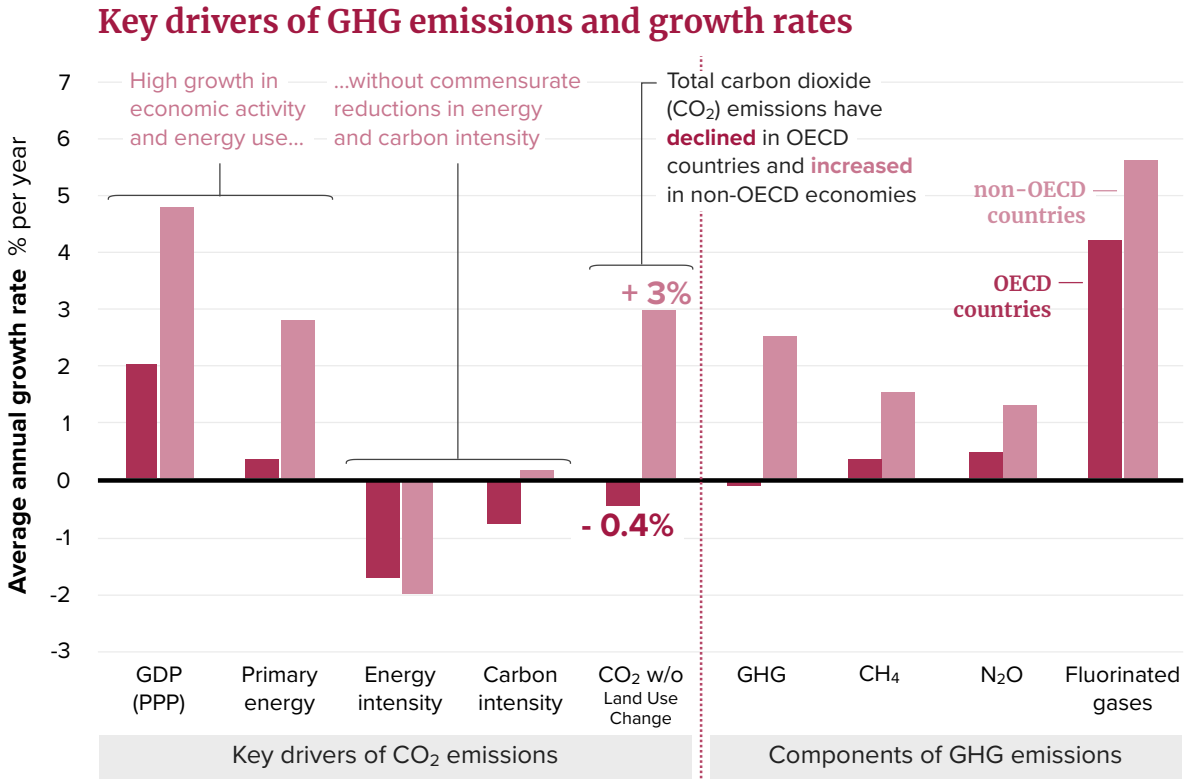


Figure 2 Average annual growth rates of key drivers of global CO_2 emissions (left of dotted line) and components of GHG emissions (right of dotted line) for OECD and non-OECD economies (adapted from UNEP, 2019).

While the recent rapid GHG emissions growth in non-OECD countries has supported domestic development and consumption, it must be noted that a considerable amount of these emissions are exported to OECD countries in the form of embodied emissions (Böhringer, Carbone and Rutherford, 2018). In that sense, high-income countries' imported emissions are higher than their territory emissions, while the emissions of upper-middle income, lower-middle income and low-income countries are often dominated by exports (IPCC, 2014a). This further highlights the global nexus of GHG emissions comprised in current production and consumption patterns and the potential role of demand-side measures and lifestyle changes towards climate neutrality (Creutzig *et al.*, 2018). Given the potential to reduce CO_2 emissions per unit of energy and reduce the carbon intensity of energy production, particularly in non-OECD countries, it also highlights the key role of development cooperation to support non-OECD countries to decarbonise their economies and boost their climate resilience.

COVID-19 will not close the emissions gap

Assumptions whereby a global economic downturn, as inflicted by the COVID-19 pandemic, will incidentally help to close the emissions gap are misleading. Much rather, COVID-19 is expected to have only a short-term impact on global emission levels. While global CO_2 emissions in 2020 could be in the order of 10% lower than in 2019 as a result of the pandemic, they are expected to increase again thereafter (Dafnomilis *et al.*, 2020). So far, the impact of recovery packages on GHG emissions is mixed. However, most analyses suggest that fossil-based recovery measures will likely receive

stronger support than low carbon alternatives (CAT, 2020a, 2020c; Energy Policy Tracker, 2020; Vivid Economics and Finance for Biodiversity Initiative, 2020). Yet, GHG emissions need to rapidly reduce in the coming years and brought to net-zero around mid-century in order to limit global warming to 1.5°C. As unabated climate change will undermine many other development issues, deep emissions reductions are seen as a condition for successful sustainable development (IPCC, 2018b).

Main Takeaway

The evident emissions gap highlights the urgency to take quick and effective action and the need for Parties to raise the ambition levels in their NDCs. The ambition level of existing NDCs regarding GHG emission reductions is, on aggregate, insufficient to meet the Paris Agreement's goals. Current development trends around the world indicate that enhanced action must engage both developed and developing countries to ensure that climate and development goals are achieved sustainably. To date, only a few of the major emitters have handed in an updated NDC in which they have distinctively raised their ambition. Acting now and taking ambitious action in the short-term can increase co-benefits of climate action to the SDGs and reduce or even avoid potential trade-offs. In particular, economic growth, job preservation, reduced air pollution, energy security and access, food security and resilient grid infrastructure would support the objectives of the 2030 Agenda to combat inequality and leave no one behind.

1.1 Status of emissions and future projections

This chapter first analyses the current status and sectoral structure of emissions and emissions trends for different countries, looking at developments in countries representing different income groups (low, lower-middle, upper-middle and high-income countries) and developing countries and emerging regions (Central and South Asia, Sub-Saharan Africa, Middle East and North Africa, and Latin America and the Caribbean) (1.1). Subsequently, the relevance of carbon sinks for the global climate as well as the current status and trends of different types of carbon sinks is discussed (1.2), followed by an overview of climate-related risks for sustainable development (1.3). Finally, the chapter outlines key implications for international cooperation to advance the achievement of the objectives of both the Paris Agreement and the 2030 Agenda (1.4).

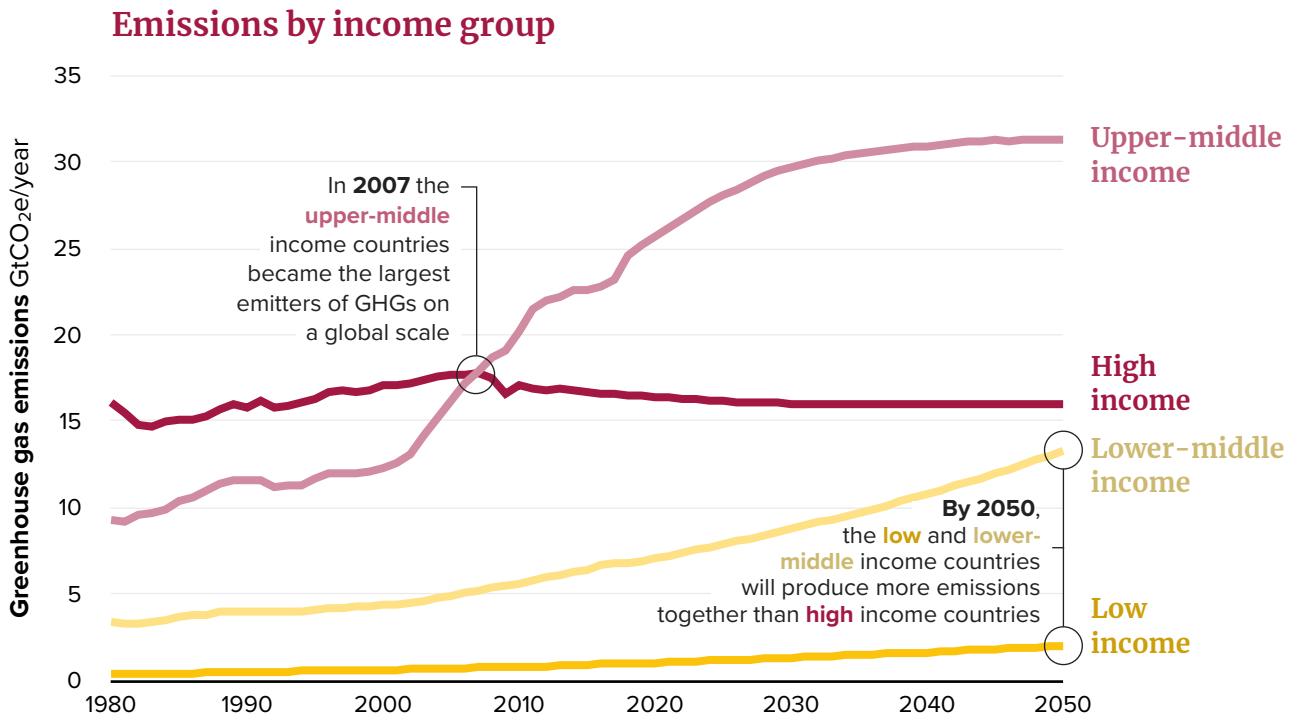


Figure 3 Historical and projected emissions (excluding FOLU emissions)[4], by income group[5] (based on Gütschow *et al.*, 2020).

4 This figure does not include emissions from forestry and other land-use (FOLU), due to methodological difficulties in projecting these emissions and related data uncertainties. GHG emissions in especially lower-middle and upper-middle income countries would be significantly greater when including forestry emissions (see Figure 4).

5 The projections are based on the Shared Socioeconomic Pathway 2 (SSP2) which is a middle-of-the-road scenario, in which social, economic, and technological trends do not shift markedly from historical patterns. Here, the downscaled SSP IMAGE scenarios dataset was used, based on convergence downscaling. Emissions from bunkers were removed before downscaling and a radiative forcing level 6.0 W/m2 was used. The scenario is comparable to a current policies scenario based on pre-COVID-19 projections (Climate Action Tracker, 2020d).

Upper-middle income countries have outpaced high-income countries as largest emitters

The required rapid reduction in GHG emissions calls for significant concerted efforts from developed countries as well as from developing countries and emerging economies. The share of global emissions from different income groups has been changing in recent years. Until 2007, high-income countries were responsible for the largest amount of global GHG emissions, but these have numbers slowly reduced. Since 2007, the collective of upper-middle income countries, including large emerging economies such as Brazil, China and South Africa, are the largest emitters of GHGs globally (Figure 3). In addition to the increasing emissions from upper-middle income countries, low and lower-middle income countries' GHG emissions are also growing rapidly. In a scenario based on current development patterns and climate policies, by 2050, the sum of low income and lower-middle income countries' emissions will exceed high-income countries' emissions (Figure 3).

Sectoral emissions splits reveal differences across income groups

Total emissions are dominated by CO_2 emissions from fossil energy use and industry, which reached a record high of 37.5 $GtCO_2$ in 2018 (UNEP, 2019b). However, the sectoral emissions split differs markedly across income groups. In upper-middle and high-income countries, a large share of GHG emissions comes from energy use. In lower-middle income and, in particular, in low-income countries, emissions from agriculture, forestry and land use (AFOLU) are more important (Figure 4). This can be explained by the dominance of agriculture and traditional bioenergy use in low-income economies. However, AFOLU emissions have stayed relatively constant since 1990 in all income groups, while a larger increase in GHG emissions can be observed in the industry and energy sectors. Since 1990, industrial and energy-related emissions have clearly grown in the lower-middle and upper-middle income countries, while remaining relatively constant in high-income countries. These differences explain countries' divergent climate policy priorities at different stages of development.

Sectoral emissions splits can also differ across countries in one income group

Zooming in on sectoral GHG emissions of BMZ global partners[6] such as India, Brazil and South Africa helps understand the importance of the country context for designing effective climate policies. Brazil and South Africa are two major emitters in the upper-middle income group, together contributing

6 The group of BMZ 'global partners' includes the following eight countries: Brazil, China, India, Indonesia, Mexico, Peru, South Africa and Vietnam.

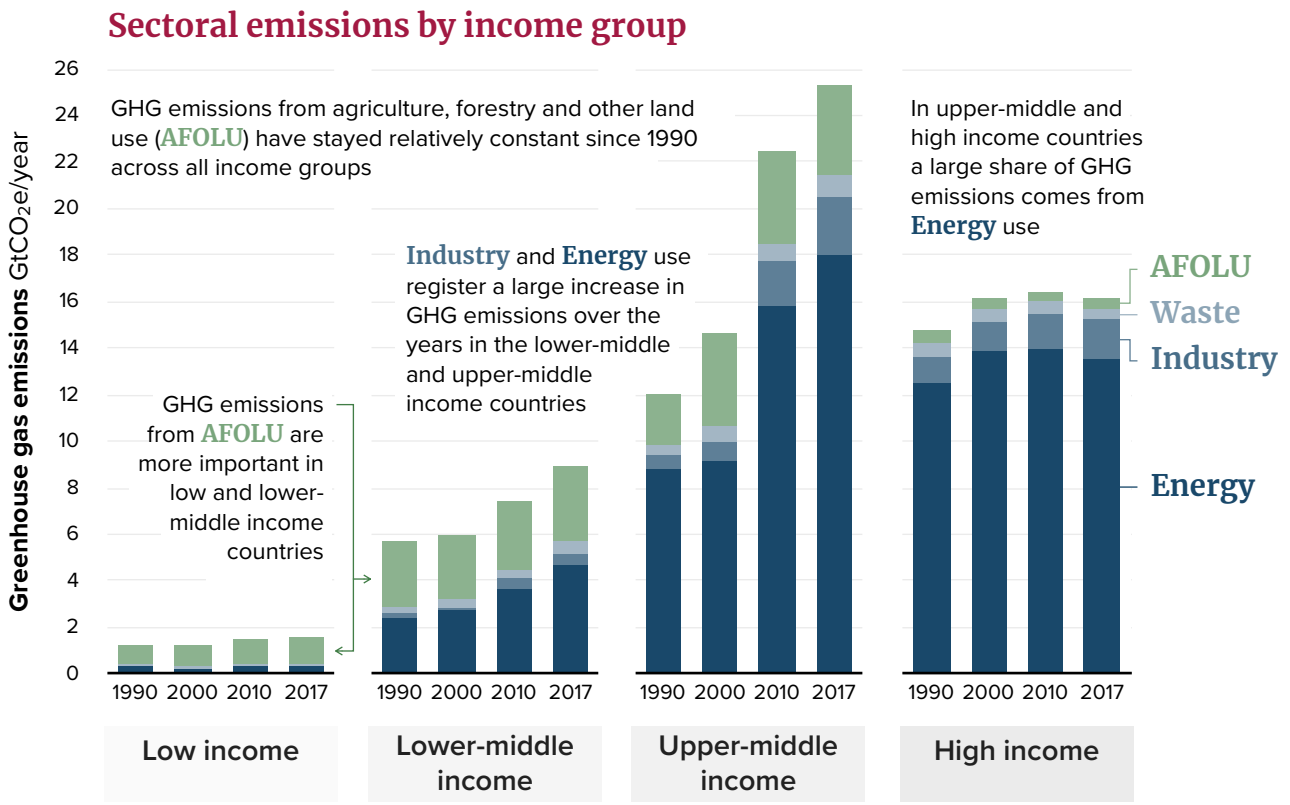


Figure 4 Historical GHG emissions, by income group and sector (based on Gütschow *et al.*, 2019; FAO, 2020a).[7]

to roughly 7% of current emissions in this group (excluding FOLU emissions). Brazil is projected to emit 30% of total GHG emissions in Latin America in 2050 — a share that would be even higher when considering FOLU emissions. South Africa, the most developed country in Sub-Saharan Africa, is projected to contribute 15% of emissions in its region in 2050. At that time, India is projected to be responsible for roughly 80% of GHG emissions in South Asia and roughly half of GHG emissions in lower-middle income countries. The sectoral emissions split by country (Figure 5) can differ considerably from the sectoral emissions split by income group (Figure 4).

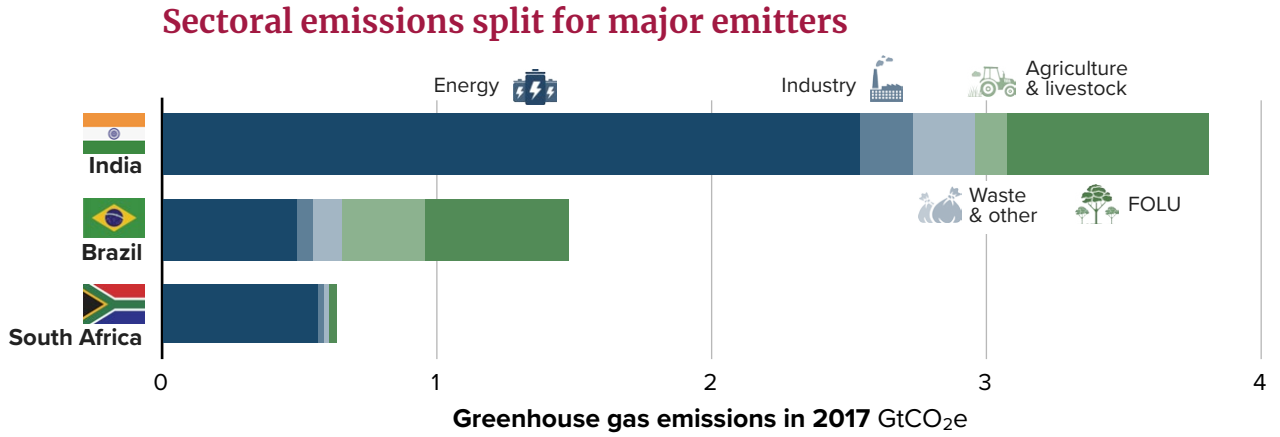


Figure 5 Sectoral GHG emissions splits across India, Brazil and South Africa (based on Gütschow *et al.*, 2019; FAO, 2020a).[8]

7 AFOLU emissions are a sum of agriculture, livestock and FOLU emissions. FOLU emissions are obtained from the FAO (FAO, 2020a), all other emissions are obtained from PRIMAP-hist (Gütschow *et al.*, 2019). FOLU emissions are based on country-reported data and calculations and are therefore illustrated for an order of magnitude. Emissions from industry include industrial processes and product use.

8 AFOLU emissions are split into agriculture and livestock and FOLU.

India

The situation in India highlights the importance to develop a just transition strategy for the energy sector, and to accelerate the switch from coal to renewables.

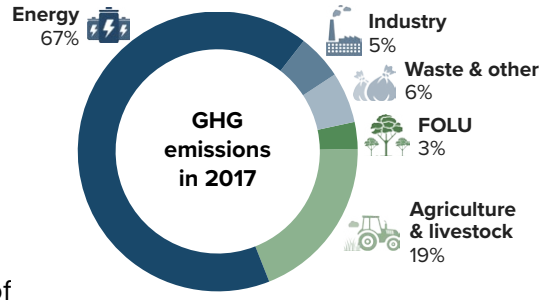


Figure 6 India's sectoral split of GHG emissions in 2017 (based on Gütschow *et al.*, 2019; FAO, 2020c).

As India contributes roughly half of the emissions from the lower-middle income group, the country's emissions split largely determines the sectoral emissions split of the lower-middle income countries as a whole (Figure 6). India's share of GHG emissions from energy is considerably higher than the share of energy-related emissions in all lower-middle income countries — 67% and 53%, respectively. Its share of AFOLU emissions, on the other hand, is lower than the share of AFOLU emissions in the lower-middle income group — 22% and 36%, respectively. This highlights the need for India to prioritise the development of a just transition strategy for the energy sector and to accelerate a transition that switches from coal to renewable energy. India submitted an NDC in 2016, which was rated as "2°C compatible" by the Climate Action Tracker (CAT, 2021). As of May 2021, no updated NDC has been submitted.

Brazil

Advancing low carbon development in Brazil will require policy making that decisively curbs emissions growth from deforestation, agriculture and livestock.

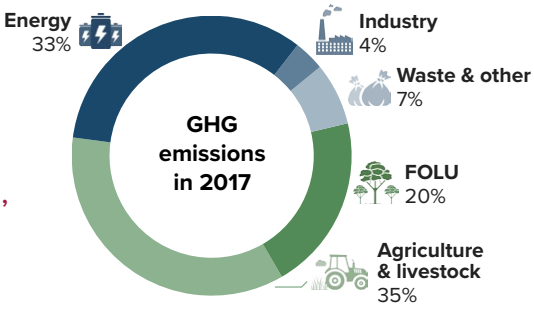


Figure 7 Brazil's sectoral split of GHG emissions in 2017 (based on Gütschow *et al.*, 2019; FAO, 2020c).

In contrast, Brazil's share of energy-related emissions is substantially lower than in all upper-middle income countries. A much larger share of Brazilian emissions is related to deforestation, agriculture and livestock instead (Figure 7). Under the current administration of President Bolsonaro, forest protection policies are being rolled back and deforestation rates soar, demonstrating the urgency for policymaking that curbs emissions growth in the country. While Brazil submitted an updated NDC in 2020, the new NDC targets were effectively weakened through an increase in the base year emissions that are used as a reference. Brazil's target is rated "insufficient" by the Climate Action Tracker (CAT, 2021).

South Africa

South Africa can leverage its post-COVID-19 recovery package to accelerate the rollout of renewables and to support a just transition pathway for the country's energy sector.

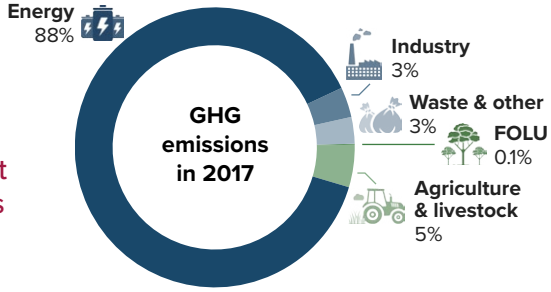


Figure 8 South Africa's sectoral split of GHG emissions in 2017 (based on Gütschow *et al.*, 2019; FAO, 2020c).

In South Africa, the share of energy-related emissions (88%) is significantly higher than in all upper-middle-income countries (71%), clearly illustrating the country's current dependence on coal-fired power. The emission shares of other South African sectors are relatively small — especially the negligible FOLU emissions (Figure 8). This illustrates the importance of accelerating the rollout of renewable energy and, as an example, use the planned post-COVID-19 economic recovery package to support a just transition of the energy sector. In 2016, South Africa submitted an NDC including a target range. However, based on the upper end of this NDC target, the Climate Action Tracker rates the target "highly insufficient" (CAT, 2021). As of May 2021, no updated NDC has been submitted.

The combined share of BMZ global partners' GHG emissions highlights that a stable climate – which is critical for the collective good of the global community – cannot be reached without this group of countries. However, of this group, as of March 2021, only India has an emissions reduction target that is considered "2°C compatible" and only China plans to strengthen its emissions reduction target in an updated NDC. This emphasises a lack of ambition in this group and the need for strategic cooperation to promote effective and efficient climate action in crucial countries. Only if these 'large emitters' decarbonise their economies in the long-term can the objectives of the Paris Agreement and the 2030 Agenda stay within reach.

The future emissions of low-income and lower-middle income countries are expected to grow significantly

When zooming in on low-income and lower-middle income countries around the globe, as shown collectively in Figure 3, the urgency of reversing their growing emissions becomes more apparent. Assuming that these countries will strive to achieve similar levels of development as upper-middle and high-income countries in the future, the potential for emissions growth is significant. Although high-income countries and regions such as the US and EU-28 are still amongst the largest emitters in the world, GHG emissions from low-income and lower-middle income countries are quickly catching up (Figure 9). To illustrate, the collective GHG emissions from BMZ bilateral and

GHG emissions growth by countries and regions

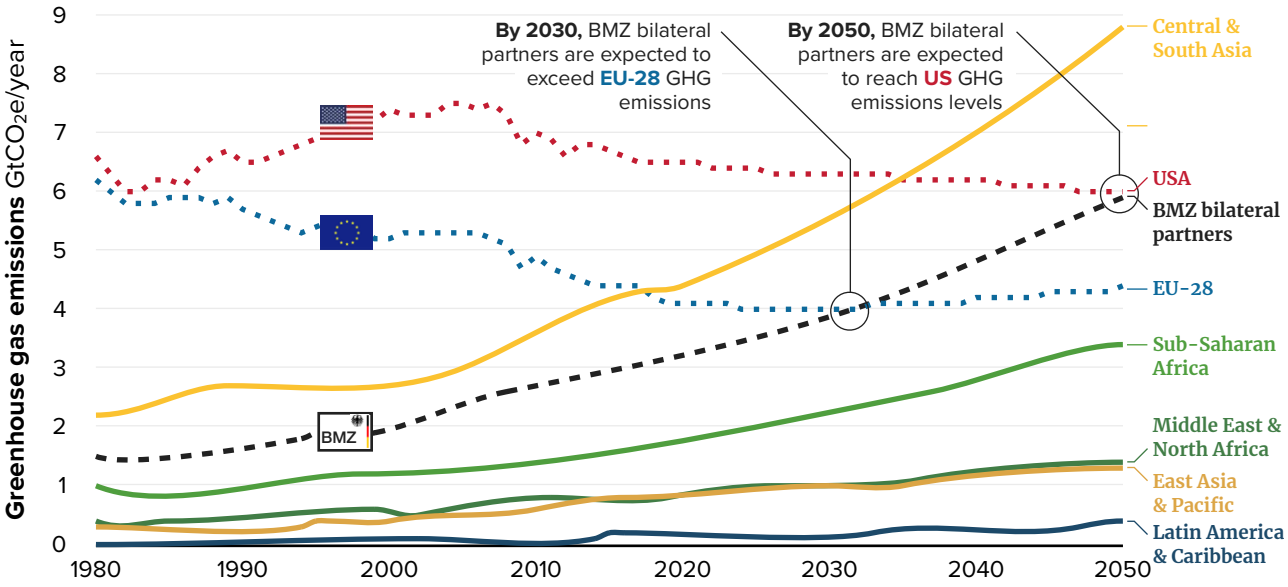


Figure 9 Historical and projected GHG emissions of low and lower-middle income countries by region, as well as for BMZ bilateral and reform partners, the EU-28 and the USA (excluding FOLU emissions) (based on Gütschow *et al.*, 2020).[11]

reform partner countries[9] are expected to exceed EU-28 emissions by 2030, in a scenario based on current development patterns and climate policies. By 2050, they are even expected to reach US emissions levels. GHG emissions of low-income and lower-middle income countries are increasing rapidly, especially in Central and Southern Asia and Sub-Saharan Africa (Figure 9).[10]

9 **BMZ bilateral and reform partners:** Afghanistan, Algeria, Bangladesh, Benin, Burkina Faso, Cambodia, Cameroon, Colombia, Côte d'Ivoire, Ecuador, Egypt, Arab Rep., Ethiopia, Ghana, Jordan, Kenya, Lebanon, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Pakistan, Rwanda, Senegal, Tanzania, Togo, Tunisia, Uganda, Uzbekistan, Zambia.

10 **Central & South Asia:** Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka, Kyrgyz Republic, Moldova, Tajikistan, Ukraine, Uzbekistan.

Sub-Saharan Africa: Angola, Benin, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo (Dem. Rep.), Congo (Rep.), Côte d'Ivoire, Eritrea, Eswatini, Ethiopia, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, São Tomé and Principe, Senegal, Sierra Leone, Somalia, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Middle East & North Africa: Algeria, Djibouti, Egypt (Arab Rep.), Morocco, Syrian Arab Republic, Tunisia, West Bank and Gaza, Yemen (Rep.).

East Asia & Pacific: Cambodia, Kiribati, Korea (Dem. People's Rep.), Lao PDR, Micronesia (Fed. Sts.), Mongolia, Myanmar, Papua New Guinea, Philippines, Solomon Islands, Timor-Leste, Vanuatu, Vietnam.

Latin America & Caribbean: Bolivia, El Salvador, Haiti, Honduras, Nicaragua.

11 Projected emissions are based on the SSP2 (see footnote 5).

Germany's partner countries show different emission patterns and related challenges for climate change mitigation

The expected GHG emissions growth and the importance of assessing country-specific emission patterns in low and lower-middle income countries can be illustrated using a number of BMZ's bilateral partner countries as examples.

Bangladesh, Nigeria, Egypt and Colombia are among the largest emitters of developing countries and emerging regions — both in 2017 and projected for 2050. As shown in Figure 10, the sectoral emissions split of the four countries differs substantially. The following section provides a brief snapshot into these illustrative examples and the issues related to climate change mitigation in major developing regions, covering Central and South Asia (Bangladesh), Sub-Saharan Africa (Nigeria), Middle East and North Africa (Egypt) and Latin America and the Caribbean (Colombia).

Sectoral emissions split for partner countries

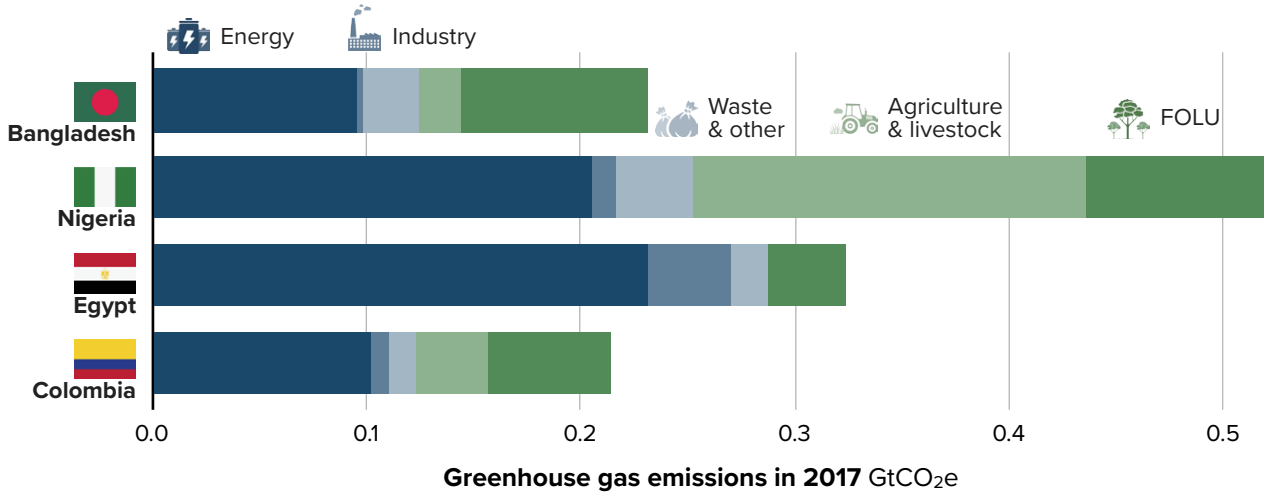


Figure 10
Country-specific sectoral GHG emissions patterns in low and lower-middle income countries as shown in the BMZ bilateral partner countries Bangladesh, Nigeria, Egypt and Colombia (based on Gütschow *et al.*, 2020).

Bangladesh

Developing renewable energies and electrifying end-use sectors can help Bangladesh align its emissions pathway with the goals of the Paris Agreement and yield co-benefits for sustainable development.

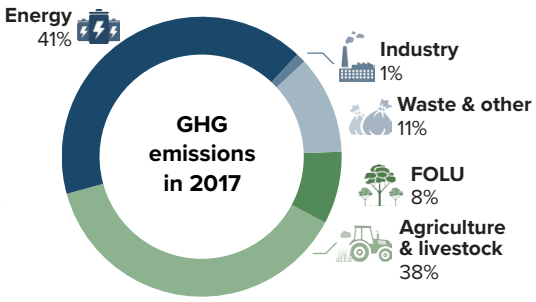


Figure 11 Sectoral GHG emissions split of Bangladesh.

Bangladesh is a lower-middle income country and one of the most vulnerable countries in the world in regards to climate change. At the present levels of global warming of about 1°C above pre-industrial levels, the impacts of climate change are already widely noticeable.

Bangladesh is predominantly an agricultural country, with agriculture and livestock contributing to around 16% of its gross domestic product (GDP) (Rasha *et al.*, 2018). This is also reflected in the country's emissions profile. Agriculture and livestock emissions, together with a smaller share of FOLU emissions, contributed the largest share to overall emissions in 2017 (Figure 11).

The agricultural sector is closely followed by the energy sector, which made up 41% of their overall emissions in 2017 due to a high share of fossil fuels in electricity generation. Emissions from the energy sector can be expected to grow steeply in the future. While existing power plants are mostly oil and gas-fired, Bangladesh has plans to develop domestic coal production and massively expand coal-fired power generation to reach a share of 35% by 2041 (Climate Analytics, 2019). At the same time, there is scope to develop renewable energies and electrify end-use sectors, which would help to align Bangladesh's emissions pathway with the Paris Agreement's goals and reap wider sustainable development objectives.

Bangladesh submitted a first NDC in 2015, where it committed to reducing GHG emissions by 5% from BAU levels by 2030 in the power, transport and industry sectors. Conditional on international support, the country pledged to increase this target to 15% below BAU in the same year. An updated version of the first NDC was submitted in December 2020, however the mitigation targets remained unchanged (ClimateWatch, 2020a).

Nigeria

Nigeria has huge potential to curb energy poverty and to spur sustainable development and economic growth through leapfrogging carbon-intensive electricity generation to low-cost renewable alternatives, including solar PV and wind.

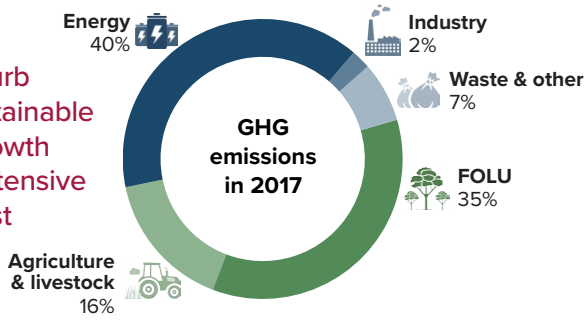


Figure 12 Sectoral GHG emissions split of Nigeria.

Nigeria is a lower-middle income country and has the largest economy and population in the whole of Africa. The country is expected to become the world's second most populous country (after India) by the end of the century and is already the second largest emitter in Sub-Saharan Africa, after South Africa.

Nigeria's economy is closely tied to oil and gas exports, with revenues from petroleum exports currently accounting for 86% of Nigeria's total export revenue (Dunne, 2020). At the same time, the country has one of the highest rates of energy poverty. While there are plans to close this gap, including through expansion of solar power, the use of more fossil fuels is equally foreseen. Nigeria has coal and natural gas reserves that are largely untapped (Dunne, 2020).

Although Nigeria's economy is heavily invested in fossil fuels, the major share of emissions arises from deforestation (FOLU), agriculture and livestock (Figure 12). However, based on the ongoing investments in fossil-based energy supply, energy-related emissions are expected to increase significantly over the next decades.

Nigeria submitted a first NDC in 2017, committing itself to reduce emissions by 20% below BAU by 2030 in the unconditional component and to 45% below BAU by 2030 conditional on international support. The target covers all sectors of the Intergovernmental Panel on Climate Change (IPCC). As of May 2021, Nigeria has not submitted an updated NDC (ClimateWatch, 2020a).

Egypt

Egypt can pave the way for a clean, safe and sustainable development of its economy by combining ambitious renewable energy targets and energy efficiency measures in its energy, transport and buildings sectors.

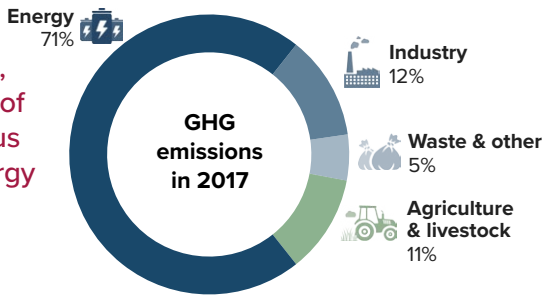


Figure 13 Sectoral GHG emissions split of Egypt.

Egypt is experiencing rapid economic growth and an expanding urban population — along with a rapidly increasing demand for energy. Egypt's fossil fuel-based power and transport sectors are among the most carbon-intensive in the Middle East and North Africa region as its energy supply is dominated by

natural gas and oil (Climate Investment Funds, 2020). With 90% of the Egyptian power sector fuelled by oil and gas, and only 10% of electricity generated by renewable energy, Egypt's power sector is responsible for the largest share of the country's GHG emissions, followed by transportation. Together with emissions from buildings and other smaller sources, these two sectors add up to a high share of energy-related emissions in the country (Figure 13).

To achieve its development goals, Egypt plans to diversify its power mix by introducing coal-fired power. In fact, coal is expected to be the main source in the energy mix by 2030. Seven coal-fired power plants are currently being constructed, with the first one planned to start operation in 2022 (Abdallah and El-Shennawy, 2020).

At the same time, Egypt announced a target to expand renewables to 42% by 2035, with a proposal to increase this target to even 60% by that same year (IRENA, 2018; Al-Aees, 2020). However, the fast increase in coal-fired power is one of the reasons Egypt is projected to remain among the high emitters of lower-middle income countries. In addition to the high share of energy-related GHG emissions, a relatively large share of Egypt's emissions comes from the industry sector.

AFOLU emissions in Egypt are low compared to the other high-emitting countries discussed in this section, mainly because there is hardly any forest in respect to the overall area and barely any deforestation has been observed (Global Forest Watch, 2020).

Egypt submitted its first NDC in mid-2017. While the primary focus of the NDC is on adaptation, outlining conditional commitments to take adaptation action, no GHG emissions reduction target was included. As of May 2021, no updated version of the NDC has been submitted (ClimateWatch, 2020a).

Columbia

Colombia's ambitious climate targets can be achieved if adequate policies are implemented to tackle emissions from the energy and transport sectors. A gradual phase-out of coal can help to reach climate neutrality by mid-century.

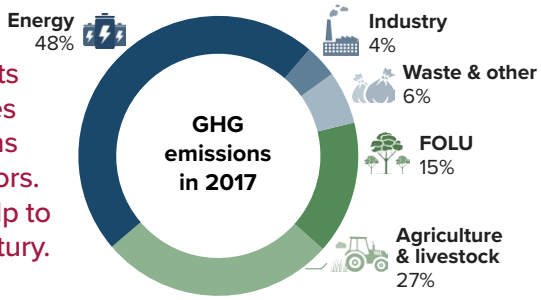


Figure 14 Sectoral GHG emissions split of Colombia.

Historically, Colombia's largest contributor to GHG emissions was the AFOLU sector (Figure 14). Although the relative contributions of AFOLU emissions have been decreasing – down from 90% in 2000 and 55% in 2012 (IDEAM *et al.*, 2017) to 42% in 2017 – the AFOLU sector is again projected to become the largest contributor to Colombia's total GHG emissions in 2030 (Ministry of Environment, 2020).

Currently, the largest share of emissions stems from the energy sector. Colombia is rich in energy resources, particularly coal, natural gas and hydropower. It is the 11th largest coal producer and the 4th largest coal exporter in the world, with export shares around 95%, making the coal industry a key economic factor for the country (Lütkehermöller, Luna and Fekete, 2018).

In 2014, Colombia exported more energy (mainly in the form of coal) than it consumed domestically, with the main customers of coal being Germany and Russia. However, coal export revenues have been decreasing since 2015 due to a drop in international demand. Therefore, Colombia is increasingly directing coal to domestic use, which underpins the plan to ramp up coal-fired power plants (Lütkehermöller, Luna and Fekete, 2018). The combination of the increasing use of fossil fuels in the electricity mix and rising deforestation rates in Colombia lead to high projected GHG emissions in the future.

Colombia submitted a first NDC in 2018, pledging to reduce its GHG emissions economy-wide by 20% from BAU levels by 2030 without international support and by 30% conditional on international support (ClimateWatch, 2020a). In December 2020, Colombia submitted an updated first NDC with a significantly stronger mitigation target, replacing all earlier targets with a new target to reduce GHG emissions by 51% below BAU by 2030. As such, the updated first NDC is closely aligned with the country's objective of achieving carbon neutrality by 2050 and represents one of the most ambitious NDCs in the Latin America and Caribbean region (Vergara *et al.*, 2021).

Main Takeaway

These snapshots of three global and four bilateral partner countries of German development cooperation show that GHG emissions patterns differ significantly across countries. Hence, tailor-made and sector-specific approaches for emissions reductions are required. They also demonstrate the substantial potential for development cooperation with regards to reversing the current GHG emissions trends. The share of energy-related emissions in each country is significant and opportunities lie within the support of countries to realise their renewable energy potential. Many countries plan to expand their share of fossil-based power, contributing to a significant projected increase in global GHG emissions.

In addition, sectors such as agriculture and forestry also hold great potential in terms of GHG emissions mitigation and sustainable development, covering areas like food security and biodiversity conservation.

By supporting sustainable progress in a variety of sectors, development cooperation can play a key role in leveraging this potential and in keeping both the Paris Agreement temperature goals and the SDGs within reach. This engagement is essential for limiting global warming and reaping the associated benefits for the global community.

1.2 Status of carbon sinks

Carbon sinks play an important role in global efforts to reverse GHG emissions trends and effectively enhance climate change mitigation and adaptation. Article 4.1 of the Paris Agreement requires countries to reach peak emissions as soon as possible "so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of this century" (UNFCCC, 2015). This can only be achieved through ambitious emission reductions in conjunction with adequate measures to preserve, enhance and restore carbon sinks.

Global land and ocean areas currently remove 50% of anthropogenic CO_2 from the atmosphere

Natural ecosystems, including soils, forests, mangroves, wetlands and oceans store large amounts of carbon. This is primarily through photosynthesis in terrestrial ecosystems and gas exchange between the atmosphere and the ocean in marine ecosystems. Global land and ocean areas are net carbon sinks, meaning that they absorb more carbon than they emit. Currently, the entire worlds land and oceans remove about half of anthropogenic CO_2 from the atmosphere, with around 10 $GtCO_2$ per year being absorbed each by terrestrial ecosystems and by marine ecosystems (Figure 15) (Sitch *et al.*, 2015; Friedlingstein *et al.*, 2020).

Global carbon cycle and annual flows

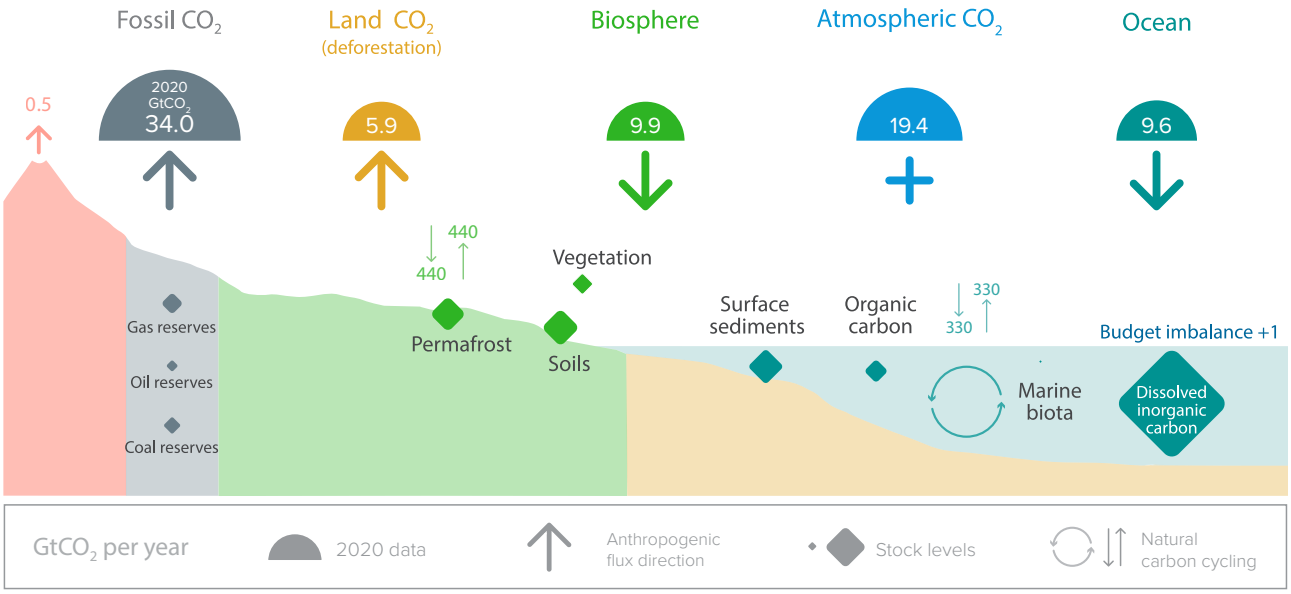


Figure 15
The global carbon cycle (adapted from Friedlingstein *et al.*, 2020).

Most carbon on land is stored in soils (1500-2500 gigatons of carbon (GtC)[12]) and permafrost (1700 GtC). Wetlands store about 300 to 700 GtC and peatlands and other vegetation (mostly forests) store about 450 to 650 GtC[13] (IPCC, 2013). The global carbon budget[14] indicates that land and ocean sinks have increased over the last six decades in proportion to total CO_2 emissions and contributed to slowing down global mean temperature increase by 0.09°C over the last 40 years (Jia ***et al.***, 2019). However, the capacity of these sinks to keep storing carbon is highly uncertain.

Climate change adversely affects carbon sinks

Climate change is directly altering biomass production on land as plants are negatively affected by heat and water stress. In addition, the spread of fires and diseases due to climate change are an increasing cause of tree mortality (IPCC, 2013; Brando *et al.*, 2020; Elias *et al.*, 2020). In addition, while rising CO_2 concentrations stimulate the rate of photosynthesis and reduce plant water demand, these positive effects are constrained by soil nitrogen contents and long exposure to extreme heat and droughts (Keenan *et al.*, 2016; Pugh *et al.*, 2018).

Furthermore, rising atmospheric CO_2 concentrations harm marine ecosystems as they lower the pH-value of the ocean. This alters the photosynthesis and enzyme activities of marine life and negatively impacts marine ecosystem services (IPCC, 2013).

Unsustainable land management practices further reduce the storage capacity of terrestrial carbon sinks

At the same time, around 25 to 75% of the original soil carbon in the world's cultivated soils have been lost, mainly due to unsustainable management practices, resulting in land degradation. This further intensifies the impacts of climate change (FAO, 2019). These developments highlight the importance to implement measures that prevent soil degradation, including sustainable land management and agroecological approaches. Similarly, loss of total land sink areas resulting from deforestation and other land-use change to vegetation types with lower carbon content is estimated to emit about 1.5 $GtCO_2$ per year (Friedlingstein *et al.*, 2019).

12 To convert GtC to the unit of $GtCO_2$, values must be multiplied by 3.664. Terrestrial ecosystems store carbon in various forms, which transform to carbon dioxide when in contact with oxygen from the atmosphere.

13 Peatlands could be storing several hundred GtC but these estimates remain uncertain.

14 The global carbon budget determines the emissions of carbon dioxide to the atmosphere through human activities, balanced by carbon storage in sinks on land or in the ocean. For any given amount of emissions, if less carbon is stored in land or ocean, more will remain in the atmosphere. Each year since 2005, a community of researchers for the Global Carbon Project produce and report a global carbon budget by quantifying the CO_2 emissions for the prior year and apportioning it to the atmosphere, the ocean or the land. This accounting of emissions and sinks, including a quantification of uncertainties, allows the research community to understand and monitor major components of and processes within the global carbon cycle (Candela and Carlson, 2017).

Research suggests that tropical forests have sequestered about 15% of CO_2 emissions in the 1990s and 2000s, but this tropical sink may have already peaked in the 1990s due to high tree mortality in the Amazon (Hubau *et al.*, 2020). Hence, particular effort to reverse deforestation trends in the Amazon and to restore forests worldwide is critical for preserving, enhancing and restoring land sinks.

Agriculture and forestry are key for carbon sink conservation and restoration and have particular relevance in many developing countries

Given the considerable carbon storage potential of different terrestrial ecosystems, the agriculture and the forestry sectors are, in general, relevant for the conservation and enhancement of carbon sinks. These sectors are crucial in developing countries and emerging economies since essential ecosystems such as rainforests, grasslands and savannahs are concentrated in countries in the tropics and sub-tropics of the global South. Yet, intensive deforestation and rapid degradation of ecosystems have often been long-lasting consequences of the pursuit of short-term economic growth and social development. The example of Europe shows where this may lead in the future. More than half of Europe's original Central and Northern forests have disappeared, mostly due to increased demand for agricultural land and the use of wood fuel (Roberts *et al.*, 2018).

Carbon sink enhancement strategies have a mitigation potential of up to 12 $GtCO_2$ per year by 2050

Strategies for enhancing terrestrial sinks, in particular, could contribute to sequestering up to 12 $GtCO_2$ per year by 2050 (Table 1) (Roe *et al.*, 2020). A majority of developing countries and emerging economies (around 86%) included mitigation in the land use, land-use change and forestry sector (LULUCF) in their NDCs (Strohmaier, R. *et al.*, 2016). The sector is particularly prominent in the NDCs of countries in South-East Asia, Sub-Saharan Africa and Latin America. However, most developing countries have also highlighted their need for substantial financial and technical support to implement respective mitigation strategies.

Carbon Dioxide Removal techniques become increasingly relevant for 1.5°C scenarios

Carbon sink enhancement is also the objective of different Carbon Dioxide Removal (CDR) techniques. All projected pathways that limit global warming to 1.5°C require active removal of CO_2 from the atmosphere. Scenarios from

Integrated Assessment Models (IAMs) evaluated by the IPCC focus on land-based CDR methods, in particular through Bioenergy Carbon Capture and Storage (BECCS) and forest-area expansion (afforestation and reforestation). Only a few models also include Direct Air Capture with Carbon Capture and Storage (DACCS) and soil carbon sequestration, on which literature only recently started to develop. Other, more speculative approaches, particularly ocean-based CDR (through ocean iron fertilisation or ocean alkalinisation) and removal of non-CO_2 gases have not yet been picked up to a relevant degree in any of the models (Forster *et al.*, 2018; IPCC, 2018a). Given that most CDR technologies remain largely unproven to date and raise considerable social and environmental sustainability concerns, additional research is needed to close the existing knowledge gap and potentially make the deployment of a wide range of CDR methods feasible at a larger scale (IPCC, 2018a).

Table 1 Strategies for enhancing terrestrial carbon sinks and relevance to developing countries and emerging economies (adapted from Roe et al., 2020).

Strategies for enhancing terrestrial carbon sinks	Relevance to developing countries and emerging economies	Mitigation potential
Reduce emissions from deforestation and degradation, conversion of coastal wetlands, and peatland burning.	Hotspots of tropical deforestation in Central Africa, South America and South East Asia.	4.6 $GtCO_2$/yr
Restore forests, coastal wetlands and drained peatlands.	Emerging economies (Brazil, Indonesia, China, India, Mexico).	3.6 $GtCO_2$/yr
Improve forest management and agroforestry.	Hotspots of tropical deforestation and most tropical countries.	1.1 $GtCO_2$/yr
Enhance soil carbon sequestration in agriculture (no till agriculture, biochar, conservation agriculture).	Emerging economies and Sub-Saharan African countries.	1.3 $GtCO_2$/yr
Bioenergy Carbon Capture and Storage (BECCS).	On land not competing for food production.	1.1 $GtCO_2$/yr

Main Takeaway

Carbon sinks are vitally important for the global climate and the pursuit of carbon neutrality. Yet, persistent threats to the respective ecosystems, notably forests, underscore the need to increase international efforts to conserve and restore effective carbon sinks and enhance carbon sink potential around the world. International cooperation should be focused on introducing sustainable land and forest management practices in the agricultural and forestry sectors in developing countries and emerging economies. Furthermore, the potential of marine carbon sinks should be examined more closely and respective enhancement methods developed that are ideally considered in future global, regional or national governance regimes. Finally, research and development on CDR options should be accelerated, and demonstration projects carried out, to realistically assess the risks and potentials of such techniques to better inform efforts to curb carbon sink loss.

1.3 Climate change impacts and associated development risks

Climate change impacts are likely to be profound even if the goals of the Paris Agreement are achieved and global warming is kept to an average increase of 1.5°C compared to pre-industrial levels. Given the current 'emissions gap' and expected emissions trajectories, global warming that exceeds an average of 1.5°C still seems far more likely at present. This makes a daunting difference as the risks associated with climate change are bound to increase exponentially with every tenth of a centigrade. Either way, the impacts of climate change prove an all-encompassing threat for human development. It is an amplifier for many development challenges associated with changes in the human environment, especially with a view to poorer communities and climate-vulnerable developing countries. From this perspective, climate policy is ultimately an exercise in risk management (Kunreuther *et al.*, 2013).

Climate change already affects the human environment

Already today, with global warming at just above 1°C compared to pre-industrial levels, changes in Earth systems that interact with human development are observable around the world. Climate change impacts manifest themselves in an increased frequency and intensity of extreme weather events, such as storms and floods, recurrent and prolonged droughts and heatwaves, as well as terminally shrinking glaciers and ice sheets, expanding cyclone seasons and rising sea levels. The latter, in turn, prompts the salinisation of coastal freshwater and land resources as well as coastal erosion.

Moreover, the warming and acidification of oceans leads to coral bleaching and the collapse of marine ecosystems (WBGU, 2013; IPCC, 2019a). Additional hazards, like wildfires, are not necessarily caused by climate change itself, but their ravaging potential is amplified by changing climatic conditions (IPCC, 2019b).

The consequences of these and other climate change impacts are typically felt most severely by poor and vulnerable populations in the global South, who are already marginalised. Not only are these countries and communities more intensely exposed to the impacts of climate change, they are also less prepared to deal with these impacts by means of adaptation. This further exacerbates prevailing inequalities (Figure 16).

Mapping climate vulnerability and adaptation readiness

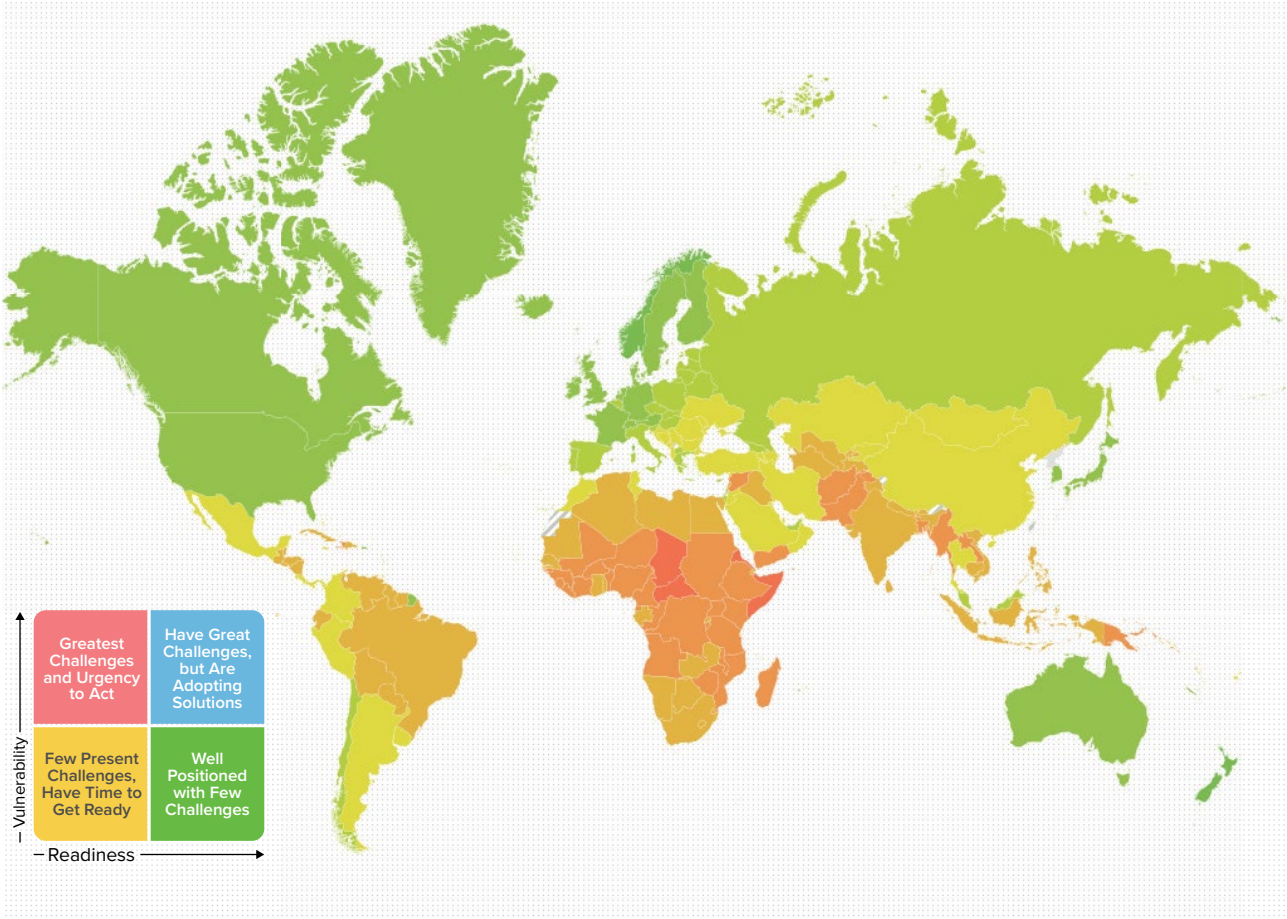


Figure 16 Countries' vulnerability to climate change and other global challenges and their readiness to address these challenges through adaptation action. The colours delineate four groups: highly vulnerable and insufficiently ready – red; not ready but less vulnerable – yellow; highly vulnerable but ready – blue; less vulnerably and ready –green (adapted from NDC-GAIN Index, https://gain-new.crc.nd.edu/).

Sudden onset events imperil lives and livelihoods overnight

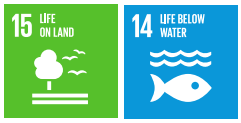
The connection between the abstract notion of climate change and its disastrous real-life impacts is most easily perceived in the case of sudden onset extreme weather events, like tropical cyclones or torrential rains and resulting flooding. These events can be highly disruptive and tend to imperil the lives and livelihoods of millions of people overnight. Accordingly, they attract considerable media attention as well as humanitarian responses through disaster relief operations and even insurance schemes. Indeed, costs resulting from extreme weather events alone have risen to a record EUR 260 billion in 2017 (Löw, 2018). While that catastrophic record has since not been met, recent reports confirm the upward trend over time, mostly due to havoc wreaked by tropical cyclones and flooding (World Meteorological Organization, 2020).

Slow onset events undermine sustainable development in the longer term

At the same time, climate change is also driving slow onset events, like sea-level rise, coral bleaching or dryland degradation that can be equally damaging to sustainable development. As they gradually alter the conditions under which current and future generations may develop, slow-onset climate impacts tend to undermine past and ongoing poverty reduction efforts, putting livelihoods at risk and exacerbating social inequalities (Aleksandrova, 2019). However, slow-onset climate impacts often remain overlooked. Due to their inherently incremental nature, they attract less media attention and, by extension, public awareness. This also makes them more challenging to respond to politically.

Ultimately, both the sudden- and the slow-onset impacts of climate change undermine past and ongoing development achievements. As such, they imperil established livelihoods and hinder the achievement of the SDGs in many ways (Roy *et al.*, 2018).

Table 2 Sustainable development implications of avoided impacts between 1.5°C and 2°C global warming (adapted from IPCC, 2018a).

Impact	1.5°C	2°C	
Water scarcity	• 4% more people exposed to water stress (reference year 2000) • Approx. 500 million people exposed and vulnerable to water stress	• 8% more people exposed to water stress (reference year 2000) • Approx. 600 million people exposed and vulnerable to water stress	
Ecosystems	• Around 7% of land area experiences biome shifts • 70-90% of coral reefs at risk from bleaching	• Around 13% of land area experiences biome shifts • 99% of coral reefs at risk from bleaching	
Coastal cities	• 31-69 million people exposed to coastal flooding • Fewer cities and coasts exposed to sea-level rise and extreme events relative to 2°C	• 32-79 million people exposed to coastal flooding • More people and cities exposed to sea-level rise and extreme events relative to 1.5°C	
Food systems	• Significant declines in crop yields avoided, some yields may increase • 32-36 million people exposed to lower yields	• Average crop yields decline • 330-396 million people exposed to lower yields	
Health	• Lower risk of temperature-related morbidity and smaller mosquito range relative to 2°C • 3546-4508 million people exposed to heat waves	• Higher risks of temperature-related morbidity and larger mosquito range relative to 1.5°C • 5417-6710 million people exposed to heat waves	

Investments in climate action today are more cost effective than addressing losses and damages in the future

Science underscores that every tenth of a centigrade of avoided global warming makes a vital difference for sustainable development. Indeed, stronger global warming increases "the likelihood of severe, pervasive and irreversible impacts for people and ecosystems" (IPCC, 2014b). Correspondingly, adaptation needs will be lower for global warming of 1.5°C compared to 2°C, as shown in Table 2 (IPCC, 2018a). In turn, more severe impacts and associated losses stretch thin the coping capacity of many human and natural systems, especially in developing countries (Figure 17). Consequently, up-front investments in climate change mitigation and adaptation are invariably more cost-efficient than a future that requires having to repair climate-related damages, manage climate-related losses and residual risks, or keep investing into development objectives that could have been achieved, or brought within reach, without unfettered climate change (Stern, 2007).

Climate impacts and risks

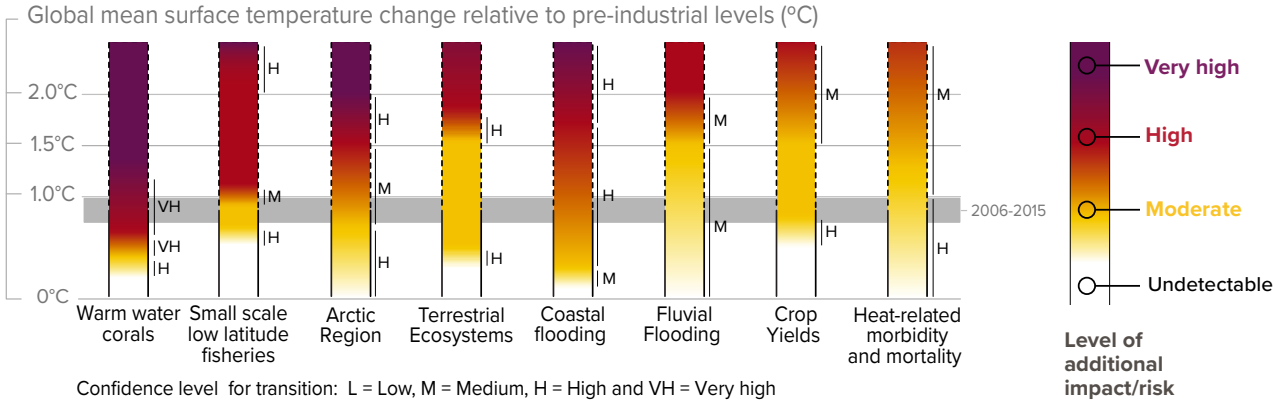


Figure 17 How the level of global warming affects impacts and/or risks (adapted from IPCC, 2018b).

Irreversible tipping points threaten to have disruptive impacts on human societies

Yet, with a view to current emissions trajectories, it seems probable that global warming will exceed the 1.5°C stipulated in the Paris Agreement. Accordingly, the mid- to long-term impacts of climate change could be even more severe and increase not only the risk of losses and damages but also entail the risk of non-linear developments. The latter could prompt feedback loops and irreversible tipping points such as a collapse of the Monsoon rain system, dieback of the Amazon rainforest or the permanent loss of glaciers and ice sheets. It is important to note that such tipping points could already be reached at a temperature increase of approximately 2°C (Lenton *et al.*, 2008; Steffen *et al.*, 2018). Each tipping point has the potential to catalyse global warming and would be likely to prompt abrupt and highly disruptive impacts on human societies (Steffen *et al.*, 2018).

Mitigation policy may also prompt adaptation needs

Finally, adaptation strategies will not only need to consider the consequences of global warming as such, but also the potentially adverse effects of mitigation policies. For instance, mitigation measures that seek to keep 1.5°C of global warming in reach, often require the use of land and water resources and associated ecosystem services. This can prompt development trade-offs that call for adaptive responses in their own right. For instance, CDR methods that depend on land and water resources will always need to consider collateral effects on rural livelihoods, agricultural production or access to and impacts on pertinent ecosystem services. Nonetheless, some mitigation measures can simultaneously enhance resilience and adaptive capacity to climate change. Such measures include, for instance, nature-based solutions like the protection of mangrove forests and of ecosystems in general, but also hydropower electricity supply (offering water reservoirs during periods of drought) and agricultural methods that protect soils in the long run.

Main Takeaway

Climate change is real. The effects of about 1°C of average global warming compared to pre-industrial levels are already observable around the world. These will become more severe with every additional tenth of a centigrade and will adversely affect real-life conditions for sustainable development. They are also unevenly spread as they disproportionately affect poor and vulnerable communities in developing countries. Increasing and upscaling national and international efforts to adapt to the consequences of climate change, to strengthen resilience and to avoid and manage climate-related risks with integrated policy responses is paramount to achieve sustainable development that leaves no one behind.

1.4 Implications for international cooperation

The prospects of developing countries and emerging economies will increasingly hinge on their response to the impacts of climate change. Indeed, the framework conditions for sustainable development are immediately affected by global warming and environmental change. International cooperation more broadly, and development policy in particular, will be key to supporting the response strategies of developing countries. The overall success of such cooperation will depend on the identification and implementation of climate-smart approaches and strategies and the provision of commensurate financial resources.

All international cooperation must align with the Paris Agreement

Development policy needs to be consistent with halting average global warming at 1.5°C to ensure that short-term development does not undermine long-term climate goals. At the same time, it needs to incorporate approaches to strengthen resilient and sustainable development and disaster risk management. It must support adaptation to climate change impacts that are no longer avoidable and ensure that cooperation outcomes in partner countries are not lost. Consequently, there is an imperative for all international cooperation and related development policy to align with the objectives of the Paris Agreement.

Trade-offs between climate and development objectives must be understood and managed

The need to mainstream climate change mitigation and adaptation into development policy and its implementation requires all agents of international cooperation to coordinate and adjust their strategic priorities. This implies that both synergies, as well as trade-offs with and consequences for already established development objectives and preferences, must be considered. Many climate policy measures promise to yield substantial co-benefits across a wide range of SDGs. Others, however, may have adverse impacts on competing development objectives. For instance, the case for improved energy security may no longer be good enough if the underlying energy production is inconsistent with the imperative to reduce GHG emissions. Likewise, supporting the expansion of renewable energy production must not be an end in itself if trade-offs are known to undercut sustainable development. Once such inconsistencies and trade-offs are identified, they can be addressed transparently. To this end, all international cooperation and

development policy will need to be climate proofed. In doing so, this aims to avoid supporting carbon lock-in in development pathways and minimise the climate change impacts on the desired outcomes of development cooperation.

International financial support is key for the achievement of climate and development objectives

International financial support is key to achieving both climate and sustainable development objectives. The Paris Agreement stipulates that "developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation in continuation of their existing obligations under the Convention" (Article 9.1). Indeed, significant shares of developing countries' NDCs are explicitly conditional on international support, a pattern that can be expected to be even more pronounced in the imminent second generation of NDCs (Maxwell, 2020). Conditional commitments within partner countries' NDCs are one case in point. In the technical terms of the UNFCCC, developing countries' expectations for donor support extend and translate into supporting the development and implementation of a variety of activities through increasing financial resources, technology transfer and capacity building, including with a view to National Adaptation Plans (NAPs) or Long-term Strategies (LTS).

Developed countries still fall short of their climate finance pledge of 100 billion dollars per year

Already in 2010, industrialised countries committed to provide funds rising to USD 100 billion per year by 2020 (as a mix of public and private sources). These funds seek to support the transparent implementation of concrete mitigation actions in developing countries and see that they are implemented in a transparent way. While methodological problems persist in determining these climate-specific finance flows, data up to 2018 shows that climate finance counting towards the USD 100 billion per year had been on an upward trajectory but is still falling short of the target (Averchenkova *et al.*, 2020).

All public and private finance flows must be aligned with the Paris Agreement

Given the enormous levels of investment required to achieve the transformation of countries and societies towards Paris-compatible sustainable development goals, it is clear that public funds alone will not be sufficient. As stipulated in Article 2.1 (c) of the Paris Agreement, all global finance flows must be made consistent with a pathway towards net-zero emissions and climate-resilient development. International cooperation has a crucial role to play in this global effort to align public and private investments in all economic sectors and financial markets with the goals of the Paris Agreement. This can be achieved

through climate-proofing all public development finance as well as by creating incentives and framework conditions in partner countries for Paris-compatible private investments. Time is a critical factor in this mission and delays in aligning finance flows today will invariably increase transformation costs in the future.

COVID-19 recovery presents an opportunity to find better ways to move forward

The need for international support in developing countries is now amplified through the impacts of the COVID-19 pandemic. The pandemic has resulted in an unprecedented humanitarian and economic crisis and has exacerbated the debt pressures on many climate-vulnerable low- and middle-income countries. Following the imperative of 'building forward better', it is important to tackle the COVID-19 and the climate crisis simultaneously by putting the world on a recovery path that is consistent with the Paris Agreement and the 2030 Agenda (Averchenkova *et al.*, 2020). The EU and Germany, not least by advancing the European Green Deal, play a leadership role on these counts. They have proven their capacity to promote climate policy and sustainable development as the primary focus for international cooperation, particularly with a view to post-COVID-19-recovery.

Indeed, if policymakers and agencies of development cooperation can ensure that the European Green Deal is adequately reflected in all of EU's external action this would be a particularly powerful lever for cross-sectoral alignment. Likewise, the same would be especially true if support was garnered among European finance ministries and sectoral line ministries (including crucial ministries of trade and economics, planning, agriculture and environment) and the respective Directorates-General of the European Commission (Iacobuta *et al.*, 2019). It would, at the same time, guide post-pandemic recovery and boost policy integration in the transformative spirit of the Paris Agreement and 2030 Agenda.

Main Takeaway

International cooperation is essential to deal with climate change. The goals of the Paris Agreement are global and can only be achieved if all countries work together and pull their respective weight in the same direction. All countries, developed and developing, need to increase their ambition to decarbonise their economies and make their development pathways sustainable, fair and resilient. By directly tackling the causes and impacts of climate change as well as by promoting climate-neutral development, international cooperation has a key role to play to ensure sustainable development pathways that leave no one behind.

Strategic action areas at the interface of development and climate policy

2

Working towards achieving the objectives of the Paris Agreement in the context of global sustainable development requires a comprehensive, integrated and ambitious approach to policymaking and policy implementation across all policy areas and at all levels of governance. It is the responsibility of national governments to provide favourable framework conditions to that end. Adjusting framework conditions domestically and internationally will be key to enabling countries around the world to live up to their international commitments under the Paris Agreement and the 2030 Agenda and to embark on truly transformative development pathways.

International cooperation can provide know-how and resources for structural reforms

Since capacities such as access to resources and technology, as well as vulnerability and development needs, vary significantly among countries, international cooperation has an essential role to play in preparing the grounds for ambitious climate action "in the light of different national circumstances" (UNFCCC, 2015). It also pools the knowledge and the means to support overarching policy and sector reforms. This may include the phasing out of fossil fuel subsidies, the introduction of carbon prices, the establishment of border adjustment measures or the strengthening of institutions and capacities for risk management.

International support instruments must correspond with national institutions

Established instruments in support of such reform approaches include Policy Based Financing (PBF), debt initiatives and debt swaps, as well as corresponding policy dialogue and technical cooperation. To live up to its full potential, the support provided through international cooperation needs to be accompanied domestically by strong inter-ministerial collaboration that allows for cross-sectoral approaches and meaningful policy integration. Indeed, considerable leverage potential lies beyond the grasp and mandate of development policy alone and will require more systemic approaches. As stipulated under Article 2.1 (c) of the Paris Agreement, the imperative to adjust the global financial system is a major case in point. The challenges posed by the current COVID-19 pandemic further underscore the need for systemic approaches and add urgency to developing and applying cross-sectoral policy responses.

This chapter starts with introducing overarching policy responses of a cross-cutting, systemic nature (2.1). It then turns to specific action areas of immediate relevance for climate change mitigation and adaptation and sustainable development in the areas of electricity supply, cities, agriculture, forests and ecosystems and water (2.2). Each of the respective sections demonstrates why and how these action areas promise to yield major co-benefits at the climate-development nexus and in what way they promote transformative change within partner countries.

2.1 Framework conditions

Inherently interlinked with the world economy, international trade and the global supply of and demand for energy and resources more generally, climate action has long outgrown its original environmental policy niche (Newell and Paterson, 2010; Bulkeley *et al.*, 2014; Ciplet, Roberts and Khan, 2015). Global structures need to be adjusted across the board for the world to shift to climate-compatible development trajectories, (NCE, 2018). Especially if dynamically growing developing countries and emerging economies are to be enabled to switch to sustainable development pathways.

The global financial system must align with the goals of the Paris Agreement

The Paris Agreement responds to that challenge, not least by directly addressing the need to adapt the global financial system to the imperatives of decarbonisation and climate-resilient development (UNFCCC, 2015b, Article 2.1 (c)). This requires governments, especially their chancelleries and finance ministries as well as appropriate regulatory authorities, to set the course (Figure 18). International cooperation more broadly and development policy, in particular, can contribute to building the necessary momentum by upscaling international climate finance and, crucially, by aligning public spending in terms of both bilateral cooperation and multilateral investments, as executed through multilateral development banks. Moreover, international cooperation can incentivise the mobilisation of private climate finance, both with a view to mitigation measures and for adaptation purposes. To this end, it can help build enabling environments for private climate finance, inter alia by adjusting taxonomies, regulations and incentives, by minimising risks for private investors (‘de-risking’) and by supporting important technology transfer and project development.

Aligning finance with the Paris Agreement

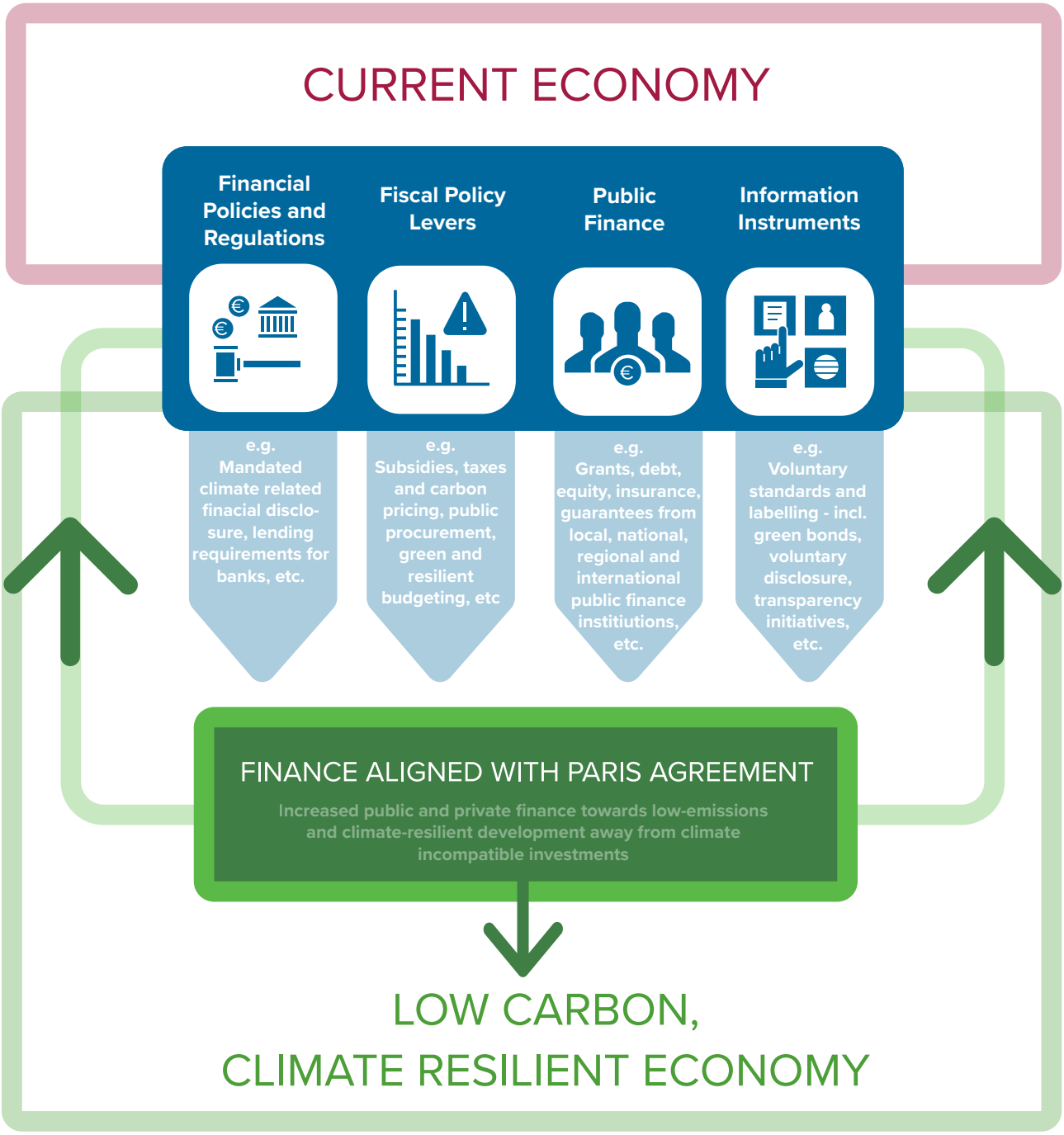


Figure 18 Aligning finance flows with the Paris Agreement (adapted from Whitley *et al.*, 2018).

By way of mobilising private climate finance and developing green financial institutions, instruments and capital markets, international cooperation also contributes to implementing the AAAA, which requires to complement public and domestic investments with private and external finance. Thus, strengthening financial systems aligned with the Paris Agreement and the AAAA is ultimately expected to contribute to global stability, equitable and sustainable growth and sustainable development more broadly (UN, 2015a, Article 105). An example of recent efforts to provide international support to such alignment is the Latin American Green Bond Fund (LAGREEN) (Box II).

Box II
The Latin American Green Bond Fund (LAGREEN)

The Latin American Green Bond Fund (LAGREEN)

The Latin American Green Bond Fund (LAGREEN) initiated by the German development bank, KfW, with support from BMZ, targets to promote the development of a green bond market in Latin America and the Caribbean (LAC).

LAGREEN will invest in green bonds issued in the region and provide technical support to new issuers. Investment activities are planned to start in April 2021.

About green bonds

Green bonds present an instrument that uses proceeds from bonds to finance green projects. For example, to advance renewable energy, energy efficiency, sustainable land use, biodiversity conservation, clean transportation, climate change adaptation, circular economy and more.

The dedication of green bond proceeds to environmental goals is typically assessed by external reviews provided by independent parties. These are based on commonly accepted industry standards (Green Bond Principles) recently established by the International Capital Markets Association (ICMA).

Green bonds are a highly innovative instrument with a strong potential to connect the mainstream financial sector with the achievement of environmental goals. The global market for green bonds has grown rapidly in recent years, yet demand for green bonds still outstrips supply and there is enormous potential for growth.

Regional context

Despite representing only 6% of global GDP, LAC countries contribute to about 12% of global GHG emissions while being among the most biodiverse and the most vulnerable regions (Climate Bonds Initiative, 2019). The capital markets in Latin America are comparatively well developed, particularly in countries like Brazil, Chile, Colombia or Mexico. The region receives significant foreign investments and there is increasing awareness for sustainable or green activities. Despite this, the global green bond market remains dominated by issuances in Western Europe (more than half of the volume issued in the first half of 2020), with LAC representing less than 2% of global issuances in 2019 (Climate Bonds Initiative, 2019). Moreover, the vast majority thereof is issued in large jurisdictions like Brazil.

LAGREEN in the context of COVID-19

In 2019, new issuances of green bonds in LAC had started to pick up and a promising number of new green bonds planned for 2020. However, as a consequence of the COVID-19-crisis, there was a significant slump in the green bond market during that year, putting a temporary stop to the further development of this still emerging sector. Despite the ongoing crisis, 2021 looks more encouraging, with a larger number of issuances in the pipeline and an increasing level of geographical and sectoral diversification. In this context, LAGREEN offers an excellent opportunity to contribute to a green recovery at an early stage by mobilising private sector funds to finance sustainable endeavours.

Engagement of Germany and the European Union

LAGREEN has a target volume of USD 500 million. So far, EUR 74.5 million in USD equivalent have been provided as risk capital (Junior Shares) by BMZ and the EU. They complement contributions by further development finance institutions (DFI) and investments from the private sector. The EU and BMZ provide the so-called "first-loss tranche" in the fund structure, absorbing risks for potential losses but enhancing the scale of its investments based on the participation of the private sector.

Authors: Diana Arango and Frank Bellon / KfW.

Adjusting global finance to international climate governance also implies a need to ensure that climate-vulnerable developing countries are no longer charged for being so in the first place. In the current system, climate-vulnerable developing countries are charged a climate risk premium, which effectively increases their cost of capital ('sovereign borrowing cost'). According to the UN Environment Programme (UNEP), some developing countries pay an additional dollar for every ten dollars of interest due to the climate risk assessments of private credit rating agencies (Buhr *et al.*, 2018). In the decade between 2007 and 2016, 40 member countries of the Climate Vulnerable Forum (CVF) paid USD 40 billion in additional interest on government debt alone and USD 62 billion in additional interest when including private external debt (Buhr *et al.*, 2018).

Phasing out fossil fuel subsidies is crucial

Another major issue with adjusting all finance flows pertains to phasing out fossil fuel subsidies. Despite how imperative this is, at present, fossil fuel subsidies still have higher distributional effects than green subsidies (Monasterolo and Raberto, 2019). However, it is well established that fossil fuel subsidies substantively contribute to the lock-in of GHG emissions and local and regional air pollution while considerably straining public budgets (van Asselt, Merrill and Kulovesi, 2018; Skovgaard and van Asselt, 2018). Hence, diverting public spending from fossil fuel subsidies to climate-smart alternatives is an overdue step in many countries. International support can help partner country governments to implement a fossil fuel subsidy reform and accompany the phase-out of subsidies with social programmes that mitigate its immediate adverse effects on the poor.

Enhanced understanding of carbon pricing and respective measures bears great potential

Next to ensuring the consistency of finance flows, carbon pricing takes pride of place among cross-sectoral approaches at the climate and development nexus. The notion to 'get the prices right' for carbon-intensive production and

consumption, notably from fossil fuel resources, has long been heralded as the single most promising lever to curb global GHG emissions (Edenhofer *et al.*, 2015; Franks, Edenhofer and Lessmann, 2017). The introduction of carbon pricing should ensure that emissions are reduced cost-effectively and that fossil fuel assets are left in the ground while at the same time, substantive revenues are generated that can be reinvested in critical infrastructure and sustainable development (Jakob *et al.*, 2016; Edenhofer *et al.*, 2019).

Moreover, if pursued through carbon taxes, carbon pricing is expected to generate revenues at comparatively lower costs than conventional taxes, such as traditional labour taxes. As an upstream source of taxation, carbon taxes imply lower administrative costs compared to conventional taxes. Last but not least, carbon pricing can be assumed to yield considerable co-benefits regarding air pollution, traffic congestion and even tax evasion, especially when compared to value-added taxes or income taxes. Consequently, economists argue that "finance ministers favour carbon taxes, even if they do not take climate change into account" (Franks, Edenhofer and Lessmann, 2017).

Development policy alone would be overburdened to introduce carbon pricing, let alone establish a global carbon market. However, it can promote and assist the introduction of policy instruments, like a carbon tax, in partner countries and facilitate the establishment of regional carbon markets through multilateral frameworks (van den Bergh and Botzen, 2020).

Carbon border adjustment measures require careful policy design

The non-existence of a global carbon price and the bottom-up spirit of the Paris Agreement provide opportunities for carbon leakage. This undermines the effectiveness of national climate policies because carbon-intensive production could be relocated to less regulated areas. Carbon border adjustment measures seek to counter this effect by levelling the playing field between domestic producers that face costly climate change policies and foreign producers that are not affected by these costs.

Yet, carbon border adjustment is contested and entails several challenges, especially concerning its compatibility with international trade law, practical feasibility and fairness (Brandi, 2013). Accordingly, the design of carbon border adjustment measures will need to carefully consider the economic effects for developing countries (Böhringer, Carbone and Rutherford, 2018). Provisions for Special and Differential Treatment under the World Trade Organization (WTO) or Common But Differential Responsibilities (CBDR) could allow for export exemptions from least developed countries from such measures (Pauw *et al.*, 2014; Mehling *et al.*, 2019). Moreover, revenues mobilised through carbon border adjustment measures could be allocated to boost international climate finance and to support transformative policy among developing country trade partners (Brandi, 2019).

Local structures and capacities for comprehensive risk management need to be strengthened

Many low- and middle-income countries show a high exposure and vulnerability to climate risks. So it is essential for these countries to prepare for dealing with such risks. Development policy can support the elaboration and application of adequate tools for risk analysis and comprehensive risk management. This can include the promotion of resilient infrastructure as well as instruments for crisis prevention and strategies for disaster risk reduction, encompassing Climate and Disaster Risk Financing and Insurance (CDRFI) solutions.

In line with the 2015-2030 Sendai Framework for Disaster Risk Reduction, risk prevention and risk management can significantly improve the security of lives and livelihoods in vulnerable countries. In a similar way, such instruments can directly support the implementation of the 2025 Vision of the InsuResilience Global Partnership, which aims to insure 500 million vulnerable people against climate risks by 2025.[15] Not least, the promotion and implementation of risk prevention and risk management strategies are key to developing adequate responses to climate-induced displacement and migration (Milan *et al.*, 2016).

Responses to long-term strategic demands under the UNFCCC require continuous support

Other cross-sectoral policy instruments relevant to the Paris Agreement (especially Article 4) include elaborating on LTS as well as broad-based support for the further development and implementation of ambitious NDCs and NAPs. To these ends, initiatives like the NDC Partnership (NDC Partnership, 2020), the NAP Global Network (BMZ, 2017) or designated SDG-Climate partnerships with global partners like India, Peru or South Africa yield promising results.

15 For the overall vision, its four overarching workstreams and a detailed workplan see www.insuresilience.org%2Fwp-content%2Fuploads%2F2019%2F09%2FInsuResilience-Global-Partnership_Vision-2025-with-Workplan1.pdf&usg=AOvVaw3hyPMPGANy57EWH-c10r0F

2.2 Priority action areas

Climate change and sustainable development are firmly interlinked. Firstly, unabated climate change itself poses significant threats to development and would make it more difficult to achieve the 2030 Agenda and its SDGs. Secondly, the development paths chosen by countries to achieve the SDGs can have significant implications on the amount of future GHG emissions and the level of climate resilience. Finally, climate policy measures, both for adaptation and for mitigation, have significant implications for sustainable development. Climate policy, notably including measures that have been stipulated under SDG 13 ("Take urgent action to combat climate change and its impacts") and its respective targets[16], is both positively and negatively linked to all other SDGs, although the positive impacts prevail (Gonzales-Zuñiga *et al.*, 2018a; Roy *et al.*, 2018).

Links between NDCs and SDGs

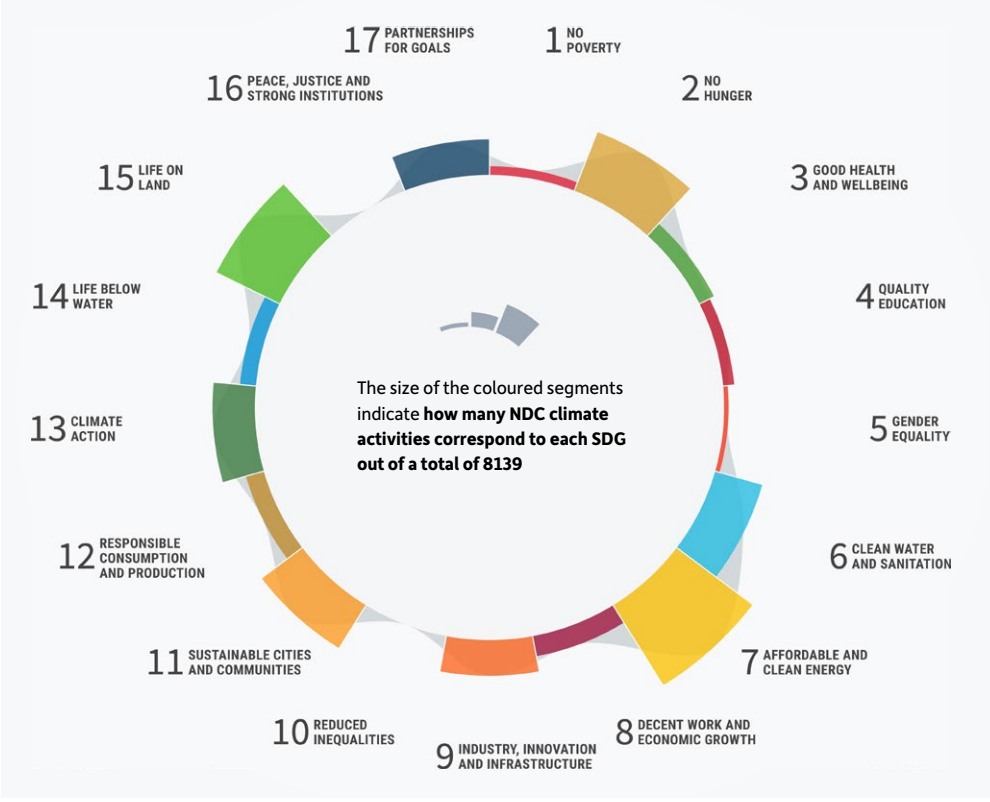


Figure 19 Climate activities included in NDCs and their link to the SDGs at the global level The bars indicate the share of NDC activities relevant to the SDG targets (adapted from NDC-SDG Connections tool, www.ndc-sdg.info).

The links between climate change and sustainable development are clearly observed in countries' NDCs under the Paris Agreement, whereby climate-related activities put forward by countries directly speak to all SDGs and their respective targets, as indicated in Figure 19 (Dzebo *et al.*, 2017). Importantly, when categorised based on the SDGs, climate-related development finance

16 Respective targets under SDG 13 include: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries (13.1), Integrate climate change measures into national policies, strategies and planning (13.2) and Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning (13.3).

of the OECD Development Assistance Committee (DAC) is shown to have contributed to all SDGs. Moreover, the allocation of climate finance across SDGs is relatively aligned with the focus of NDC activities. This holds true for both finance flows in which climate was reported as the 'principal objective' and for climate-relevant finance, which further includes climate as a significant or component objective. It can be observed that climate-relevant finance, as well as NDC activities, contribute most extensively to SDGs 7 (energy), 11 (cities), 2 (zero hunger), 6 (water) and 15 (life on land) (Figure 20).

Contributions of climate-relevant finance and NDC activities to the SDGs

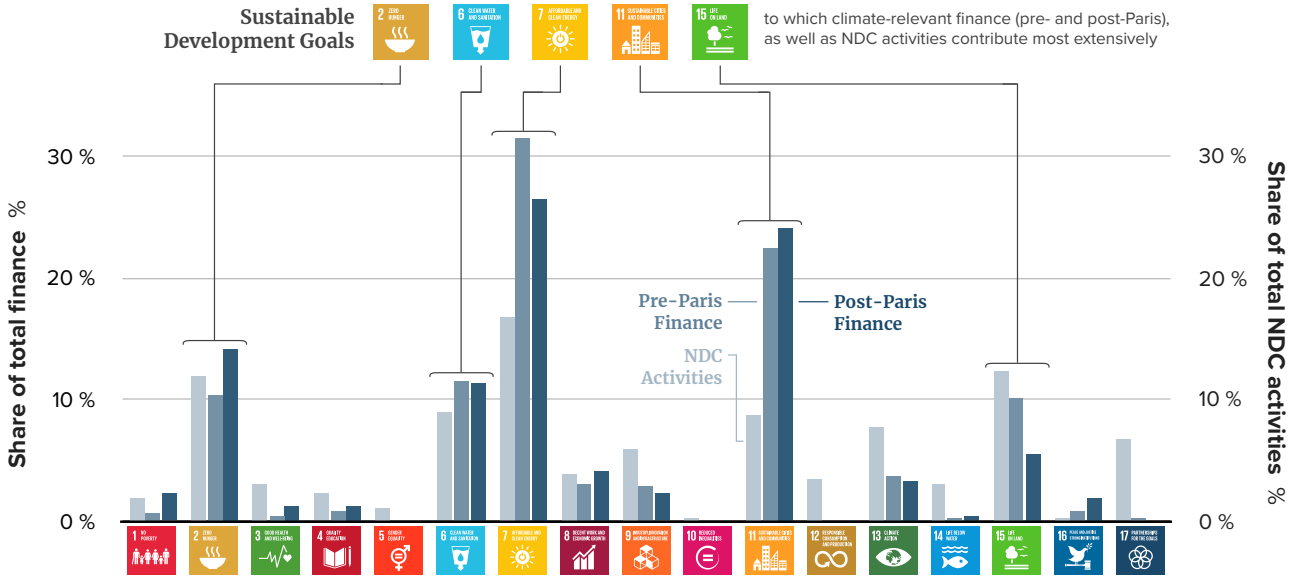


Figure 20
Share of NDCs' climate activities, based on the NDC-SDG Connections tool (Figure 19) and share of pre-Paris (2010–2015) and post-Paris (2016–2018) climate-relevant OECD development finance, by SDG (based on Iacobuta *et al.*, under review a).

There are numerous interlinkages between climate action and the SDGs

Distinct climate actions can be categorised as primarily targeting a specific SDG-related area, such as expanding solar photovoltaic energy generation to enhance SDG 7. However, any climate action can be assumed to also affect other SDGs. For instance, Figure 21 and Figure 22 demonstrate that climate action targeting four of the most prevalent SDG action areas of the NDCs (i.e., energy, life on land, agriculture and cities) can have a broad range of positive and negative impacts on other SDGs, too, depending on the implementation context. In that sense, decarbonisation has extensive implications for the energy systems (SDG 7), urbanisation (SDG 11), water usage (SDG 6), industrial development, production and consumption (SDGs 9 and 12) and economic growth (SDG 8), while boosting resilience is crucial to reducing poverty (SDG 1) and hunger (SDG 2). Figure 21 and Figure 22 illustrate that, on balance, the number of synergies across climate action and other SDGs clearly outweighs the number of trade-offs. The only exceptions are some low-carbon energy supply technologies including those relying on natural gas or on carbon capture and storage (von Stechow *et al.*, 2015; McCollum *et al.*, 2018).

Interlinkages between mitigation action and the SDGs

Figure 21
Synergies and trade-offs of climate change mitigation action with the SDGs (based on Iacobuta *et al.*, under review b).

Interlinkages between adaptation action and the SDGs

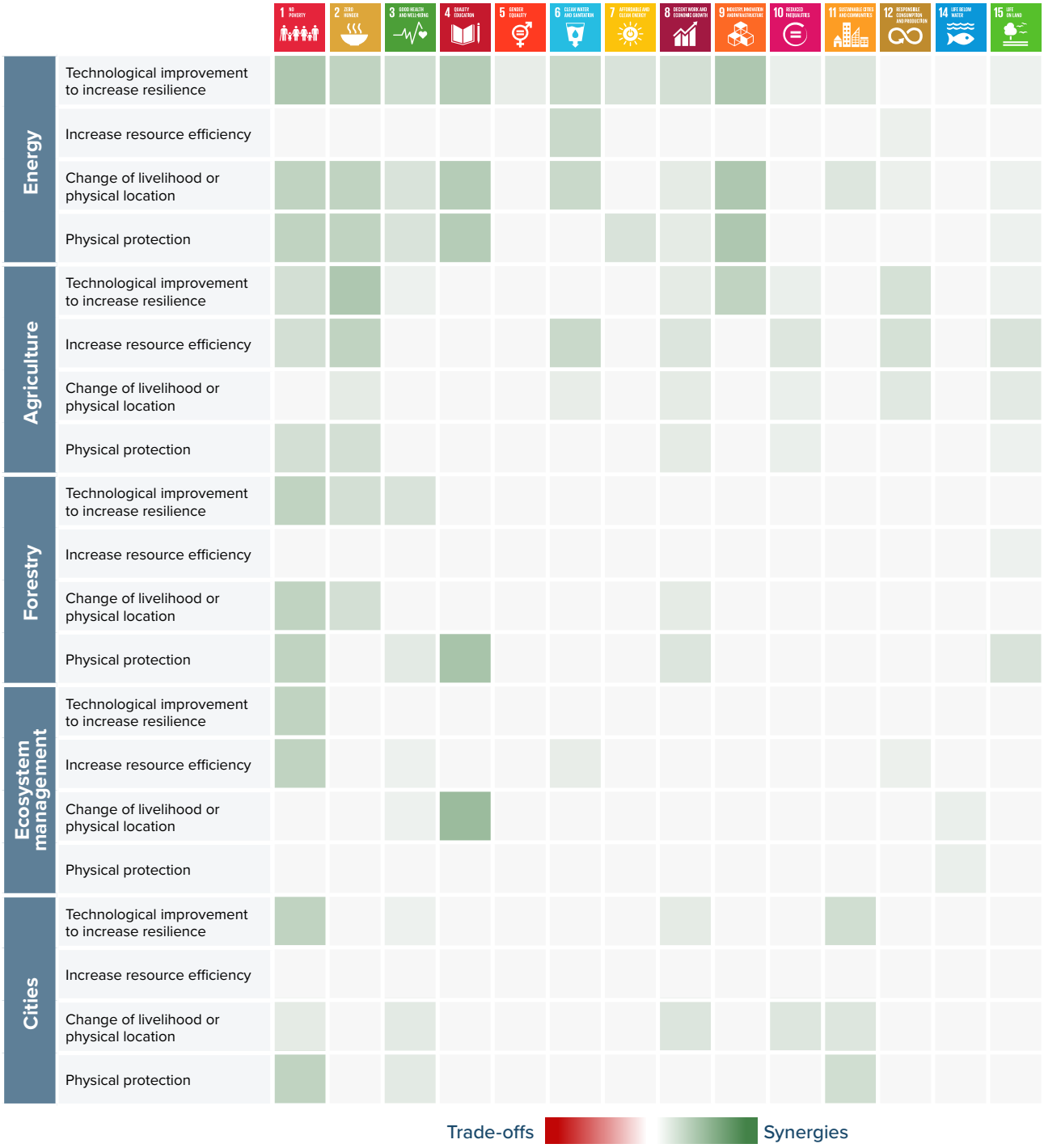


Figure 22
Synergies and trade-offs of climate change adaptation action with the SDGs (based on Gonzales-Zuñiga *et al.*, 2018a).

In the following sections, an in-depth analysis of the top five SDG action areas is provided. These are considered the most prominent among climate actions pledged in the NDCs (as in Figure 19) and are supported through development finance (as in Figure 20). They are **energy** (SDG 7), in particular electricity supply; **cities** (SDG 11); **agriculture** (SDG 2); **forestry and ecosystems** (SDG 15); and **water** (SDG 6).

To this end, a focus is placed on how international cooperation and development policy, more specifically, can address the respective sectors both from a climate policy and a sustainable development perspective. By zooming in on the action areas mentioned above, the interlinkages between climate and sustainable development action are illuminated and key challenges for sustainable transformation and development in each sector are identified. In doing so, essential areas for action in the context of international and development cooperation are determined, as well as important leverage points that could be engaged to stimulate transformative change and enhance policy coherence. Box III provides an overview of the structure of each action area.

Box III
Structure of analysis for the strategic action areas

Structure of analysis for the strategic action areas

Introduction

Current status of empirical trends and climate policy needs within the sector, including the respective mitigation potential and contribution to the NDCs.

Climate-development interlinkages

In-depth information on key categories of relevant climate action options, their respective climate-development interlinkages and why and how they are particularly relevant in the specific sector from the perspective of a) advancing decarbonisation; and b) boosting resilience.

Main challenges and obstacles

Major challenges and barriers to the implementation of climate action in the context of sustainable development and low-carbon and climate-resilient sector transformation – with a focus on those particularly relevant to development cooperation.

Leveraging transformational change

Identification of key action areas that promise to be effective through international cooperation to ensure alignment with both the Paris Agreement and the 2030 Agenda. Guidance on concrete measures that could support policy coherence and enhance synergies while addressing trade-offs between the objectives of the two international agendas.

Evidence from German development cooperation

Presentation of illustrative good practice examples from German development cooperation in key partner countries for each action area, highlighting the country context, challenges and opportunities, and the specific engagement of German development cooperation.

Electricty Supply

Introduction

As a resource, energy is essential for general economic and social development. Nearly every good and service that contributes to economic growth requires some form of energy. Moreover, energy is critical for access to basic services, such as healthcare and education. The provision of universal access to affordable, reliable and modern energy services, as requested by SDG 7.1, is therefore crucial to supporting the elimination of poverty and to reducing inequality (IEA, 2018c). However, apart from being a driver of economic and social development, energy use is the leading source of GHG emissions globally, and a major source of air pollution, causing severe environmental and health problems in many parts of the world. In 2018, fossil fuel CO_2 emissions from energy use and industry reached a record high of 37.5 $GtCO_2$, accounting for approximately 68% of total global CO_2 emissions (UNEP, 2019b). Simultaneously, the World Health Organization (WHO) estimates that ambient air pollution, primarily rooted in fossil fuel combustion, causes around 4.2 million premature deaths every year. Household air pollution from cooking with polluting fuels adds another 3.8 million premature deaths per year (WHO, 2020).

In order to achieve the targets of the Paris Agreement, total global CO_2 emissions must be reduced to net-zero by mid-century, while total global GHG emissions must target net-zero towards the end of the century. This means that a full decarbonisation of the global energy system must be achieved by around 2050 (Rogelj *et al.*, 2015). A major part of this transformation needs to occur in the electricity supply sector, which, together with heat, accounted for 14 $GtCO_2$ in 2018 (IEA, 2020). Given that market-ready, low-emission technology solutions for electricity production are readily available and that deep emission cuts in other sectors depend on increased access to clean electricity, decarbonisation of the electricity supply sector needs to be prioritised ahead of other sectors.

Wind and solar power generation. Photograph: Mel Stoutsenberger

Recent developments show that rapid decarbonisation of the electricity sector is possible. This is mainly due to the quickly decreasing costs of renewable energy technologies over the last decade. Estimates of the Levelized Cost of Energy (LCOE) for solar photovoltaic (PV) have fallen by over 80%, reaching USD 60 per megawatt-hour (MWh), with auction prices in favourable locations even reaching USD 20 per MWh. The LCOE estimates for offshore and onshore wind power have fallen by 55% since 2010, with auction prices for onshore wind approaching USD 20 per MWh in some countries (ETC, 2020). In many countries, these costs are below the costs of new coal or gas plants and, in some countries, even below the operational costs of existing fossil fuel-based power plants (ETC, 2020). This has two implications. First of all, new investments into fossil fuel-based power generation involve a high risk of stranded assets. Secondly, the cost of generating renewable energy-based electricity is not a barrier anymore. However, other challenges at a policy, market and technical level need to be considered when integrating higher levels of variable renewable energy into existing electricity supply systems.

SDG7 - Affordable and Clean Energy linkages

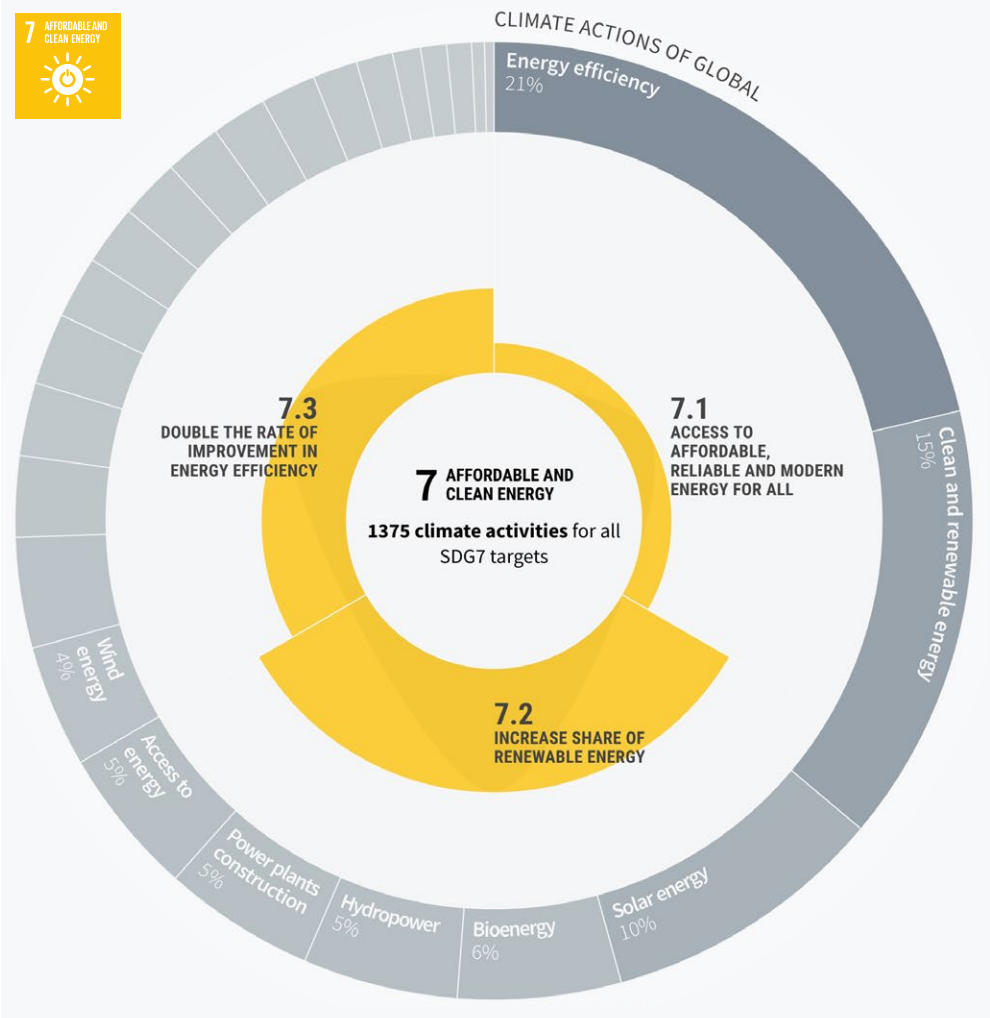


Figure 23 Climate activities in NDCs globally and their link to the energy sector. The inner coloured bars indicate the share of NDC activities relevant to the SDG targets and the outer circle indicates the shares of these activities corresponding to specific action types (based on the NDC-SDG Connections tool, www.ndc-sdg.info).

In its entirety, the energy sector is an important area for mitigation action outlined in countries' NDCs (Figure 23). On a global average, energy efficiency on the demand side and renewable energy measures on the supply side are in the focus of NDCs and are targeted specifically through respective country actions and plans. While SDG 7.1 (electricity access) is key for least developed and developing countries, SDG 7.2 (sustainable energy) and SDG 7.3 (energy efficiency) are important action areas in both.

Box IV
The relevance of energy efficiency

The relevance of energy efficiency

Energy efficiency, combined with renewable energy and other measures, is indispensable to achieving the global climate targets. According to IEA, energy efficiency can realise over 40% of the carbon emissions reductions required to meet the targets of the Paris Agreement, being the largest single contribution to total CO_2 mitigation, followed by renewable energy (IEA, 2018b).

Energy efficiency has enormous potential to boost economic growth, improve energy security, and reduce GHG emissions. Between 2015 and 2018, technical efficiency improvements reduced energy-related carbon emissions by 3.5 $GtCO_2$ globally (IEA, 2019).

Given that a great part of the energy being consumed globally is lost during the production, transportation and consumption process, there is a huge opportunity to save energy and use it more effectively. This is particularly true in countries where the energy intensity of economic activity is high and where a backlog of investment, outdated technology, and a lack of expertise about available energy resources can offer significant potential to improve efficiency. In this context, energy efficiency improvements could have benefits beyond energy savings, including reduced household and industry energy bills and improved air quality (IEA, 2018b).

As each unit of energy saved reduces the pressure on energy systems and has vast sustainability implications, energy efficiency measures are also highly synergistic with many other SDGs once the barrier of upfront costs is addressed. At the same time, switching to low-carbon energy sources presents a wider variety of SDG impacts, including some particularly challenging trade-offs, such as phasing out fossil fuels and related job losses. Moreover, renewable energy is the area of action that holds great potential for technological innovation, energy efficiency and job creation and is hence covered by the largest number of energy-related NDC climate activities (Figure 23).

For these reasons, this section will focus on electricity supply and how challenges and barriers of a switch to renewable electricity can be overcome while synergies are enhanced through development cooperation.

While challenges are numerous when countries embark on a pathway towards a renewable energy-based electricity supply system, an increasing number of countries deploys innovative approaches to address different aspects of their respective transition challenges. South Africa, for example, has developed the continent's biggest market for renewable energy, mainly due to the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). Since the launch of this competitive procurement programme for renewable energy in 2011, USD 16 billion in private-sector investment has been committed to projects totalling more than 5 GW of renewable energy. This resulted in significant reductions in tariff rates for solar PV and wind over a short period of time. The programme is also significant for enabling the achievement of South Africa's NDC target (PATPA, 2020; KfW, GIZ and IRENA, 2021).

Climate-development interlinkages

Mitigation and adaptation action in the electricity supply sector shows interactions in terms of synergies and trade-offs with all 17 SDGs as well as, more broadly, with the 2030 Agenda (Gonzales-Zuñiga *et al.*, 2018a). In fact, SDG 13 (climate action) is intrinsically linked to SDG 7 (clean energy and electricity access), including through the target to increase sustainable energy (SDG 7.2). The implementation of both SDGs should therefore go hand in hand.

Climate action aimed at decarbonising the electricity supply sector and making it more resilient to climate change can significantly enhance sustainable development in many areas. Strong positive links can be found with regards to healthcare (SDG 3), water and sanitation (SDG 6), decent jobs and economic growth (SDG 8) and industry, innovation and infrastructure (SDG 9). For example, the building of infrastructure and industry should always be planned in conjunction with SDG 7, to enable productive use of energy and therefore foster sustainable development. Apart from these synergies, there may also be trade-offs between climate action in the electricity supply sector and specific SDGs. These need to be closely considered and managed in order to minimise potentially adverse effects on poverty eradication and food security (SDG 1 and 2) or on water and sanitation (SDG 6).

Advancing decarbonisation

In most countries, mitigation action in the electricity supply sector focuses on renewable energy generation. The expansion of renewable energy technologies in general and of renewable-based off-grid electricity in particular has strong and direct synergies with several SDGs. At the same time, not all renewable energy technologies show equal synergies. The deployment of bioenergy, geothermal power and concentrated solar power, for example, needs to be carefully planned and considered within each local context in order to successfully minimise potential trade-offs (Table 3).

Table 3
Synergies (green circles) and trade-offs (red circles) between climate mitigation action and SDGs in the electricity supply sector (own compilation, based on Gonzales-Zuñiga *et al.*, 2018c).

Non-biomass renewables		
●	Installation of large-scale renewable energy technologies can reduce land and resource access for dependent communities.	
●	Renewables can reduce air, water and soil pollution and related non-communicable diseases when displacing fossil fuel-based alternatives or bioenergy.	
●	Most renewable energy technologies reduce thermal and non-thermal water pollution when displacing fossil fuel-based alternatives.	
●	Solar PV and wind technologies use considerably less water than thermal alternatives (including thermal renewable technologies).	
●	Deployment of solar CSP and geothermal technology can lead to thermal and non-thermal water pollution if the used water is discharged in water bodies.	
●	Deployment of solar CSP can lead to increased water use for cooling and cleaning while it is usually deployed in water scarce locations.	
●	Most renewable energy technologies support increased resource efficiency and help decouple economic growth from environmental degradation.	
●	Development of renewable energy technology can go hand in hand with building climate-proof infrastructure and industry and can enable the productive use of energy.	
Bioenergy		
●	Biofuel production can lead to an increase in land prices which can affect food prices and food access.	
●	Monocultures and intensive use of nutrients for biofuel production can lead to soil degradation and loss of biodiversity, which can affect food production and food access.	
●	Biofuel production can lead to non-thermal water pollution through increased fertiliser run-off from crop cultivation.	
●	Biofuel production can lead to increased water use for irrigation of crops, biofuel processing and for cooling in power plant operation.	
●	Monocultures and intensive use of nutrients for biofuel production can lead to soil degradation and loss of biodiversity, which can negatively affect ecosystem services.	
Off-grid renewables		
●	Off-grid renewable electricity can replace burning of biomass, animal dung or charcoal for heat and cooking, improving indoor air quality and reducing related diseases.	
●	Off-grid renewable electricity can support local health-care facilities and allow, for example, refrigeration for medicines.	
●	Off-grid renewable electricity can help reach remote communities, increasing access to affordable, reliable and modern energy services.	
●	Off-grid renewable electricity can support decent employment by increasing people's access to electricity and to related economic opportunities.	

Renewables investments	
●	Investments in renewable energy technologies can support economic productivity through diversification, supply chain development, new decent jobs and innovation.
●	Investments in renewable energy technologies can generate modern and sustainable energy services and increase energy security in countries that rely on fossil fuel imports.
●	Some renewable energy technologies (e.g., tidal energy, BECCS) are not commercially mature and bear the risk of increasing electricity prices and related poverty in the mid-term.

Boosting resilience

Adaptation action in the electricity supply sector focuses on the decentralisation of power generation and on increased access to modern, climate resilient electricity informed by future climate risks. This has potential synergies with several SDGs, including with poverty eradication and food security (SDG 1 and 2), with health (SDG 3) and with decent work and economic growth (SDG 8), while no direct trade-offs are apparent (Gonzales-Zuñiga *et al.*, 2018b) (Table 4).

Carefully assessing climate-development interlinkages when designing policies and measures in the context of climate and development cooperation for the electricity supply sector can help maximise benefits to all relevant SDGs while effectively minimising the trade-offs.

Table 4
Synergies (green circles) between climate adaptation action and SDGs in the electricity supply sector (based on Gonzales-Zuñiga *et al.*, 2018b).

Reliable renewable energy sources	
●	Reliable sources of electricity (especially in rural areas) can raise living standards through the provision of basic healthcare, education, water and sanitation services.
●	Reliable sources of electricity can help reduce disruptions in food production and cooling.
●	Reliable sources of electricity support the functioning of medical facilities.
●	Reliable sources of electricity can increase access to financial services, encourage investment and ensure continuous business operations that boost economic growth.
●	Reliable sources of electricity can help achieve technological innovation and upgrading.
Non-biomass renewables	
●	Reliable and clean sources of electricity reduce the need to use traditional means of energy production (e.g., fuel wood) that cause non-communicable diseases.
●	Reliable and clean sources of electricity help to improve the nutritional situation and facilitate increase physical energy.
Off-grid energy	
●	Reliable off-grid sources of elecricity can be used for irrigation to boost food production and cope with climate impacts.

Main challenges and obstacles

Countries are at very different stages of reforming their electricity supply sectors to better incorporate new technologies, ensure reliability and affordability of electricity supply, reduce emissions and meet a wide range of other SDGs. This transition comes along with several challenges that need to be adequately addressed in order to make the changes socially and economically successful. Ideally, these challenges are not considered in isolation but in an integrated approach that takes into account their interaction and opportunities for comprehensive solutions.

Accelerate the expansion of renewable energy

Over the past decades, considerable public and private efforts have been invested to speed up the development, diffusion and implementation of renewable energy technologies around the world. Yet, experiences from different countries show that a full transition of the energy system towards 100% renewables can be a long and at times difficult process (Negro, Alkemade and Hekkert, 2012; Stram, 2016; REN21, 2019). Several challenges can compromise the rapid uptake of renewables, including at the policy, market and technical level. Some of these challenges may be accentuated in developing countries and emerging economies.

Policy and institutional challenges: Incumbent technologies, actors and institutions in the electricity supply sector are often powerful and well organised and may significantly decelerate the pace of the sector's transition. Several countries experience an uncertain policy environment and volatile regulatory developments (including 'stop and go' policies) as well as a lack of stable and aligned policy support schemes, especially for variable renewable energy sources. Moreover, there is often a misalignment of policies between different policy levels (local versus national) or across sectors. These barriers can lead to a lack of trust in governments and make entrepreneurs and investors reluctant to take risk and invest in renewable energy technologies (Negro, Alkemade and Hekkert, 2012).

Market-related challenges: In many countries, the electricity market is still dominated by fossil fuel technologies that reap the benefits from economies of scale, long periods of technological learning and socio-institutional embedding. The deployment of renewable energy technologies and, in particular, of variable renewable energy sources, often seems to be incompatible with the paradigm of large-scale centralised generation. The market design must be adjusted in order to allow new technologies to become competitive and profitable and to prevail against their fossil fuel-based competitors (Negro, Alkemade and Hekkert, 2012).

Technical challenges: The integration of large shares of variable renewable energy sources into existing electricity grids comes along with several technical challenges which can be attributed to the specific characteristics of these sources. The variability, remoteness and electromechanical nature of variable renewable energy sources may lead to challenges. These include

load balancing and reserves challenges, monitoring and control challenges, network congestion or negative residual load, to name just a few (De Vivero *et al.*, 2019).

Some of these challenges can be addressed by constructing and expanding strong and reliable electricity supply infrastructure that offers a range of services, including flexibility, storage solutions and smart applications. These cushion potentially adverse effects of increased renewable energy integration while ensuring a stable and reliable electricity supply.

Phase out fossil fuels

Most of the currently planned coal capacity is concentrated in fast-growing developing countries and emerging economies. In 2019, China recorded the biggest increase in coal generation due to rapidly growing electricity demand, accounting for 50% of global coal generation in that year. Similarly, some Asian countries registered electricity demand growth that was almost exclusively met with coal, including in Indonesia, Malaysia, the Philippines, Pakistan and Vietnam (Steckel *et al.*, 2015; Jones *et al.*, 2020). Other Asian countries, including India, South Korea and Japan, saw a decrease in coal generation as electricity demand slowed, new solar was added, and nuclear power plants were restarted (Figure 24) (Jones *et al.,* 2020).

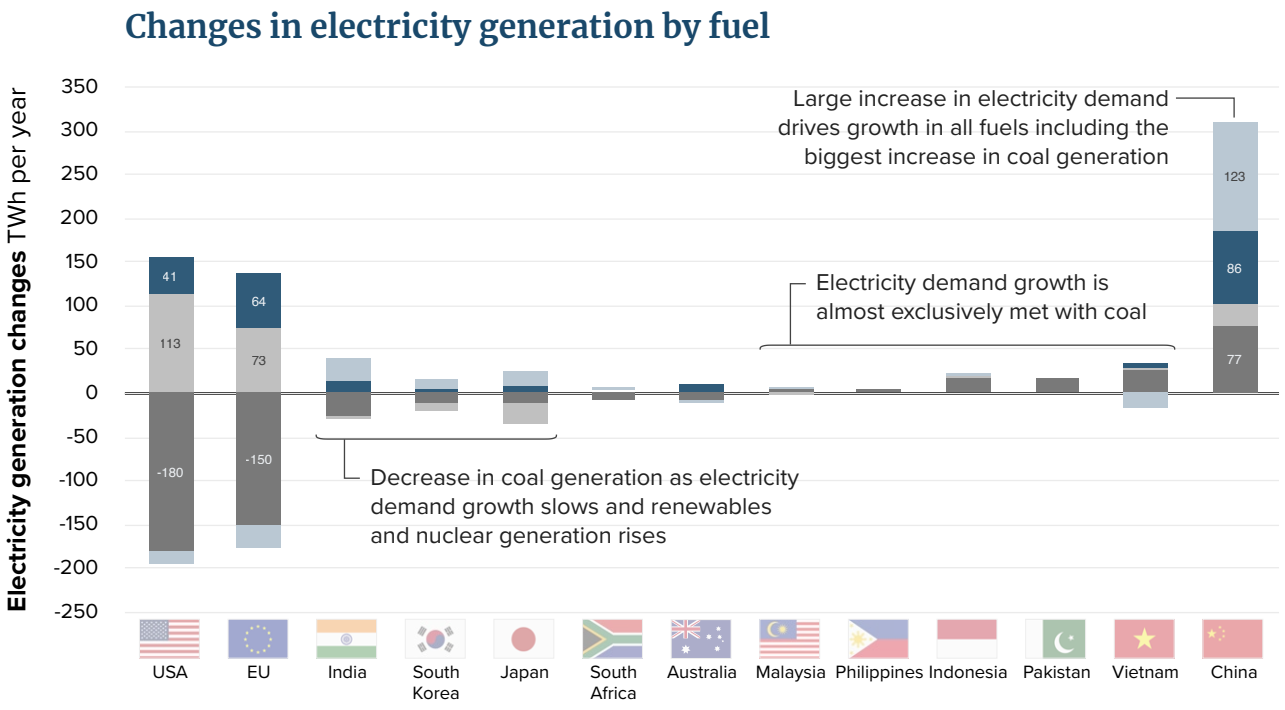


Figure 24 Global electricity generation changes in key coal consuming countries in 2019 (adapted from Jones *et al.*, 2020).

Phase-out challenge: Requesting the phase-out of fossil fuels from countries that are either highly dependent on fossil fuels, have large domestic fossil fuel resources or aspire to rapid fossil fuel-based industrialisation is politically and economically challenging. Some countries in Africa, including South Africa and Botswana, rely on coal for more than 90% of their electricity production. In others, including Algeria, Angola and Nigeria, fossil fuel exports represent approximately 95% of total export revenues (Hoegl and Iacobuta 2020).

Resource-rich developing countries are at times reluctant to abandon their fossil fuel exploitation plans and argue that higher-income and higher-capacity countries need to constrain their fossil fuel production first. Yet, these countries have also committed to the Paris Agreement, and it is evident that deep emission cuts are required worldwide to meet global targets. Hence, it is an international responsibility to support the identification of inclusive alternative solutions for developing countries whose economies depend heavily on the exploitation and usage of fossil fuel resources.

'Just transition' challenge: Pathways consistent with the 1.5°C target of the Paris Agreement require economy-wide transitions and deep structural changes which can disrupt livelihoods, create stranded assets and displace jobs. This may be particularly relevant to economic sectors, regions and communities that are highly dependent on fossil fuel resources, or where opportunities for economic diversification are limited. Therefore, in order to cushion the adverse effects of a transition in the electricity supply sector, related costs and benefits must be distributed fairly among all workers and communities to ensure that no one is left behind (CSIS, 2020). While the concept of 'just transition' is gaining momentum and there is general agreement that sustainable development and social equity must go hand in hand, empirical work and good practice examples on how to achieve 'just transition' is still lacking, especially in the developing world (CSIS, 2020). It is highly unlikely that a universal solution will be found that can ensure an equitable transition in all contexts, given that the economic structure and the way workforce or communities are organised vary considerably across different countries or regions (Piggot *et al.,* 2019). Against this backdrop, it is important to better understand how transitions can impact different political, economic and social contexts in the developing world and how procedural and organisational elements from successful electricity sector transitions in the past may help minimise the adverse effects of similar transitions in the future.

Leveraging transformational change

In 2018, OECD DAC countries provided USD 7.3 billion in official development assistance (ODA) for energy sector projects in recipient countries. This is equivalent to 3% of the total ODA spent in that same year (OECD.Stat, 2020). Looking at financial support for energy sector projects from a climate finance perspective, around USD 188 billion of mitigation finance was spent in the energy sector in 2017/2018, of which USD 58 billion was allocated to renewable energy generation in particular. In addition to public climate finance, renewable energy generation attracts large shares of private investments, with 85% of all tracked private mitigation finance in 2017/2018 flowing into respective projects (Buchner *et al.,* 2019).

Several programmes and projects in international development cooperation focus on the promotion of clean and reliable electricity supply. These already include distinct climate components that guide project planning and implementation. However, to ensure that all cooperation is well aligned with the Paris Agreement and the 2030 Agenda, there are opportunities to strengthen the climate-related purpose of these interventions further and enhance the integration of climate and sustainable development-related policies.

Enable leapfrogging to renewable energy

Context: Many developing countries and emerging economies stand at a crossroads with regards to their energy sector development. To promote economic growth and reduce poverty, the increase of energy supply in general and electricity access in particular is an important lever, but risks locking in polluting fossil fuel infrastructure.

Opportunity: In the electricity supply sector, the development of decentralised renewable energy systems shows large potential for leapfrogging. Leapfrogging traditional stages of development by direct adoption of the newest technologies or by exploring alternative pathways of technological development in the energy sector can have significant climate and wider sustainable development benefits. Steep cost reductions of renewable energy technologies present a great opportunity to electrify rural areas in developing countries and emerging economies through off-grid solutions, bypassing the costly expansion of the national energy grid. Equally, the expansion of grid-connected renewable energy technologies can help meet growing demand while creating a solid base for decent jobs and low-carbon economic growth. Thus, while developed countries in Europe and elsewhere struggle to adjust their fossil-fuel based electricity supply systems, developing countries have the opportunity to build infrastructure suitable for high shares of renewable energy technology from the start.

Role for development cooperation: Development cooperation can support leapfrogging in the electricity supply sector through a number of avenues. Providing access to risk-tolerant finance and innovative technology, offering support for the development of hard and soft infrastructure needed to create an innovation ecosystem, and aiding in elaborating clear strategies and supporting policies will enable leapfrogging to renewable energy systems. As an important action area in this context, the expansion of off-grid renewable energy technologies would benefit from additional financial assistance, such as long-term low-interest loans or grants, and finance for specific demonstration projects.

Furthermore, the development and provision of specific de-risking instruments can help to promote private sector engagement to expand off-grid renewable energy systems. Early recognition of the leapfrogging potential in different countries' electricity supply sector and tailor-made support through development cooperation projects and programmes can help translate these leapfrogging opportunities into sustainable growth.

Identify and offer alternatives to fossil fuel exploitation and usage

Context: Several developing countries and emerging economies are highly dependent on fossil fuels for electricity generation. They also have large domestic fossil fuel resources or aspire rapid fossil fuel-based industrialisation. Facilitating a timely phase-out of fossil fuels in these countries will require compelling alternatives that can provide continued revenue streams, new job opportunities and a reliable energy supply.

Opportunity: While many developing countries and emerging economies count on fossil fuels in the future, several of these countries also have a high potential for renewable energy generation that could go well beyond domestic demand. An appealing alternative to fossil fuel-based energy production (including for domestic or foreign electricity generation) can be offered by using this renewable energy potential, for example, through supporting green hydrogen production and distribution in developing countries and emerging economies and beyond. Increased supply of green hydrogen, for example, can help reduce emissions in several sectors, promote industry and infrastructure development and innovation, boost the economy and provide clean energy and electricity to both producing and consuming countries alike.

Role for development cooperation: Development cooperation on innovative green hydrogen projects can include finance mechanisms, capacity building and support for the creation of the necessary policy and regulatory frameworks to accelerate the uptake of green hydrogen in developing countries and emerging economies. Two important aspects to be considered in this context include local technology and infrastructure development for the production and distribution of green hydrogen, as well as adjustments of important trade agreements. In that sense, stimulating green hydrogen demand globally, including in the EU and Germany, could open a bigger market and help developing countries and emerging economies move away from fossil fuels. Furthermore, support for regional energy corridors and respective infrastructure through which neighbouring countries can trade renewable energy may also offer an alternative to fossil fuel exports. In general, support for the development of a local renewable energy industry can help sustainably transform the economy away from fossil fuel-based growth. In doing so, it creates decent jobs, promotes sustainable development and provides access to clean and affordable electricity.

Support strong institutions and scientific evidence for transition planning and implementation

Context: The transition of the electricity supply sector towards low-carbon development implies deep structural changes with serious consequences for the economic and social tissue of countries' societies. In order for this transition to be successful and sustainable in the long-term, it must be technically sound, must be perceived as fair by those living in affected countries and regions and it must ensure that its benefits are equally distributed while the negative consequences are mitigated.

Opportunity: Careful and inclusive planning that involves policymakers and affected stakeholders are essential to ensure a smooth, sustainable and 'just transition' in the electricity supply sector. Strong and reliable institutions are essential for providing the necessary capacity to plan and implement the transition process. Furthermore, transition plans must be based on sound analysis of socio-economic risks and benefits related to this process and ideally result in the design of tangible roadmaps that outline solutions for affected regions and communities.

Role for development cooperation: Development cooperation can support planning for and implementation of 'just transitions' in the electricity supply sector. By strengthening existing institutional infrastructure and helping create new institutions to facilitate a favourable environment for transition planning, development cooperation can also support technological innovation, research and development and local entrepreneurship in developing countries and emerging economies. Furthermore, sound scientific evidence on the country-specific benefits related to a transition in the electricity supply sector can support political buy-in and strengthen the acceptance and engagement of the private sector and civil society. This, in turn, can drive transformative action.

Consideration of the potentially adverse effects that may come along with an electricity sector transition is equally important. The development of a robust evidence base on socio-economic risks and related exposure of individual countries and stakeholder groups can support the early elaboration of risk management strategies. This is key for promoting and enhancing a just transition with wider support within the population of different developing countries and emerging economies.

Develop climate-compatible eligibility criteria for programmes in the electricity supply sector

Context: Not all development cooperation projects necessarily speak to the climate agenda and not all climate projects automatically aspire to wider sustainable development objectives. For example, supporting natural gas infrastructure could, at first sight, reduce emissions if replacing coal, but would not be compatible with full decarbonisation as required under the Paris Agreement. Given the urgency to make good and quick progress on both accounts, specific instruments are needed to improve the coherence of policies and actions.

Opportunity: Given the massive potential for climate-development synergies in projects and programmes that target the electricity supply sector, a strategic inclusion of climate aspects in the design of development cooperation projects can help ensure that potential synergetic effects are being harnessed. It also seeks to ensure that efficient and collective advancement of both the climate and the development agenda is being achieved.

Role for development cooperation: For this purpose, climate-compatible eligibility criteria can be developed to ensure that development cooperation activities (of a financial or technical nature) advance low-carbon and climate-resilient development pathways in the electricity supply sector. They must also be compatible with the Paris Agreement and the 2030 Agenda. The European Investment Bank (EIB), for example, has recently announced the deployment of such eligibility criteria as part of its climate strategy (EIB, 2020). Climate-compatible eligibility criteria can be rooted in the existing body of scientific evidence on the link between mitigation and adaptation with regards to sustainable development objectives. Through the application of such criteria in the design stage of projects and programmes as well as in the final selection process, it can be ensured that the only development

cooperation projects implemented are those which contribute not only to specific or wider sustainable development objectives, but also to mitigation and adaptation in the electricity supply sector.

Raise awareness, facilitate mutual learning and ensure multiplication of success stories

Context: Given that countries differ with regards to their geographical characteristics and socio-economic conditions, there is no silver bullet for achieving a successful electricity supply sector transition across all countries. Yet, there may be similarities between countries and regions regarding certain aspects of the transition, which can be leveraged to accelerate the global transition process.

Opportunity: Lessons learned and technical know-how from ongoing electricity supply sector transitions around the world can bear significant value for those countries that newly embark on the transition process. This can stimulate mutual learning between countries with similar conditions.

Role for development cooperation: Development cooperation can promote knowledge and experience-sharing through the establishment of platforms and forums that facilitate a regular and guided exchange between countries and stakeholders. This, in turn, can significantly enhance information flow, understanding and problem-solving capacity including in developing countries and emerging economies. Furthermore, the identification of good practices in certain countries or regions can help design effective support programmes for other countries in the same region or for countries in other regions that have similar conditions. Experience has shown that there is large potential for joint learning and mutual support with regards to the challenges and opportunities the electricity sector transition brings along. A further option to better harness this potential can lie in models of triangular cooperation, which provide opportunities to explore the multiple strengths of several partners in a joint approach, fostering co-creation and innovation.

Evidence from German development cooperation

BMZ currently assists some 50 partner countries in pursuing climate-friendly energy sector pathways, with energy being a priority area of bilateral cooperation with 23 countries. In terms of financial support, energy is also one of the largest single items in Germany's development cooperation portfolio, with EUR 2.9 billion spent on renewable energy and energy efficiency measures in 2018. Main instruments used to pursue development cooperation in the energy sector include financial and technical assistance as well as capacity building measures, which are primarily implemented through KfW and GIZ (BMZ, 2020b).

An example of how German development cooperation successfully promotes clean and reliable electricity supply is the project "School electrification with solar home systems" in Uganda, which is being implemented since 2018 (Box V).

Box V
Development cooperation in the electricity supply sector — good practice evidence from Uganda

UGANDA: School Electrification with Solar Home Systems in Uganda

Key facts[17]

LOW-INCOME COUNTRY

GDP PER CAPITA (PPP, 2019)
- USD 2,284

HDI (2019)
- 0.528 (159th)

GHG EMISSIONS (2018)
- 70.7 $MtCO_2e$ (total)
- 1.66 tCO_2e (per capita)

ND GAIN INDEX (2018)
- 166 (of 181)

Region

Country context

Uganda is a landlocked country in the East African region. Although Uganda has considerable natural resources, it suffers from high poverty rates and is considered the least developed in the area. It is one of the countries that contributes least to climate change yet is severely affected by and particularly vulnerable to its consequences.

The elevation and location of Uganda close to the equator provides good conditions for productive agriculture. The agricultural sector forms the backbone of Uganda's economy, contributing over 20% of GDP and employing over 70% of the population. It is also the most significant source of emissions in Uganda, with the AFOLU sector contributing 86% to total emissions, followed by the energy sector (10.8%). Economic growth has been constrained over the past years, mainly because of the inadequacies of infrastructure, including electric power infrastructure.

17 Data for the key facts is taken from the following sources: Income group, taken from World Bank Country and Lending Groups (World Bank, 2020); GDP per capita, expressed as purchasing power parity (PPP) in current international dollars, taken from World Bank Data (World Bank, 2021); Human Development Index (HDI) value and ranking, taken from 2020 Human Development Report (UNDP, 2020b); GHG emissions, total and per capita, taken from Climate Watch/ CAIT database (WRI, 2021); Notre Dame Global Adaptation Index (ND GAIN), taken from ND GAIN website (ND GAIN, 2020).

Challenges and opportunities

Uganda's economy and population are growing and with it its energy demand. Today, only 42% of the population has access to electricity (57% in urban areas and 38% in rural areas). Lack of access to electricity goes hand in hand with poverty and usage of polluting fuels like dirty diesel generators, firewood, kerosene lamps or charcoal. These are expensive solutions that are not only a health threat but also harmful to the environment. Indeed, about 90% of the total primary energy consumption is currently generated from biomass. Enabling access to clean and affordable energy sources, including from solar and wind generation, offers improved livelihoods and better education and health. In their efforts to improve living conditions, it is crucial that countries with low levels of electrification do not take a fossil fuel path, thereby exacerbating the climate crisis.

Engagement of German development cooperation

With support from Germany, Uganda is defining a new political framework for renewable energy and energy efficiency. By creating a conducive environment for local and foreign investment in climate-friendly renewable energy, Uganda can meet the climate targets of its NDC. Furthermore, Uganda participates in the Green People's Energy Initiative for Africa, which is part of the Marshall Plan with Africa. Through the involvement of citizens and private sector companies, the initiative aims to improve the conditions for decentralised and low-carbon energy supply in rural areas in nine African countries. In Uganda, the project runs from December 2018 to September 2022 and has a budget of EUR 4.4 million. It supports the introduction of capacity building on renewable energy at training centres in order to educate teachers and renewable energy specialists. It also advises rural businesses and commercial enterprises on the decentralised use of renewable energy and social institutions on the purchase of decentralised renewable energy systems. Furthermore, the initiative supports the electrification of primary schools. So far, more than 100 teachers, as well as local government staff, have been educated about the advantages of modern Solar Home Systems for primary education.

Main takeaway

Green People's Energy for Africa Uganda demonstrates that solar lighting and power at primary schools can make an important contribution to creating a productive and safe learning environment for children, thereby promoting solar electrification solutions as an important element of low-carbon development in sub-Saharan Africa.

A class room equipped with a solar lighting system at a Ugandan primary school.

Authors: Valentin Hollain, Dorothea Otremba, Elina Weber / GIZ.
Photo: Valentin Hollain, GIZ Uganda.

Cities

Introduction

The world is rapidly urbanising. Already in 2014, over half the global population lived in cities (UN, 2014). In the next 30 years, some additional 70 million people are expected to move to urban areas every year (IPCC, 2018b). Forecasts for 2050 suggest that almost 90% of urbanisation will happen in Asia and Africa (UN, 2019). In Africa alone, the urban population is expected to grow by more than half a billion people by 2040. By 2050, roughly two-thirds of the global population will live in cities (UN, 2014). Current urbanisation patterns are not on a sustainable pathway and suggest a massive growth in GHG emissions. Yet, cities are also hubs of innovation with significant transformative potential. For example, with adequate urban planning they can avoid carbon lock-ins and maladaptation.

Cities are crucial for mitigation. They currently emit 75% of all CO_2 from energy use (Sims *et al.,* 2014; Andersson *et al.,* 2016). By 2050, worldwide urban infrastructure has to accommodate around 2.5 billion new city dwellers. Informal settlements are of key significance in this context — they are expected to grow faster than the city average and, at the same time, yield the highest mitigation potential (Núñez Collado and Wang, 2020). Accordingly, community participation and access to climate-friendly solutions for the urban poor is highly relevant for new developments in infrastructure. This includes critical upgrades of informal settlements as well as upgrades to transport networks and buildings.

Transport – including primary road, rail, air and marine transportation – made up roughly a quarter of energy-related CO_2 emissions in 2016 (IEA, 2018a). Mitigation efforts in the transport sector are estimated to amount to annual emission reduction potentials of 1.9 billion tons of CO_2 by 2030 (Gota and Mejia, 2018). For instance, the Global Commission on the Economy and Climate suggests that an incremental investment of USD 10.6 trillion in public, non-motorised and low-emission passenger and freight transport between

Solar panels for supplying own necessity of electricity in the city. Photograph: BrazilPhotos

2015 to 2050 could yield an annual abatement of up to 2.8 gigatons of CO_2-equivalent by 2050 relative to BAU, with an average payback in less than 12 years (Gouldson *et al.,* 2015).

Overall, however, the growth in demand for mobility is dynamic, particularly in cities in the developing world. Accordingly, the total number of urban passenger-kilometres travelled could triple between 2010 and 2050 under a BAU scenario. At the same time, many short-term measures, such as eco-driving, vehicle fuel efficiency and improved logistics, are cost-effective and promise tangible co-benefits for human health and general well-being, including cleaner air and reduced noise pollution (Gota and Mejia, 2018). The transport sector even represents one-third of the global potential to reduce urban GHG emissions in the period leading to 2050 (Gouldson *et al.*, 2015).

According to some estimates, if cities were to improve and increase investment in public transport and non-motorised travel, more than USD 100 trillion could be saved in cumulative public and private infrastructure spending, while simultaneously avoiding 1.7 billion tons (40%) of annual CO_2 emissions from urban passenger transport by 2050 (Replogle and Fulton, 2014).

SDG11 - Sustainable Cities linkages

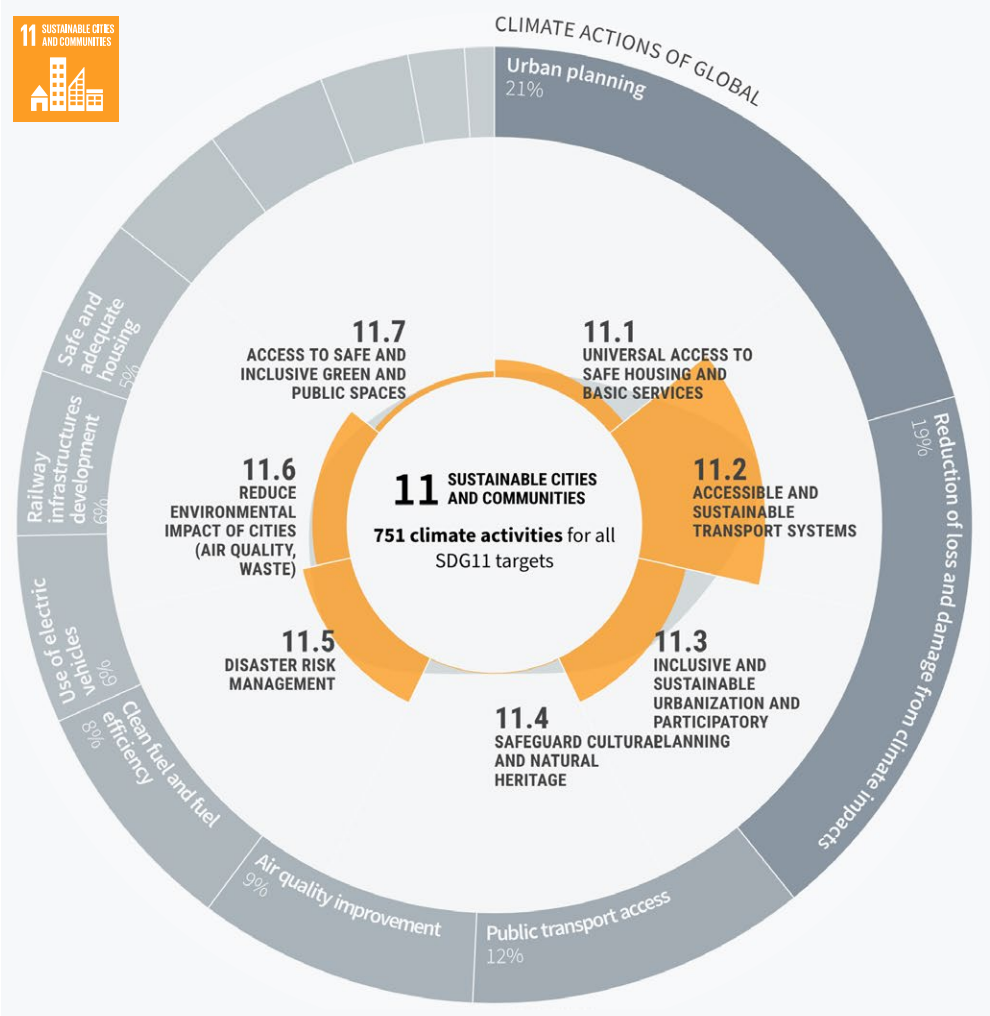


Figure 25
Climate activities in NDCs globally and their link to cities. The inner coloured bars indicate the share of NDC activities relevant to the SDG targets and the outer circle indicates the shares of these activities corresponding to specific action types (based on the NDC–SDG Connections tool, www.ndc-sdg.info).

Cities are also central from an adaptation perspective (Leal Filho *et al.*, 2019). Often located on rivers or coastlines, cities are highly vulnerable to the impacts of slow-onset changes, such as sea-level rise and natural disasters, which are already becoming more frequent and intense as a result of global warming. By 2030, millions of urban residents will be at risk due to events such as floods and mudslides on the heels of drought, wildfires and extreme weather. In addition to lives, USD 4 trillion worth of assets are at risk (CDP, 2014). Informal settlements, which accommodate a vast share of the growing urban population in developing regions, are particularly vulnerable to climate change impacts. They typically lack basic infrastructure and tend to sprawl in disaster-prone areas (Sharifi, 2021).

Accordingly, cities are also a key example of the importance of subnational climate action. On the front line of climate change impact, more and more municipal leaders are adopting ambitious climate policies promoting compact urban structures, low-carbon transport systems, energy-efficient buildings and sustainable waste management systems. These measures can help enable increased climate ambition at the national level. The potential of sub-national action for mitigation is considerable (Kuramochi *et al.*, 2020).

Recent research estimates that the mitigation potential of such subnational initiatives, mostly from cities, may add up to about 20 $GtCO_2e$, an amount far beyond the existing NDC pledges (Hsu, Tan, *et al.*, 2020). Either way, cities play a fundamental role in implementing the Paris Agreement as around two-thirds of all NDCs refer to measures in cities. As shown in Figure 25, SDG 11-related issues are present in 9% of NDC activities. While some NDCs relate to some or even all targets under SDG 11, accessible and sustainable transport systems (11.2) and disaster risk management (11.5) are the most prominent cities-related SDG targets addressed across NDCs. Rapid urbanisation is therefore both an immense challenge and a key window of opportunity for the climate-development agenda. As former UN secretary-general Ban Ki-moon put it: “Our struggle for global sustainability will be lost or won in cities” (UN-Habitat, 2012). Either way, cities will play an important role in the efforts required to implement the Paris Agreement and the 2030 Agenda.

Encouragingly, this realisation is already met with considerable activity on the ground, albeit for a variety of motives (Barber, 2013; van der Heijden *et al.*, 2019). For instance, the example of the Colombian capital Bogóta and its ‘Transmilenio’ bus rapid transport (BRT) system has long been commended as exemplary for structural improvements towards more sustainable urban transport (Gilbert, 2008). It provides a viable alternative to emissions-intensive individual transport, is accessible even for the urban poor and yields a host of co-benefits, including reduced congestion and improved air quality. Driven by central government policy, the Bogóta model has been replicated and sustained in other Colombian cities (Mirailles, 2012). Indeed, BRT systems have since been emulated in many developing countries, with and without international funding (Heinrichs and Scholz, 2012).

Climate-development interlinkages

Cities and local actors are key to the implementation of the Paris Agreement and the 2030 Agenda. Cooperation with local actors is essential to achieving 65% of the SDG targets (Misselwitz, Salcedo Villanueva and Meinert *et al.*, 2015). Local efforts and collaboration are critical for implementing sustainable development strategies, as both the challenges and potentials of climate policy and sustainable development converge in the urban environment. Urban infrastructure must fundamentally change from current practice in order to accommodate growing populations and still achieve the objectives of the Paris Agreement and the 2030 Agenda. SDG 11 ("Make cities and human settlements inclusive, safe, resilient and sustainable") squarely anchors the importance of cities for sustainable development. Its targets focus on the availability of services in urban settlements (for example, housing and transport) (11.1, 11.2); human settlement planning and management (11.3); world cultural and natural heritage (11.4); the effects of disasters (11.5) and environmental issues (air quality, waste management) and green and public spaces (11.6, 11.7).

While SDG 11 is key for urban development, cities and urbanisation entail both promises and pitfalls for sustainable development beyond this city-specific SDG (Table 5 and Table 6). For instance, rapid urbanisation often led to expanding informal settlements that lack infrastructure (SDG 9), which undermines the attainment of multiple SDGs, including those related to health (SDG 3), education (SDG 4) and clean water and sanitation (SDG 6). Moreover, cities are often characterised by pervasive inequality (SDG 10) and urban poverty (SDG 1), are challenged to cope with massive migration dynamics (SDG 10), and function as a threat to terrestrial and coastal ecosystems (SDG 15 and 14, respectively). At the same time, cities are uniquely positioned to address these challenges thanks to their role as industrial hubs and centres of innovation (SDG 9), creativity and education (SDG 4) that together account for more than 80% of global GDP (SDG 8).

While cities lead to climate-damaging urban nutrition patterns, on the one hand, they can also become catalysts for more sustainable consumption and production patterns (SDG 12) on the other hand, for example by improving waste management and advancing circular economy approaches at urban scales. Development cooperation and urban leaders must, however, harness the potential for innovation in cities to address these challenges quickly. This is because the window of opportunity to adapt to current challenges, avoid lock-ins and maladaptation and to minimise damage from urban consumption and production is rapidly closing. Adequate planning and governance are critical to this end.

A compact polycentric urban form, which hinges on good urban planning, is a prerequisite for the sustainable development of low-carbon and resilient cities, including sustainable mobility systems, functional density and green public spaces. Appropriate urban governance (SDG 16) is needed for transparent and information-based decision-making that adequately addresses the public interest. Adequate planning and governance can help leverage synergies between adaptation and mitigation in cities (Sharifi, 2021).

Advancing decarbonisation

Table 5
Synergies (green circles) and trade-offs (red circles) between climate mitigation action and SDGs in the action area of cities (own compilation, based on Gonzales-Zuñiga *et al.*, 2018c).

Inclusive low-carbon mobility	
●	Low-carbon mobility reduces air pollution and related non-communicable diseases.
●	Easily walkable and cyclable cities promote physical exercise.
●	Affordable public transport counteracts inequalities among city residents.
●	Public transport reduces the death toll of traffic accidents and increases access to safe and affordable transportation.
Resilient low-carbon buildings and infrastructure	
●	Investments in resilient and low-carbon buildings and infrastructure can contribute to providing access to basic services, such as water and sanitation.
●	Investments in resilient and low-carbon buildings and infrastructure can contribute to providing access to basic services, such as affordable energy.
●	Investments in resilient and low-carbon buildings and infrastructure can contribute to providing access to affordable housing.
●	Denser cities with adequate green spaces can contribute to reducing heat stress.
●	Investments in resilient and low-carbon infrastructure can attract investments and contribute to economic productivity.
●	Demand for housing can lead to conversion of farmland and peri-urban green areas into built environments, disturbing ecosystem services through conversions of local ecosystems.

Boosting resilience

Table 6
Synergies (green circles) between climate adaptation action and SDGs in the action area of cities (based on Gonzales-Zuñiga *et al.*, 2018b).

Resilience against everyday disasters and climate risks	
●	Storm water drainage, early warning systems, effective disaster management and emergency services can safeguard basic services like health care.
●	Storm water drainage, early warning systems, effective disaster management and emergency services can safeguard basic services like water and sanitation.
●	Storm water drainage, early warning systems, effective disaster management and emergency services can safeguard economic productivity.

Box VI
The New Urban Agenda and the need for a 'new urban paradigm'

The New Urban Agenda and the need for a 'new urban paradigm'

Global leaders adopted the New Urban Agenda (NUA) at the 2016 United Nations' Habitat III Summit — the first key opportunity to reflect on the roles of cities for the implementation of the Paris Agreement and 2030 Agenda. Implementation of the NUA calls for strengthened transnational cooperation. In the so-called Quito Implementation Plan, governments, municipalities, civil-society organisations, private-sector companies, scientific institutions and other players were invited to submit tangible measures to implement the NUA.

Yet, the implementation-related effect of the NUA might be limited. By the end of the Habitat III conference, only 64 commitments were submitted. Another key challenge is that the NUA does not include clear-cut indicators for measuring its implementation, leaving open how the monitoring of the impact will take place (Dick, 2016). Whereas the NUA's first section mentions that it can contribute to achieving the SDGs, the document does not spell out any details.

Overall, the NUA does not sufficiently emphasise the huge importance of cities for global sustainable development and for mitigating climate change and adapting to its impacts. At the same time, a corresponding 'new urban paradigm' could be instrumental to avoid BAU mistakes and path dependencies in urban governance. By guiding complex management challenges in cities in the energy, transport and building sectors with a view to social cohesion and economic competitiveness, it could serve as a key lever to advance the implementation of the Paris Agreement and the 2030 Agenda (Lanfranchi *et al.*, 2018).

Main challenges and obstacles

While the transformative potential of cities is widely acknowledged, tapping this potential, in regard to growing as well as rapidly unfolding urban structures, is no mean feat. Urban governance invariably needs to address cities as moving targets.

Preventing detrimental path-dependencies

One central problem is that fast-growing cities can generate detrimental path-dependencies, above all by locking in high carbon infrastructure such as roads or power plants. The change and speed of global urbanisation and the associated implications for climate change mitigation and resource consumption can hardly be underestimated. Current infrastructure practice will use around half of the remaining carbon budget that is left to keep global warming below 2°C (Müller *et al.*, 2013) (Figure 26). Climate-friendly cities based on renewable energy instead of fossil fuel power plants must represent the way forward, from both a climate and a sustainable development perspective. Yet, this is not automatically the case. It requires awareness as well as ambitious action by today's generation of city-level decision-makers.

Urban infrastructure for sustainable growth

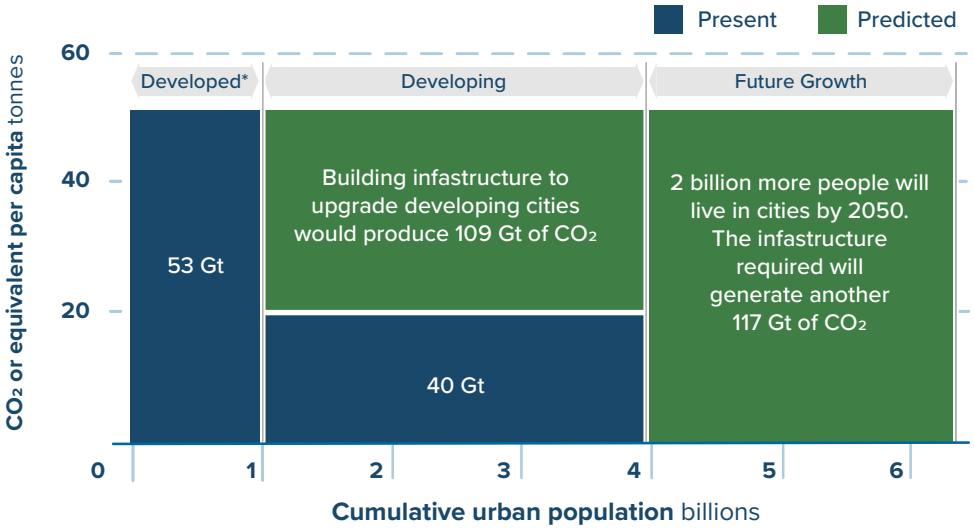


Figure 26 Urban infrastructure and the carbon budget (adapted from Bai *et al.* 2018).

Lack of integrated governance approaches that take account of inter-sectoral and rural-urban linkages

Planning and governance in urban development are essential. For example, it can ensure that demand for more housing does not necessarily translate into urban sprawl. In contrast, decision-making in policy silos and flawed planning processes prevent adequate consideration of cross-cutting solutions and opportunities. A central challenge is to design programmes that combat urban poverty and inequality while simultaneously reducing emissions in view of growing urban populations with essential needs, in

particular in informal settlements. Moreover, in order to take into account the close connection between urban areas, peri-urban areas and adjacent regions, new governance models are required to monitor and govern the opportunities and challenges associated with increasing mobility demands, growing financial and material flows, as well as increasing rural-urban migration.

Lack of long-term planning and integration with national approaches

Municipal governments are often pressed for quick-fix solutions. Confronted with competing challenges, decarbonisation and climate-related risks are rarely a priority. Accordingly, municipal actors often do not take a long-term perspective or the means that are required for adequate resilience measures, sound waste management and low-carbon transport and infrastructure. This indicates that cities are often not sufficiently involved in the development of national goals and policies such as NDCs or NAPs, let alone countries' LTS. National governments typically provide cities neither with an adequate mandate nor with sufficient resources for implementation. This results in a lack of ownership for pertinent strategies and policies at the local level and is in turn reflected by a lack of alignment between policies across levels of governance.

Financing gaps

Many municipal governments face significant budget constraints. Moreover, large shares of available budgets are consumed by operational costs of basic municipal services like waste management (World Bank, 2018). This is an important challenge considering that limiting global warming to 1.5°C will require annual investments of around USD 2.4 trillion in urban energy systems alone (IPCC, 2018b). At the same time, cities face multiple funding challenges. For example, they often have limited control over finance disbursement (which is allocated at the national level) and limited opportunities to get access to large-scale funding in terms of global climate finance (which is usually geared at the national level).

Harnessing digitalisation and other innovative technologies

On the one hand, city governments see great potential in using big data for the development of smart cities and smart urban governance for sustainable urban development. Social media offers great potential for the mobilisation and public participation of the urban population in climate policy, which is essential for the ownership and therefore the sustainability of climate policy measures. In order to achieve development effects through the use of climate-efficient technologies, these must be well embedded in the respective social, cultural and economic context. On the other hand, data protection risks are particularly acute in the case of authoritarian regimes.

Leveraging transformational change

In 2018, OECD DAC countries provided more than USD 8.1 billion in official ODA for "urban development and management" (OECD.Stat, 2020). Through the lens of the SDGs, the assessment of climate-relevant finance committed by OECD DAC donors reveals a strong spotlight not only on SDG 7 (energy) but also on SDG 11 (sustainable cities). In fact, the data shows that more than 20% of overall finance is focused on issues related to SDG 11 and that this city-relevant share has risen since the adoption of the Paris Agreement (Iacobuta *et al.*, under review a). The focus on SDG 11 is reflective of rapidly expanding urbanisation, the large share of GHG emissions by cities and the potential of measures such as strengthening sustainable transport systems and disaster risk reduction.

Moreover, the potential for cities can be further leveraged by strengthening integrated planning approaches and the tools for strategy implementation (Keilmann-Gondhalekar, Vogt and Eisenbeiß, 2018). This can be demonstrated in the context of land policies or funding models for urban development. In identifying the untapped potential and by building on existing efforts, it is important to further promote a transition towards climate-friendly and resilient cities. This will contribute to achieving the goals of the Paris Agreement and the 2030 Agenda and help leverage synergies in that context.

Promote low-carbon urban mobility

Context: The transport sector is responsible for roughly a quarter of direct CO_2 emissions from fuel combustion, with road vehicles accounting for almost three-quarters of these emissions (IEA, 2018a). Without mitigation policies, existing transport trends indicate that transport-related CO_2 emissions could increase by 55% by 2030 compared with 2010 levels (Gota and Mejia, 2018).

Opportunity: Since urban transport systems are a major driver of CO_2 emissions, addressing urban mobility offers considerable potential. In addition, low-carbon urban mobility generates substantial co-benefits for sustainable development, notably by improving air quality and, thereby, promoting good health. Transport systems should be fully decarbonised by means of a properly functioning and fully electrified local public transport system based on renewable energy and improved infrastructure for pedestrians and cyclists. At the same time, mobility should be made inclusive so that individuals from all income groups can safely travel around cities at low cost. Through the introduction and application of the Avoid-Shift-Improve (A-S-I) framework, mobility planning follows a holistic approach to the reduction of transport emissions. Technological improvements notwithstanding, the decarbonisation of transport should focus on reducing the need for travel through strategic and compact urban planning and by shifting away from individual motorised transport towards shared mobility and active mobility.

Role for development cooperation: To leverage the enormous mitigation potential in cities, it is important to scale up support to low-carbon transport planning and infrastructure while ensuring that especially public transport is safe and affordable. Promising entry points include the Transformative Urban

Mobility Initiative (TUMI) that was initiated in the context of the Habitat III Summit in 2016 (BMZ, 2016) and the Action towards Climate-friendly Transport initiative (ACT) that BMZ and UN-Habitat launched in 2019. Moreover, through support for forward-thinking spatial planning, development cooperation can seek to shorten distances for residents in cities, providing them with good access to employment, services and social participation. In addition, the links between different fields, such as urban planning and transport planning, can be emphasised and collaborative efforts can be improved. The spatial aspect of planning requires adequate consideration to this end. Promoting a polycentric, compact and dense urban form with mixed-use areas (i.e., residential, offices and retail) that curbs travel needs can help to leverage low-carbon urban mobility. Development cooperation should leverage these and other related co-benefits that result from linking housing policy, building codes and urban transport with customised approaches that reflect different local characteristics and contexts.

Financing the leapfrogging into resilient and low-carbon urban infrastructure and buildings including by upgrading informal settlements

Context: The ongoing wave of urbanisation can create disadvantageous path dependencies by locking in high carbon infrastructure. However, by 2050, the worldwide building stock will have to reduce emissions by 80 to 90% compared to 2010 levels and the energy consumption of all new buildings will need to be fossil-free starting this year to be on a pathway that is consistent with 1.5°C (IPCC, 2018b).

Cities are growing particularly fast in many developing countries and emerging economies. In Africa, where the urban population will grow rapidly in the coming decades, building construction, infrastructure and energy planning is likely to soon be at a crossroads. At the same time, many cities in developing countries and emerging economies lack access to adequate finance.

Opportunity: New or redeveloped urban settlements offer the opportunity to build resilient and low-carbon structures, as they are not yet locked into high emissions infrastructure. Moreover, the upgrading of informal settlements entails the enormous potential for mitigation, adaptation and sustainable development. Political, legal and institutional conditions, as well as training of decision-makers and relevant professional expertise, are key to this end. Ensuring access to finance for resilient climate-friendly cities can also help to leverage the synergies between climate action and sustainable development in the context of urban development.

By improving energy efficiency of existing and new buildings, energy consumption can be cut in half (Svenfelt, Engstrom and Svane, 2011). Likewise, alternative urban construction materials from renewable and recycled resources can avoid emissions from cement and steel production. Notably, wood-based construction can even function as a carbon sink by storing the carbon dioxide taken up from the air by trees (Churkina *et al.*, 2020). Ultimately, the sustainability of construction materials is contingent on the regional context and prospective trade-offs, for instance with a view to land-use and water management.

Role for development cooperation: Development cooperation needs to ensure that vulnerable groups have access to climate-friendly and resilient infrastructure and buildings. This will prevent further growth of precarious informal settlements in parallel to the formal city. Investments of around USD 4 trillion annually in infrastructure in developing countries and emerging economies are needed over the next few years (NCE, 2016). Yet, these investments must provide a window of opportunity to support leapfrogging to low carbon and resilient urban systems. German development cooperation already supports cities in getting the needed funds (BMZ, 2020a). For instance, initiatives like Leadership for Urban Climate Investments (LUCI), including the City Climate Finance Gap Fund (CCFGF) and the C40 Climate Finance Facility (CFF) can play a key role by helping cities in developing countries and emerging economies to generate bankable, climate-smart infrastructure projects.

Furthermore, development cooperation should focus on harvesting the immense savings potentials in terms of energy and emissions. In the context of buildings and low-carbon construction, the use of sustainable and local construction materials should be supported. Low-carbon construction in developing countries and emerging economies could be promoted via a corresponding credit line with the respective property being used as security. National policymaking is also important for setting incentives for climate-friendly investments or disincentives for carbon-intensive ones (IPCC, 2018b). It is important to strengthen the municipal financial basis by also mobilising private capital (WBGU, 2016; UNFCCC, 2019). In addition, approaches like land value capture allow communities to recover and reinvest land value increases generated by public investment (Smolka, 2013; Germán and Bernstein, 2018).

Make cities more climate resilient

Context: The density of cities and their agglomeration of infrastructure make them highly vulnerable to the impacts of the climate crisis. Port and coastal cities, in particular, are some of the most severely impacted places. Approximately 800 million people live in coastal cities that are projected to experience sea level rise of up to 0.5 meters by 2050 (World Economic Forum, 2019).

Opportunity: Adaptation is a field well-suited to a participatory, community-driven approach, and concepts like community-based adaptation have crystallised in recent years. It is intended to fill in where traditional governance methods fall short, for example, by rounding out deficient regulatory policy, emergency preparedness and insurance (Archer et al., 2014). While cities of varying development status have begun to include climate adaptation considerations in their long-term planning, they often focus on the physical side of adaptation, like flood or water management (Anguelovski and Carmin, 2011). However, beyond physical fortifications against climate hazards, the clarity of the relationship of adaptation to social outcomes is growing (Sims et al., 2014). For example, the same traits that render cities highly vulnerable to climate change (i.e., density and agglomeration) also give rise to unique opportunities like resilience-building through public spaces. This approach transcends physical resilience to consider how adaptation can benefit quality

of life and social cohesion at the community level (Peinhardt, 2021). Any sustainable climate adaptation effort must include considerations for social well-being and equity. It follows that these considerations for the public realm are just one of many parts to a comprehensive approach to climate adaptation — one that delves into multidisciplinary areas of practice like food systems, disaster risk reduction and public health.

Role for development cooperation: Development cooperation should support urban development that considers the city-specific needs to adapt to climate change impacts. It needs to boost both physical and social resilience in urban contexts, including through long-term planning and land policies that are based on a notion of common good. Key measures include building permeable cities that absorb heavy rainfall with green spaces to reduce heat island effects, considering when and how to adapt to sea-level rise, as well as implementing other measures to fight poverty and inequality. In cities that are under-resourced or particularly physically or socially vulnerable, the urgency and difficulty of adaptation is exacerbated by inadequate infrastructure, housing and service provision (Sims *et al.*, 2014). Broadly speaking, this gap can be addressed through resilient infrastructure, alongside the expansion of capacity and policy frameworks to take on community-led adaptation projects. Development cooperation should also promote the alignment of short- to medium-term goals and look towards not only supporting long-term planning, but also coordinated and effective implementation.

Prioritise governance and political and social aspects of sustainable urban development

Context: Tackling climate change and promoting sustainable development in cities requires effective governance. This is crucial for planning, coordinating and implementing the extensive but necessary transformations within cities and across wider metropolitan areas. It is also crucial for getting non-government actors, such as citizens and the private sector, involved to create synergies and ensure that the transformations are inclusive. However, cities in developing countries and emerging economies are often facing governance challenges (IPCC, 2018b). Established governance methods are often not commensurate to address urban adaptation and mitigation challenges.

Opportunity: Effective multi-level governance can enable local adaptive and mitigation capacity and sustainable urban planning to strengthen the substantive, political and economic inclusion of urban residents (IPCC, 2018b). Local governments are vital for safeguarding that existing key actors, including civil-society stakeholders, can contribute to shaping urban development and improve their living conditions (WBGU, 2016).

Role for development cooperation: Sustainable urban development and planning should be expanded in development cooperation, for example, through a focus on renewable energy generation, urban resilience, low-emission building and sustainable waste management. At a national level, improving the political, legal and institutional frameworks for urban planning is critical for designing and implementing cross-sectoral approaches. Integrated urban development needs to tackle the nexus of social, political, economic

and ecological systems in cities. It needs to consider natural resource management and balanced socio-economic development with stronger integration across strategic urban sectors, actors and stakeholders, spatial areas and governance levels (Keilmann-Gondhalekar, Vogt and Eisenbeiß, 2018). While promising advances have been made (e.g., Andersson *et al.*, 2016), including with the Urban Nexus Approach (Wong, 2019), integrated strategies to urban development are yet to be fully incorporated into development cooperation.

Strengthening governance and capacity-building at the subnational level can play an important role in mainstreaming sustainable construction, land-use planning and infrastructure development. The 'human factor' must be taken into account. Sustainable technologies and infrastructure can only work as intended if they are actually used and understood in relation to the cities' ecosystem as a whole. Behavioural science findings should therefore be systematically included in the planning of corresponding development cooperation projects. In order to leverage synergies between climate policies and sustainable development in the urban context, development cooperation needs to prioritise political and social aspects of sustainable urban development. The expansion of political participation beyond elections is central to innovative, inclusive and effective measures while avoiding the perpetuation of inequalities along with the city's development. This includes participatory forums, such as citizens' councils, and soliciting input from otherwise neglected and often disadvantaged groups, such as young people, women, migrants and refugees. In view of rising urban inequality, this will be essential for the legitimacy and sustainability of climate action and to avoid exacerbating inequality. Social media can also be instrumental in advancing mobilisation and broader participation of the urban and metropolitan population. In general, the dynamics of urbanisation and its design options through sustainable urban development and planning must be considered in the context of the megatrend of digitalisation.

As the key drivers of subnational climate action, empower cities and improve exchange

Context: As of December 2020, more than 18,000 different non-state and subnational actors have registered more than 27,000 climate actions on the UNFCCC Global Climate Action portal, including more than 10,000 cities from around the world[18]. The global urbanisation trend is driven particularly hard by small and medium-sized cities with less than 500,000 inhabitants. On one hand, their rapid growth offers many opportunities. On the other hand, they often lack the financial and personal capacity for adequate climate action. Subnational climate action needs to account for the specific needs of individual cities, as well as their local and regional context. While many non-state and subnational climate actions do target low-income and lower-middle-income economies, the implementation gap in these countries remains greater (Chan *et al.*, 2019). This highlights the important role for development cooperation to leverage this untapped potential for climate actions.

18 UNFCCC, NAZCA (2020). https://climateaction.unfccc.int/

Opportunity: The potential of subnational climate action, especially by cities, is immense and even exceeds current NDC pledges (Hsu, *et al.*, 2020a). Recent research shows that most cities are on track to achieve their 2020 emission reduction targets, which underlines the importance of cities as key actors (Hsu, *et al.*, 2020b). Moreover, recent research indicates that sub-national actions support increased national action, which further stresses the promises of action at the city level (Hultman *et al.*, 2020). Leveraging climate action by empowering cities as key subnational actors can help to enable enhanced climate policy action that also contributes to achieving the SDGs, for example, by improving air quality and the health of city dwellers (Table 5). At the same time, non-state climate and sustainability actions may not be self-reinforcing (Chan *et al.*, 2019). Supporting mechanisms can help leverage the untapped potential for generating synergies and sustain subnational actors' underlying engagement.

Role for development cooperation: Development cooperation can empower cities as key actors for fighting climate change and promoting sustainable development. Efforts are needed to mobilise and implement sub-national climate actions that benefit the world's most vulnerable people in developing countries and emerging economies. Development cooperation can help by providing incentives for cities in developing countries and emerging economies to engage, for example, through improving access to knowledge, high-level recognition, material and immaterial support and demonstrating good practices for replication elsewhere (Chan *et al.*, 2019). An enabling environment can also be created by institutionalising feedback mechanisms between international agendas and city actions. For example, the voluntary national reviews of SDG implementation and 5-year reviews of NDCs under the Paris Agreement could check the progress of city actions and compatibility with sustainability goals (Chan *et al.*, 2019).

Moving forward, development cooperation can build on approaches such as the Talanoa Dialogue[19] (GIZ, ICLEI and UN-Habitat, 2018) or work with transnational city networks that include government officials and civil society. Development cooperation could also support public diplomacy and town-twinning partnerships between European and non-European cities. The use of existing partnerships or city networks could further boost such exchange and help to sustain the engaging cities' focus on climate-resilient and sustainable urban development. Moreover, greater exchange and inter-ministerial coordination in donor countries, including across implementing agencies that work on sustainable urban development, could drive positive developments. Complemented by in-depth exchange with science, the private sector and civil society, this could contribute to leveraging the potential to strengthen resilient and low-carbon cities.

19 The Talanoa Dialogue refers to a process under the Fiji Presidency of the UN climate change conference COP23 that provided a designated platform for non-state and local actors to showcase promising ideas to address climate change (UNFCCC, 2018).

Evidence from German development cooperation

BMZ currently works with more than 50 partner countries to support sustainable urban development. Urban development projects by German development cooperation account for around EUR 15 billion (BMZ, 2020d). BMZ focuses on the following fields of activity:

- Poverty reduction and social integration in cities;
- Sustainable urban development for climate protection and resource efficiency;
- Decentralisation — good governance and local action;
- Needs-based and efficient urban management;
- Regional development, spatial planning and inter-municipal cooperation; and
- Cooperation with international actors.

An example of how German development cooperation successfully promotes climate action in urban environments is the project “Climate change adaptation in coastal cities in Bangladesh” (Box VII).

Box VII
Development cooperation in the action area of cities — good practice evidence from Bangladesh

BANGLADESH:
Climate change adaptation in coastal cities

Key facts[20]

LOW-INCOME COUNTRY

GDP PER CAPITA (PPP, 2019)
- USD 4,964

HDI (2019)
- 0.614 (135th)

GHG EMISSIONS (2018)
- 220.75 $MtCO_2e$ (total)
- 1.37 tCO_2e (per capita)

ND GAIN INDEX (2018)
- 162 (of 181)

Region

Country context

Bangladesh, a least developed country in South Asia, is one of the most populous and densely populated countries in the world, especially along its 580 km of coastline. As a poor, low-lying and largely riverine country it is particularly vulnerable to the impacts of climate change, notably by tropical cyclones and floods. These impacts are projected to be compounded further in the future through more frequent storms, heavy rainfall and flooding and sea-level rise.

Challenges and opportunities

Tackling the country's pronounced vulnerability to climate change is essential for improving the country's crisis resilience and for promoting sustainable development, especially in the context of densely populated cities like Khulna in the south-western coastal lowlands. In Khulna, one-fifth of the more than 660,000 inhabitants lives in slums and is particularly vulnerable, with many houses being recurrently flooded for weeks and typically lacking functioning drainage systems. Due to the lack of adequate infrastructure, schools, hospitals and workplaces are often difficult to reach. Expanding and repairing roads, dams and drains improves flood protection. Adapting to the impacts of climate change thus improves the resilience of the growing population through better hygienic conditions and access to health care and education. It also promotes local economic activities, thereby contributing to combatting urban poverty.

20 Data for the key facts is taken from the following sources: Income group, taken from World Bank Country and Lending Groups (World Bank, 2020); GDP per capita, expressed as purchasing power parity (PPP) in current international dollars, taken from World Bank Data (World Bank, 2021); Human Development Index (HDI) value and ranking, taken from 2020 Human Development Report (UNDP, 2020b); GHG emissions, total and per capita, taken from Climate Watch/ CAIT database (WRI, 2021); Notre Dame Global Adaptation Index (ND GAIN), taken from ND GAIN website (ND GAIN, 2020).

Engagement of German development cooperation

Bangladesh is a bilateral partner country of German development cooperation. German development cooperation supports climate-adapted urban development in Bangladesh in Khulna and other cities. In Khulna, a KfW project, with support from BMZ, has focused on investing in the climate-adapted and resilient expansion of local infrastructure to improve the resilience of the urban population.

Key measures included building drainage channels and dams and expanding and fortifying roads. Around 200,000 people, half of which live in poverty, benefit directly from better rainwater drainage and flood protection. Building on these successes, a new project will focus exclusively on promoting climate-adapted urban development.

In this upcoming project in Khulna, a comprehensive climate vulnerability and risk analysis was undertaken to identify those measures together with the city that are most strongly needed in terms of climate change adaptation and making Khulna climate resilient also in the medium term. Based on this analysis, the project will mainly focus on improving the drainage management system, surface water management and river bank protection. In addition, the city administration receives targeted funding, for example for training and equipment for operations and maintenance to ensure the sustainable management of urban climate adaptation measures.

Main take away

This project has been among the first ones in German development cooperation with an explicit focus on climate change adaptation that addresses poverty while reducing people's vulnerability to the consequences of climate change.

Author: Christina Bartz / KfW.
Photo: Embarkment road and flooded inner city in Khulna. Photo by Jashim Salam.

Agriculture

Introduction

The agricultural sector is central to the livelihood of more than 2 billion people globally, and is key to the economy of many low-income countries, where food insecurity remains a concern (IPCC, 2019b; World Bank, 2019). In addition, many developing countries are located in low latitudes in the tropics and subtropics, where the strongest negative impacts of climate change are projected and farmer's adaptive capacity is low (Porter *et al.*, 2014). A global mean temperature rise above 1.5°C would reduce the yield of staple cereal crops in Sub-Saharan Africa, Southeast Asia and Central and South America, thus stabilising temperatures well below a 2°C average is central to reducing projected climate impacts in these regions (Hoegh-Guldberg *et al.*, 2018).

Developing countries and emerging economies together contribute 80% of global agricultural emissions, with half of these emissions being produced by agricultural activities in six emerging economies (Vermeulen and Wollenberg, 2017a; FAO, 2020d). The main sources of emissions include enteric fermentation from livestock, rice cultivation and fertiliser management on croplands. While the largest share of global livestock emissions stem from cattle raised in South America (21%), global emissions from rice cultivation originate almost entirely from paddy fields in Asia (90%). Smallholders contribute about 40% of agriculture emissions in developing countries (Vermeulen and Wollenberg, 2017b). In addition, current agricultural intensification practices undermine the health, soils, biodiversity and freshwater resources of critical ecosystems and have a huge environmental footprint. For example, 70% of global freshwater withdrawal is used for irrigation and overuse of synthetic fertilisers is a major cause of pollution in aquatic ecosystems (Foley *et al.*, 2011). In fact, half of the nitrogen fertiliser applied to crops is not absorbed by plants (Steiner *et al.*, 2020).

Everyday life for farmer with cows in the countryside. Photograph: DCPhoto

The agricultural sector in developing countries and emerging economies faces many challenges. On the one hand, productivity must increase to ensure enough food is produced to meet the need of a growing population. Providing sufficient caloric quantity and nutritionally diverse food to this end is one of the biggest challenges for agriculture and food systems. On the other hand, the sector's environmental footprint and GHG emissions must be reduced. This requires climate-smart and sustainable agricultural intensification as well as changes in production and consumption patterns. At the same time, the sector must adapt to climate impacts and secure resilient rural livelihoods while protecting environmental resources and ecosystems (WRI, 2018).

To address these challenges, the agricultural sector requires a radical shift in the way food and other agricultural-based products are being produced and consumed. Rapid deployment of climate action to build resilient crop and livestock systems, while reducing their emissions and other environmental footprints, are needed to sustainably increase food production (IPCC, 2019b). To achieve the temperature goals of the Paris Agreement, emissions from agricultural activities must decrease by at least 40% by 2050 (Roe *et al.*, 2019). With this goal in mind, improving livestock and cropland management is crucial to reduce methane emissions from livestock and rice cultivation, and nitrous oxide emissions from agricultural soils (IPCC, 2019b; Roe *et al.*, 2019).

Alternatives to traditional intensification are increasingly being pursued to achieve sustainable agriculture and food systems while improving their productivity. These include Climate-Smart Agriculture (CSA), landscape multifunctionality and agroecological frameworks. CSA focuses on achieving three pillars — agricultural productivity, climate adaptation and mitigation (FAO, 2010). Landscape multifunctionality, also presented as a climate-smart landscape approach, recognises the essential role of trees and species diversity in agricultural landscapes (Minang *et al.*, 2015). This approach integrates environmental and socio-economic dimensions of agroforestry, which is the combination of trees to crop or livestock production systems and examines the implications beyond the farm level. Agroecology overlaps with CSA and landscape multifunctionality but places a strong emphasis on ecological principles, farmers and indigenous knowledge and sovereignty, which is particularly suited to support and empower vulnerable groups (HLPE, 2019). Agroecology is defined by the Food and Agriculture Organization as the science of applying ecological concepts and principles to manage interactions between plants, animals, humans and the environment for food security and nutrition (FAO, 2018). Agroecology also aims to protect human and social values, as well as culture and food traditions. All of the approaches described here are complementary and each offers specific values in a different context and for different target groups.

Climate-smart practices enhancing carbon sequestration, such as agroforestry, biochar addition to soil, use of cover crops and reduced tillage, offer promising solutions to address both the cause of climate change and the direct impacts it has on agriculture (HLPE, 2019; IPCC, 2019b; Roe *et al.*, 2019). In addition, agroecological measures can minimise the use of synthetic fertilisers and other inputs, and could reduce emissions by up to 1.6 $GtCO_2e/y$ (HLPE, 2019; IPCC, 2019b).

The most effective mitigation measures across the global food system include sustainable intensification of meat production and a shift to plant-based sources of proteins in developed countries and emerging economies. This could mitigate emissions by up to 9.5 $GtCO_2e/y$ (IPCC, 2019b). Reducing food waste and losses across the supply-chain could also reduce emissions by up to 4.5 $GtCO_2e/y$ (IPCC, 2019b). In addition, the use of high-quality feeds for ruminants, and improved water and residue management in rice fields, are important mitigation measures (Roe *et al.*, 2019). However, mitigation measures in smallholder agriculture must not pose a constraint to rural livelihood and economic development, and therefore support should focus on promoting synergies between mitigation, adaptation and rural development (Vermeulen and Wollenberg, 2017b). There is growing evidence that agroecological principles support the realisation of these goals (HLPE, 2019; Andrieu and Kebede, 2020).

Nearly all developing countries have considered both mitigation and adaptation in their NDCs for the agricultural sector, but only a few have set mitigation targets (Richards *et al.*, 2015; FAO, 2016). Only 17 countries explicitly mentioned agroecology in their NDCs, and only six countries considered mitigation based on agroecological principles (Andrieu and Kebede, 2020). Figure 27 illustrates the links between climate actions in NDCs and the

SDG2 - Zero Hunger linkages

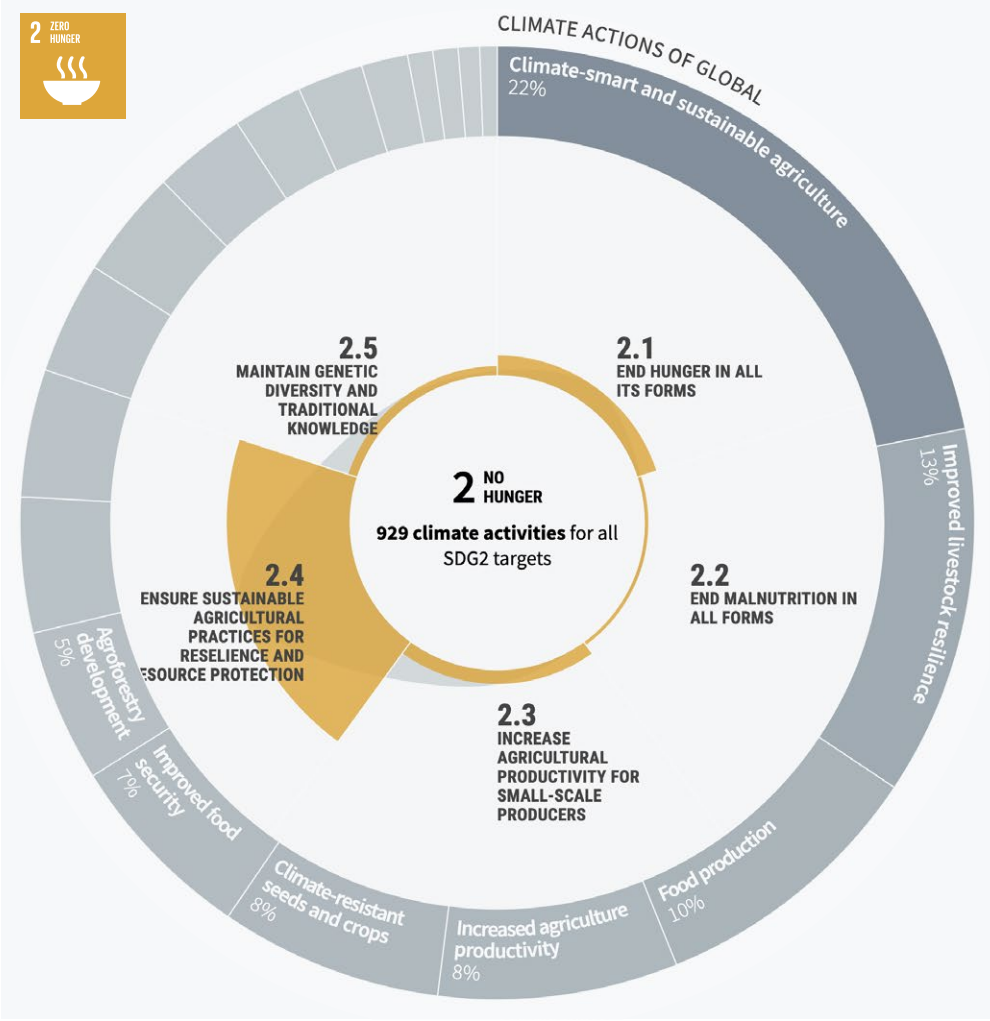


Figure 27
Climate activities in NDCs globally and their link to the agriculture sector. The inner coloured bars indicate the share of NDC activities relevant to the SDG targets and the outer circle indicates the shares of these activities corresponding to specific action types (based on NDC-SDG Connections tool, www.ndc-sdg.info).

targets of SDG 2, which directly relates to the agricultural sector. Promoting approaches to sustainable agriculture, including agroecology, CSA and landscape multifunctionality, as well as knowledge transfer and capacity building, can be achieved through international financial and technical support. This will be crucial to the successful implementation and scaling-up of climate action to transform agricultural systems in developing countries.

A compelling example for the merits of sustainable land management and the multiple co-benefits it can yield, even under conditions of severe drought, is Ethiopia's long-term approach to soil and water conservation in the Tigray dryland region (Munro *et al.*, 2008, 2019; World Future Council, 2017). Strategically combining voluntary labour from local farmers with a 'food for work' policy yielded an effective restoration of degraded drylands with sustained positive impacts on soil fertility, groundwater levels and agricultural crop productivity (IPCC, 2019b). While afforestation is central to this scheme and can result in increased carbon storage, its comprehensive success is based on enhanced erosion control and water catchment and the provision of agricultural livelihoods with reliable and growing rural incomes.

Climate-development interlinkages

Mitigation and adaptation actions in the agricultural sector are relevant to the realisation of most SDGs and are particularly central to eradicating poverty (SDG 1) and food insecurity (SDG 2), improving nutrition and health (SDG 3), conserving water resources (SDG 6), sequestering carbon and enhancing climate resilience (SDG 13) and preserving ecosystems and biodiversity (SDG 15). In addition, improving the sustainability of the supply and post-harvest value-chain contributes directly to responsible food consumption and production (SDG 12). While the synergies between climate actions in the agricultural sector and broader sustainable development objectives are considerable, there are very few trade-offs (Table 7 and Table 8).

Advancing decarbonisation

Table 7 Synergies (green circles) and trade-offs (red circles) between climate mitigation action and SDGs in the agriculture sector (own compilation, based on Gonzales-Zuñiga *et al.*, 2018c).

Improved meat production efficiency	
● Increase food security.	
● Reduce agriculture water use.	
● Reduce land area required to produce feed, reducing conversion of ecosystems into agricultural land.	
Shift to plant-based diets	
● Nutritional and health benefits for population currently consuming high amount of meat.	
● Potentially negative effects on health of population suffering from malnutrition (e.g., iron deficiency).	
● Reduce methane emissions and nitrogen input and related soil, air and water pollution	

Improved water management in rice production	
Improve water use efficiency.	
Increase food security.	
Improved soils/fertilisers management	
Increase food security.	
Reduce nitrogen leaching and related soil, air and water pollution.	
Protection of soils from degradation.	
Sustainable production and consumption.	
Food waste and post-harvest losses reductions	
Reduce food losses and waste across the entire value-chain.	
Increase food availability and thus contribute to greater food security.	
Agroecology and Agroforestry	
Safeguard biodiversity and improve health of soils and other ecosystems, also enhancing carbon sinks.	
Reduce rural poverty in the long term through provision of a variety of products and services.	
Minimise use of agricultural inputs.	
Increase availability of diverse food and medicinal products, benefiting both food security and health.	
Regulate water resources.	
Increase food security.	
Empower smallholders and promote traditional and indigenous knowledge.	
Can reduce farm economic return in the short term.	
Agroforestry can result in lower crop yield due to competition for resources between trees and crops.	

Boosting resilience

Table 8 Synergies (green circles) between climate adaptation action and SDGs in the agriculture sector (based on Gonzales-Zuñiga *et al.*, 2018b).

Early warning systems and farm insurance schemes	
● Increase food security.	
● Reduce poverty.	
● Reduce inequalities.	
● Provide safety net to farmers.	
Farm diversification	
● Increase food security.	
● Reduce rural poverty.	

Main challenges and obstacles

In developing countries and some emerging economies, implementing and scaling-up transformative actions in the agricultural sector is particularly difficult, due to financial, institutional, technical and human capacity barriers (Ross *et al.*, 2019). Lack of access to technology and finance, as well as land tenure rights, are key barriers for the adoption of new measures (IPCC, 2019b). In addition, transformative measures that address productivity, mitigation and climate risks require long-term planning that often conflicts with short-term governance priorities in developing countries and emerging economies.

Financial and economic barriers

Lack of sufficient finance is a key constraint to developing and implementing sustainable measures in the agricultural sector (Steiner *et al.*, 2020). National priorities for short-term economic development tend to conflict with global GHG emission reduction efforts relying on costly measures or a shift in agricultural commodities production and exports. In fact, the import of specific high-value crop commodities from developing countries and emerging economies by developed countries, and respective revenue streams, are an important driver of indirect emissions from deforestation due to cropland expansion in producing countries. The comparatively high short-term economic return of inorganic fertilisers and pesticides makes these farming intensification practices more appealing, particularly in countries that aspire for rapid and strong economic growth.

Land tenure rights

Conflicts regarding land tenure are a challenge especially for smallholder farmers and indigenous communities. Weak tenure security or a lack of recognition of customary tenure impede the ability of farmers and marginalised groups to make decisions and manage their land (Hurlbert *et al.*, 2019). Supporting reforms to strengthening land tenure systems can provide a great incentive for farmers to make sustainable decisions on their land and facilitate their access to credits to purchase inputs and machinery.

Technical and human capacity barriers

Lack of knowledge is a significant barrier to adopting new techniques and technologies (Steiner *et al.*, 2020). Post-harvest losses are also an issue in developing countries and emerging economies due to less efficient harvest techniques and inadequate storage facilities. About 40% of food produced is lost due to inadequate storage (Steiner *et al.*, 2020).

Tracking and reporting of national emissions remain a challenge due to technological barriers (Richards *et al.*, 2015; FAO, 2016). Countries have highlighted the need for tools and guidelines that support the monitoring and reporting of emissions in the agricultural sector. The lack of precise information on emissions sources and quantity impedes the prioritisation of measures addressing specific emissions sources.

Governance and policy coherence

Poor governance and a lack of policy coherence across scale and sectors are important challenges for the implementation of sustainable measures in developing countries and emerging economies. They are key barriers for the agricultural sector in particular (Hurlbert *et al.*, 2019). Polycentric governance can address some of these challenges by integrating actions at different levels of governance (local, regional, national and global) to improve their effectiveness and coherence across scale and aspects of food systems (Ostrom, 2010). For example, it's important to ensure that the specific needs of farmers and rural communities are fully reflected in regional and national policies.

Leveraging transformational change

In 2018, OECD DAC countries provided more than USD 5.5 billion in official ODA for projects in the agricultural sector in developing countries. This is about 6% of the total ODA allocated across all sectors (OECD.Stat, 2020).

Scaling up existing projects and programmes around sustainable intensification and resilience of agricultural and food systems is needed across developing countries and emerging economies to achieve the Paris Agreement targets. Priority should be placed on deploying soil management strategies that protect soil health and enhance carbon sequestration (tillage, agroforestry, biochar), financial support, capacity building and raising public

awareness to shift demand to more sustainable food systems. In general, it is of paramount importance that climate and sustainable development actions in the agricultural sector safeguard food security while protecting the rural economy and livelihood.

Enable the adoption of climate-resilient technologies and low-emission practices

Context: Low agricultural productivity and high climate vulnerability are key challenges in developing countries and most of Sub-Saharan Africa, South Asia and Central America. Several low-emission options exist for boosting crop productivity and increasing the resilience of cropping systems to climate change. However, their adoption, especially by smallholders, is low. As highlighted in the previous section, the main challenges are a lack of access to financial resources, unclear land tenure rights and limited access to information and training.

Opportunity: The breadth of technologies and practices include soil management practices that improve soil carbon sequestration while protecting the health of ecosystems (e.g., conservation tillage), agroforestry and crop rotation, climate-resilient seeds, and micro-irrigation infrastructure based on renewable energy sources. Agroforestry, for example, offers multiple environmental and economic benefits, but requires long-term planning and support as the benefits are not immediately perceived (Mbow *et al.*, 2014). In order to reduce farm inputs and their related emissions, and increase soil carbon sequestration, agroecological practices such as the use of cover crops, crop rotations and conservation tillage can enhance biological and ecological processes in agricultural production systems (HLPE, 2019). Extension services and digital advisories via mobile phones, radio and TV, for example, can significantly improve farmers' access to relevant information about new technologies and climate services. Furthermore, getting access to seasonal climate outlooks can enhance to the use of adequate seeds and improve the timing of planting and harvesting.

Role for development cooperation: Boosting private sector investments in expanding and diversifying markets is a key financial strategy for empowering smallholders and stimulating rural activities. Support to the development of policies and financial programmes facilitating private sector investment is a key area for development cooperation. Finance instruments addressing climate risks, such as international funds (e.g., Adaptation Fund and Green Climate Fund) as well as insurance, should be deployed in combination to address the various layers of risk (Martinez-Diaz, Sidner and McClamrock, 2019). Another important support area involves farmers' access to credits and insurance schemes. Innovative approaches include value chain lending and mobile-based finance (Steiner *et al.*, 2020).

Building capacity of key actors in poor rural areas is an important action area. This can directly help women and other under-represented groups adopt new technologies and early-warning systems by supporting their access to credits, insurance and other financial resources. Moreover, building their capacity to implement sustainable land management practices can greatly contribute

to improved soil fertility and increased yield sustainability, and therefore raise farm income. In addition, building the capacity of farmers through knowledge-transfer and financial programmes that support smallholders in Sub-Saharan Africa, South Asia and Central America is needed. In South Asia, for example, farmers need financial support and training to adopt improved water management techniques in rice fields and sustainable fertiliser management practices. Across regions, small-scale farmers need improved climate services and access to insurance products that respond to failing harvests and help build resilient agricultural supply chains. Finally, development cooperation can support reforms to land tenure systems that give women and marginalised farmers access to land tenure rights. In general, a multi-level approach that integrates targeted programmes, policy advice and finance is recommended.

Support sustainable intensification of meat and dairy production in low-income countries and a shift towards plant-based alternatives in high- and middle-income countries

Context: Meat and dairy production is the largest source of GHG emissions from agriculture. When consumed in sufficient quantity, meat and dairy provide an important source of proteins and micronutrients such as zinc and iron. However, their overconsumption, which is a problem for populations in developed countries and rapidly urbanising areas, cause health-related risks such as obesity and chronic cardiovascular diseases (Steiner *et al.*, 2020). As such, halving consumption of meat and dairy in high- and middle-income countries would not only make a substantial contribution to global mitigation efforts but also contribute to major health benefits (Steiner *et al.*, 2020). On the other hand, underconsumption of meat and dairy is a major cause of food insecurity and malnutrition in low-income countries.

In these countries, the production of meat and dairy food products must increase sustainably to minimise emissions related to livestock production systems while ensuring greater access and availability of nutritious animal food products. This can be achieved by promoting sustainable intensification of livestock systems that significantly reduce enteric fermentation from livestock, improve manure management on pasture and use crop by-products and waste for feed.

Opportunity: On the consumption side, incentives to reduce meat demand and promote plant-based protein alternatives to meat in high- and middle-income economies are central to achieving significant emissions reductions from agriculture. In addition, emissions from deforestation arising from agricultural land conversion for feed crop cultivation must be avoided. As such, improved labelling and supply-chain traceability can significantly reduce those imports by developed countries and emerging economies that caused deforestation in developing countries. On the production side, sustainable livestock measures include animal breeding and the deployment of technologies that reduce methane emissions from cattle. In addition, sustainable intensification of dairy farms should also be supported. These

include the use of methane inhibitor supplements to cattle feed, along with improved feed quality and grassland management using agroecological and agroforestry practices. Finally, the promotion of a circular livestock supply chain, where by-products from crops are used to feed local livestock, is another central strategy for reducing the environmental footprint of meat and dairy production (Van Zanten *et al.*, 2018).

Role for development cooperation: In high- and middle-income countries, policies focusing on reducing meat and dairy consumption and on shifting food demand to plant-based diets should be prioritised. Development cooperation efforts can raise consumer awareness on the health and environmental consequences of meat and dairy consumption and on promoting deforestation-free and carbon-neutral products along with high-quality dairy and meat fed on agroecological pasture systems. In addition, regulating and transforming international trade and markets of meat and dairy products must also prevent a shift of emissions from one developing country to another. Support can also focus on a reform of subsidies to promote the transition of the livestock industry away from the traditional livestock value-chain, while creating new employment opportunities. In low-income countries, development cooperation should support sustainable intensification of livestock systems based on agroecological and climate-smart principles. Support can consist of providing financial and technical resources and capacity-building via knowledge transfer and education. This facilitates the adoption of sustainable intensification measures.

Coordinate efforts to reduce post-harvest food losses and food waste

Context: Global estimates of food loss and waste reach about 1.7 Gt per year, resulting in more than 2 $GtCO_2eq$ per year emitted to the atmosphere (Steiner et al., 2020). Food loss and waste are the highest for quickly perishable food items such as vegetables, fruits and dairy, as well as roots and tubers. In developing countries, poor or inadequate storage facilities are the main reason for food losses. In addition, 10 to 20% of cereal harvest is lost in Sub-Saharan Africa (Steiner et al., 2020).

Opportunity: Deployment of hermetic storage bags to store grains, for example, could reduce losses due to inadequate storage facilities. In addition, solar-powered cooling storage facilities are essential for adapting post-harvest storage under a warmer climate (Steiner et al., 2020).

Role for development cooperation: Development cooperation can play an essential role in supporting the deployment of financial resources to use effective storage equipment in developing countries. By supporting programmes that raise consumer awareness and disseminate information on improving food use and reducing waste, demand for imported products with high environmental footprints, such as out-of-season fruits and vegetables, could be substantially reduced.

Evidence from German development cooperation

Over the past years, BMZ increased its commitment to support international food security and global environmental protection projects, for example, via the "ONE WORLD – No Hunger" initiative. A focus lies on projects and programmes supporting climate resilience and low emission agriculture as well as on agroecological farming, especially in Africa and Latin America. In this context, BMZ invests EUR 1.5 billion every year in rural development and food security (BMZ, 2020c).

An example of how German development cooperation successfully promotes climate change adaptation and sustainable development in the agricultural sector is the project "Climate change adaptation of agricultural value chains in Madagascar", which is being implemented since 2017 (Box VIII).

Box VIII
Development cooperation in the agricultural sector – good practice evidence from Madagascar.

MADAGASCAR: Climate change adaptation of agricaltural value chains in Madagascar

Key facts[21]

LOW-INCOME COUNTRY

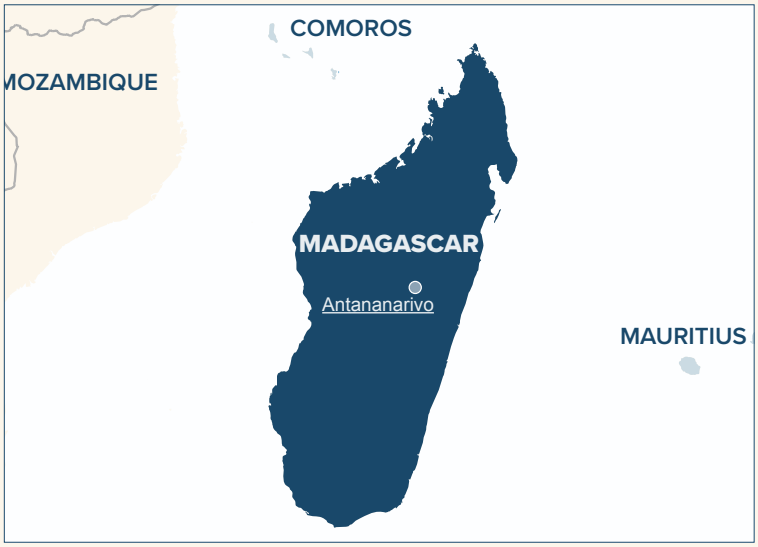
GDP PER CAPITA (PPP, 2019)
- USD 1,720

HDI (2019)
- 0.528 (164th)

GHG EMISSIONS (2017)
- 41.3 $MtCO_2e$ (total)
- 1.6 tCO_2e (per capita)

ND GAIN INDEX (2018)
- 164 (of 181)

Region



21 Data for the key facts is taken from the following sources: Income group, taken from World Bank Country and Lending Groups (World Bank, 2020); GDP per capita, expressed as purchasing power parity (PPP) in current international dollars, taken from World Bank Data (World Bank, 2021); Human Development Index (HDI) value and ranking, taken from 2020 Human Development Report (UNDP, 2020b); GHG emissions, total and per capita, taken from Climate Watch/ CAIT database (WRI, 2021); Notre Dame Global Adaptation Index (ND GAIN), taken from ND GAIN website (ND GAIN, 2020).

Country context

Madagascar is the world's fourth-largest island state, situated in the western part of the Indian Ocean, about 400km east of the African coast. It is widely recognised for its rich biodiversity and unique flora and fauna but, at the same time, is one of the world's poorest countries. The majority of Madagascar's land area is cultivated (70%) and nearly all GHG emissions come from the AFOLU sector (98%), with the largest single source being deforestation. Due to its location in the Indian Ocean, Madagascar is exposed to cyclones and floods and is highly vulnerable to climate change because of a lack of appropriate infrastructure and limited adaptive capacities. The country faces significant climate risks, especially for the agricultural sector that contributes 40% to the country's GDP and employs 80% of its population.

Challenges and opportunities

The most common climate hazards Madagascar is facing are shifting rainfall patterns, prolonged dry spells and droughts. Heavy precipitation events and cyclones are also problematic. These hazards threaten the agricultural sector and the livelihoods of rural communities due to their strong dependency on climatic conditions. These climate risks are exacerbated by the prevalence of small-scale farming and inefficient processing and marketing of agricultural commodities. This is due to limited access to agricultural inputs and technologies, poorly accessible land and a lack of appropriate financing mechanisms to support farmers and activities throughout the value chain. In light of this situation and the dramatic levels of income poverty among the rural population, climate change adaptation initiatives need to focus on no-regret measures with an immediate and visible impact on rural livelihoods. Integrated approaches tackling both climate change and wider SDGs are essential to ensure resilience and sustainability of the interventions.

Engagement of German development cooperation

The bilateral project "Adaptation of agricultural value chains to climate change" (PrAda), supported by BMZ and co-financed by the EU, seeks to foster economically viable and climate-resilient value chains. This project tackles climate risks holistically and aims to:

- Increase risk preparedness through improved climate services for the agricultural sector;
- Reduce risks through selected adaptation actions on the ground; and
- Improve risk retention through the introduction of an index insurance product.

These goals are embedded in a value chain approach targeting the efficiency of the various agricultural activities as well as their structural framework conditions through sound agricultural policies and better organisation and cooperation among actors. The project has a duration of five years (March 2017 to February 2022) with a total budget of EUR 22.8 million. Key partners include the Ministry of Agriculture, Livestock and Fisheries, the National Meteorological Office, the local insurance company ARO as well as a range of additional actors from the private sector. Activities related to climate risk insurance are closely coordinated with the InsuResilience Initiative, where Madagascar is a member country, and its Minister of Agriculture is part of the High Level Consultative Group of the InsuResilience Global Partnership.

Logic of intervention

Objective: economically viable and climate-resilient agricultural value changes

2) Development and adaptation of agricultural values chains

3) Climate risk insurance

1) Climate services for agriculture

Main take away

The PrAda project directly and immediately improves the livelihoods of rural communities by ensuring that their economic activities can be sustained and grow despite adverse climatic conditions. It considers the entire climate risk continuum and brings together the public sector, research institutions and private actors to foster economically viable and climate-resilient agricultural value chains.

Authors: Isabell Kiener and Michael Brossmann / GIZ.
Photo: Rossy Heriniaina/GIZ. Flowchart: GIZ/PrAda

Forestry and Ecosystems

Introduction

Natural ecosystems play a critical role in both climate and development through the breadth of goods and services they provide. For example, they help regulate water flows, improve soil fertility and reduce erosion, improve air quality and provide habitat for biodiversity (IPBES, 2019). Terrestrial and marine ecosystems are major sinks of carbon and have so far sequestered half of global anthropogenic CO_2 emissions annually (IPBES, 2019). Changes in land cover and land use in forest and other natural ecosystems are significant sources of GHG emissions, especially in developing countries (FAO, 2020).

Tropical deforestation is the biggest source of CO_2 resulting from land cover and land-use change. Although this is slowing down, at least 10 million hectares are still deforested annually. This produces around 5 $GtCO_2e$ per year, which is equivalent to at least 7% of total annual anthropogenic emissions (Gibbs, Harris and Seymour, 2018; Ceres, 2020).

Tropical deforestation is mostly driven by commercial agriculture to produce soybean, palm oil, timber and beef in the Amazon and South-East Asian rainforests (Lawson *et al.*, 2014). These commodities are traded globally, making the big importers, namely China, the US and the EU, indirectly responsible for a large proportion of deforestation (Pendrill *et al.*, 2019). Commercial farming remains a minor driver of deforestation in the Congo basin but is rapidly growing (FAO and UNEP, 2020). Furthermore, drainage of peatlands for commercial agriculture emits about 2 $GtCO_2e$ per year (UNEP, 2016), while conversion of coastal wetlands emits around 1 $GtCO_2e$ per year (Pendleton *et al.*, 2012).

Climate change increases existing pressures on forests and other natural ecosystems, which can reverse the storage of carbon. One of the biggest

Logging in lowland rainforest in Sabah Borneo. Photograph: Mint Images

threats is forest wildfires. This is, for example, a growing driver of deforestation in Indonesia as a result of drier and hotter conditions (Austin *et al.*, 2019). Forest health is also adversely impacted by more frequent pest and disease outbreaks as a result of climate change. This affects 35 million hectares per year. These outbreaks affect tree growth and survival rates, with implications for both wildlife and humans (Anderegg *et al.*, 2020). In addition, increasing occurrences of droughts are causing a decline in biomass production and an increase in tree mortality.

The mitigation potential from interventions targeting forests and other ecosystems is considerable. In total, the interventions can provide up to a third of the needed cost-effective mitigation by 2030 (Roe *et al.*, 2019). Avoided deforestation, afforestation and reforestation, forest management and other nature-based interventions can reduce net emissions by up to 24 $GtCO_2e$ per year (Griscom *et al.*, 2017). Peatland interventions can reduce emissions by around 2 $GtCO_2e$ per year, and coastal wetland interventions can reduce emissions by around 3 $GtCO_2e$ per year (Roe *et al.*, 2019).[22]

Nature provides several sustainable solutions to adapt to climate change. For instance, ecosystem-based adaptation (EbA) encompasses a range of strategies that aim to restore, preserve and build on ecosystems to make use of their goods and services. These seek to support populations in adapting to climate change (UNEP, 2015).

EbA is particularly central in developing countries where the population often relies heavily on natural resources for their livelihood. The range of options are extensive and effective interventions are specific to the type of ecosystems. Examples of EbA include reforestation and watershed restoration in mountain ecosystems to build resilience against floods and landslides, rangeland and wetland rehabilitation in drylands and wetlands, respectively, as well as reforestation. In urban areas, the creation of green spaces also helps to protect against floods and mitigate urban heatwaves (UNEP, 2019a).

Interventions targeting forests and other ecosystems (e.g., mangroves and riverine ecosystems) have a significant adaptation potential. Forest ecosystems offer local ecosystem services that reduce the vulnerability of communities and society to climate-related events like floods, heatwaves, extreme weather events, sea-level rise and climate sensitive vector-borne diseases. This helps people to adapt to these changes. Moreover, as climate change affects forests, adaptation measures can help to reduce negative impacts and maintain ecosystem functions.

Figure 28 illustrates the linkages between land-based strategies elaborated in the NDCs and the protection and conservation of terrestrial ecosystems (targets of SDG 15 'Life on Land').

22 Note that cost effectiveness should not be the only criterion to guide the selection of mitigation interventions as such interventions can be linked to complex governance issues and adverse framework conditions that may hamper their implementation.

SDG15 - Life on Land linkages

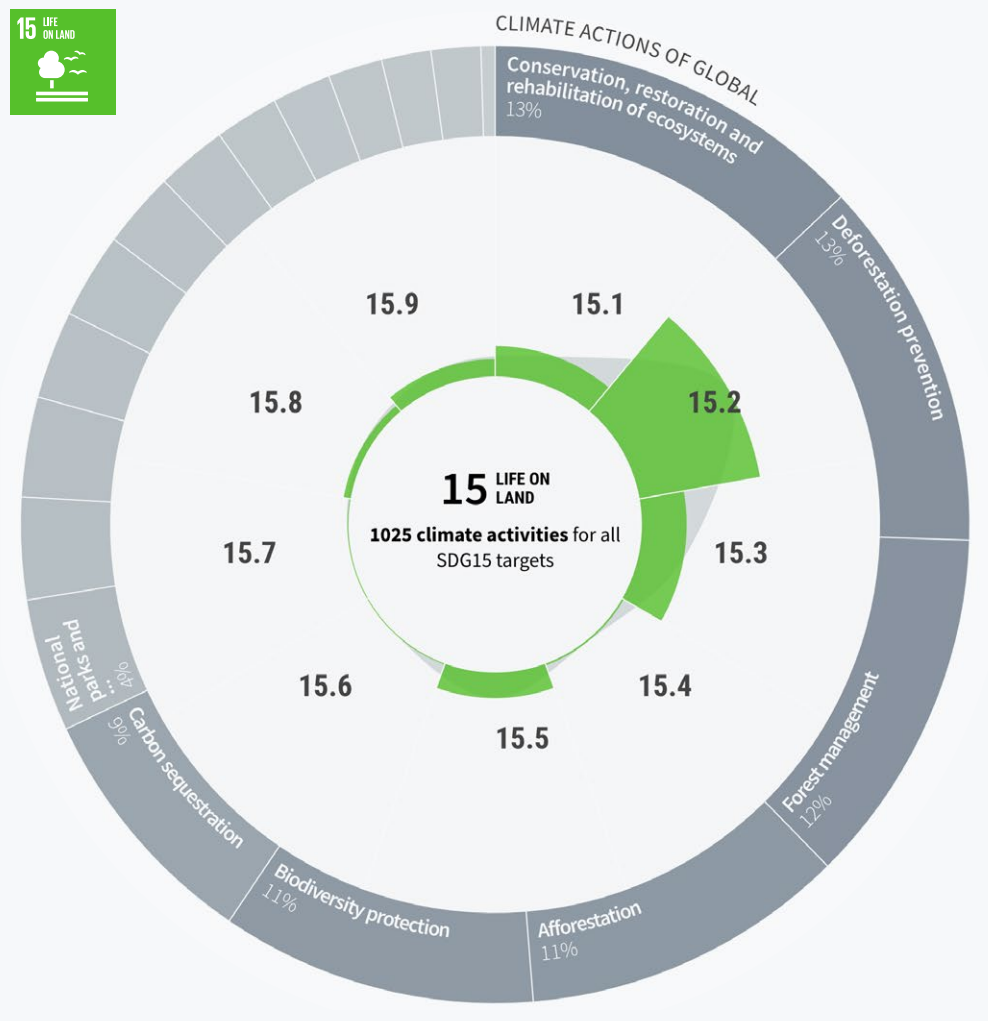


Figure 28
Climate activities in NDCs globally and their link to the forestry and ecosystems sector. The inner coloured bars indicate the share of NDC activities relevant to the SDG targets and the outer circle indicates the shares of these activities corresponding to specific action types (based on NDC-SDG Connections tool, www.ndc-sdg.info).

The international framework for reducing emissions from deforestation and forest degradation in developing countries, REDD+[23], aims to provide economic incentives to developing countries for conserving and protecting forests. This contributes to both mitigation and adaptation objectives. However, 15 years after its creation, even though the rate of deforestation is slowly decreasing in most regions, except Africa, deforestation continues to be high (FAO, 2020e).

One limitation of REDD+, when implemented only at the local level, is the focus on land-use change through smallholder expansion while omitting commercial agriculture, which is the primary driver of tropical deforestation. The scale of successful REDD+ implementation is therefore often constrained by the absence of an enabling environment. The implementation of REDD+ at a jurisdictional and national level supports the creation of an enabling environment for transformational change, including governance and private sector engagement. However, in its current form, REDD+ does not offer adequate economic incentives to stop large-scale land clearing for the

23 REDD stands for "Reducing Emissions from Deforestation and forest Degradation" and is a United Nations-backed framework that aims to curb climate change by stopping the destruction of forests. REDD+ goes beyond deforestation and forest degradation and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (UN-REDD Programme, 2020).

production of more valuable intensive mono-culture crops such as palm oil, soybean and cattle. It is also far from providing sufficient economic incentives to divert from the mining of coals or gemstones (Skutsch and Turnhout, 2020).

Still, there are exceptions to the rule. Countries like Costa Rica, who proactively adopt green economy approaches to foster sustainable land use and forest-based mitigation policy, also stand to benefit from science-policy interfaces like those developed under international schemes like REDD+. Indeed, Costa Rica is recognised as a "frontrunner in developing land-use approaches with a strong reputation for conservation and sustainable forestry" (Wallbott and Rosendal 2018).

Box IX
The mitigation potential of seas and coastal ecosystems

The mitigation potential of seas and coastal ecosystems

The global ocean covers nearly three-quarters of the Earth's surface and contains most of the Earth's water in liquid and ice form (IPCC, 2019a). Oceans play a central role in regulating the Earth's climate via CO_2 uptake and heat exchange. In addition, marine and coastal ecosystems provide food to more than 3 billion people. Oceans also provide energy and multiple benefits for health, well-being, cultural values, tourism and economic development, and thus play an essential role in the realisation of most SDGs (Stuchtey *et al.*, 2020). In addition, the global ocean provides a large number of employment opportunities and contributes around USD 1.5 trillion to the global economy (Stuchtey *et al.*, 2020).

While ocean sinks have sequestered around 30% of total anthropogenic CO_2 emissions since the 1980s, climate change threatens the ocean's ability to sequester more carbon in the long run. Mitigation strategies for marine ecosystems, also called 'blue carbon' strategies, include restoration of vegetated coastal ecosystems, such as mangroves, tidal marshes and seagrass meadows (IPCC, 2019a). While there are no global estimates for the full mitigation potential, restoration of mangroves has the highest carbon sequestration potential per unit of area restored (~9 ton of carbon per hectare (tC/ha)) in comparison to other ecosystems such as wetlands (~6 tC/ha) and forests (~4 tC/ha) (Lovelock and Reef, 2020).

Finally, sustainable use of ocean resources, sustainable fishing, the construction of low-carbon ports facilities and deployment of ocean-based renewable energy infrastructures are all important strategies for achieving the ocean's full mitigation potential (Stuchtey *et al.*, 2020). However, ocean-based mitigation options, as well as more broadly nature-based solutions, remain absent in countries' NDCs (Stuchtey *et al.*, 2020). Particular attention should be given to addressing this gap and supporting the development and planning of ocean-based climate actions. This is particularly key for developing countries, which contribute to 56% of global fish production and trade of fish and seafood (UNCTAD, 2015).

Climate-development interlinkages

Climate-related forest and natural ecosystem interventions have significant co-benefits (e.g., biodiversity conservation, water resources regulation and food and energy security) and relatively few trade-offs for development (e.g., food insecurity and land conflicts) (IPCC, 2019b). Forest, peatland and coastal wetland interventions have positive impacts on most of the SDGs (Table 9 and Table 10). In particular, life on land (SDG 15) and life below water (SDG 14) benefit enormously from most interventions. It is important to consider that mitigation and adaptation interventions in this action area may produce or reinforce trade-offs with respect to other SDGs, namely zero poverty (SDG 1), zero hunger (SDG 2) and decent work and economic growth (SDG 8). However, to avoid or minimise trade-offs, all interventions should undergo an informed consent process realised through Free Prior and Informed Consent (FPIC)[24] and be co-developed with the local communities in order to enhance effectiveness and equity outcomes (Martin *et al.*, 2016; Lehmann, Martin and Fisher, 2018).

Advancing decarbonisation

Table 9
Synergies (green circles) and trade-offs (red circles) between climate mitigation action and SDGs in the action area of forestry and ecosystems (own compilation, based on Gonzales-Zuñiga *et al.*, 2018c).

Avoided or reduced deforestation and forest degradation	
●	Maintains natural habitat for pollinators and benefits 35% of global food production.
●	Provision of products and services for the maintenance of livelihoods and human wellbeing.
●	Forested watersheds provide 75% of freshwater.
●	Natural ecosystems protection.
●	Conflicts on land access for natural resources use and other activities.
●	Competition for land to produce food.
●	Can increase inequalities between large landowners and smallholders.
Afforestation and reforestation	
●	Increased availability of biomass for energy, under afforestation.
●	Improved water regulation, including reduced flooding.
●	Competition for land to produce food.
●	Without adequate land use policy and subsidies, employment and economy can be negatively affected.

24 Free Prior and Informed Consent (FPIC) is a right that is recognised by the United Nations and pertains to indigenous peoples to allow them to give consent and negotiate the terms of use of their territories. It is embedded within the universal right to self-determination (FAO, 2014).

Forest management	
●	Natural ecosystems protection.
●	Contributes to human health and wellbeing, including through provision of clean water.
●	Provision of biomass for energy access.
●	Sustainable use of natural resources.
●	Sustainable growth and innovation.
Avoided or reduced wetland conversion and increased restoration	
●	Protection of peatland ecosystem function and biodiversity.
●	Protection of coastal wetland function and biodiversity.
●	Cleaner water via improved drainage and retention as well as regulation.
●	Conflicts on land access for natural resources use and other activities.

Boosting resilience

Table 10 Synergies (green circles) between climate adaptation action and SDGs in the action area of forestry and ecosystems (based on Gonzales-Zuñiga *et al.*, 2018b).

Ecosystem-based adaptation	
●	Terrestrial ecosystems protection.
●	Contributes to human wellbeing.
●	Protection of water resources and provision of clean water.
●	Improved capacity to produce food via increased adaptation.
●	Provision of biomass.
●	Sustainable growth and innovation.
●	Support for poor populations that rely strongly on natural resources.
●	Protection of aquatic ecosystems.

Main challenges and obstacles

To achieve the full mitigation potential of forest and other ecosystems in developing countries and emerging economies, the successful implementation of forest and other nature-based solutions requires stronger stakeholder engagement, better governance and policy coordination across all sectors. Cost-benefit analysis of options, knowledge transfer and capacity building is also required (WRI, 2018). The following challenges need to be addressed inclusively and sustainably in order to leverage transformational change in this action area.

Power asymmetries among stakeholders

In forests and other natural ecosystems, power asymmetries among stakeholders is a key barrier for the governance and implementation of climate action. Priorities and needs of local communities and indigenous peoples are often dismissed by multinational companies and governments for whom economic growth and investment returns are the priorities. Furthermore, implementation of mitigation and adaptation actions on forested land remains a challenge, especially due to conflicts over land tenure, lack of context-specific knowledge, insufficient financial resources and insufficient dialogues and engagement of local and indigenous communities (Angelsen *et al.*, 2018).

Financial and economic barriers

In terms of potential conflict with national economic development priorities, lack of financial resources is an important barrier to implementing mitigation and adaptation measures in the forestry sector. This is partly due to partial or inadequate assessment of the full benefits of forests and their omission in policy planning (WRI, 2018). Large-scale agricultural expansion, which is more economically profitable, contributes to 40% of deforestation. Deforestation also occurs due to economic pressure from other sectors, such as timber production and infrastructure and transport development.

Land tenure rights

Another crucial barrier is poor governance on land-tenure rights. In Africa, 90% of rural land ownership is undocumented and therefore highly vulnerable to land grabbing for large-scale plantations and cash crop production, which is a key driver of deforestation (Byamugisha, 2013). Land ownership by indigenous tribes in Brazil, for example, have shown to prevent pastureland and soybean expansion into forest area (Oxfam, International Land Coalition and Rights and Resources Initiative, 2016).

Leveraging transformational change

In 2018, OECD DAC countries provided only USD 0.5 billion in official ODA for projects in the forestry sector in developing countries. This is much less than for the agricultural sector (with USD 5.5 billion in 2018). However, ODA allocated to forestry projects has been increasing recently, after a decreasing trend until 2016 (OECD.Stat, 2020). Bilateral and multilateral ODA targeting biodiversity protection amounted to between USD 4-10 billion per year in 2019. This is only 5% of total global biodiversity finance – including national, international and private finance flows – which amounted to USD 124-143 billion in that same year (Deutz *et al.*, 2020).

There are several opportunities to further strengthen policies and interventions that promote a joint approach towards climate action, forest conservation and biodiversity protection in international development cooperation.

Better linking climate and biodiversity action

Context: Climate change and biodiversity loss are interconnected. They are linked through climate change effects on biodiversity and through changes in biodiversity that contribute to climate change. It is therefore necessary to find solutions that advance climate action (mitigation and adaptation) and biodiversity conservation in an equitable and sustainable manner.

From a societal challenge perspective, and also when considering the current funding gaps, highlighting the interconnectivity is essential. Despite biodiversity finance growing over the last years, there is still a significant gap in the finance required to halt biodiversity loss (OECD, 2019). As of 2019, the biodiversity financing gap ranges between USD 598 billion and USD 824 billion per year (Deutz *et al.*, 2020). This gap is one of the challenges hampering the achievement of both the Convention on Biological Diversity's (CBD) Strategic Plan and the SDGs in developed and developing nations (UNDP, 2018; OECD, 2019).

Similarly, while climate finance has been growing steadily and has reached record levels in 2019, investments still fall short of what is needed under a 1.5°C scenario (Buchner *et al.*, 2019). The pressing nature of climate change and biodiversity loss indicates the need to step up financing to combine finance for climate and biodiversity action and also to understand the impacts of such investments. Recent research highlights that the biodiversity (and the climate) financing challenge goes beyond the finance gap and encompasses a set of other related challenges that include, among others, improving governance, understanding its effectiveness and refining allocation mechanisms (Berghöfer *et al.*, 2017).

Opportunity: The relation between biodiversity and climate change is straightforward. Accordingly, a careful design and implementation of nature-based solutions can enable synergies to be harnessed between mitigation, adaptation and biodiversity conservation (Cohen-Shacham *et al.*, 2019). Mainstreaming biodiversity safeguards into climate finance as well as climate

actions into biodiversity finance can help to harness these synergies. To this end, understanding that climate adaptation and the conservation of biodiversity and ecosystems are essential for nature-based solutions and to maximise the co-benefits of climate adaptation, biodiversity could feature more consistently in donor strategies aimed at mitigation.

Role for development cooperation: Development cooperation can help harness the climate-biodiversity synergies and to mainstream biodiversity conservation into climate change finance. This can be done by integrating climate, biodiversity and equity criteria more prominently into project design, implementation and evaluation. The full benefits associated with nature-based solutions, which can occur over longer periods than alternative measures focused on short-term economic returns, also need to be better understood by the population as well as local and regional land-use planners. Therefore, activities that focus on capacity building and knowledge sharing to increase dissemination of information related to nature-based solutions, specifically on their implications for ecosystems' health and the provision of their services, is an important area of support.

Propose regulation for global markets for primary commodities that cause deforestation

Context: Most tropical deforestation continues to occur as a result of growing market demand for a few commodities, namely beef, palm oil and soybean, which leads to cropland and pastureland expansion on primary forests. Hotspots of tropical deforestation include the Amazon basin and Indonesia. The Congo basin, where gross deforestation remained relatively low so far, is recently becoming a new hotspot of rapid deforestation rates (FAO and UNEP, 2020).

Opportunity: Stopping tropical deforestation is a central mitigation strategy necessary to the achievement of the Paris Agreement temperature goal. Economic growth based on export of primary commodities to meet growing demand is a key incentive to cropland and pasture expansion and logging activities, driving around 90% of deforestation in developing countries and emerging economies in Latin America, Africa and Southeast Asia (Curtis *et al.*, 2018). Thus, supporting countries in addressing international drivers of deforestation is essential. Forest conservation strategies must address both demand and supply side simultaneously and create adequate incentives towards deforestation-free supply-chain.

In addition, local/indigenous peoples that rely on forest and other natural ecosystems should be integrated into any relevant intervention. A key aspect is the use of FPIC and other social safeguards, ensuring that interventions do not compromise ecosystem services that are indispensable for local populations.

Role for development cooperation: Development cooperation support can play a role in reforming and regulating EU demand for palm oil, soybean and beef, which are largely imported from deforestation hotspots countries (Rajão *et al.*, 2020). In addition, supporting the development and enforcement of national policy together with the development of real-time remote sensing

techniques can be effective for protecting forested areas. It is also central to supporting policy that formalises and supports truly communally governed forests (Hein *et al.*, 2020). Finally, cooperation strategies can also support the development of ambitious industry standards for improving the transparency of commodity supply chains driving deforestation (Steiner *et al.*, 2020).

Support collective and secure land tenure rights for forest-dependent comunities

Context: The establishment of protected areas (PA) has been at the core of biodiversity conservation interventions and receives strong support from development cooperation. Substantial advances have been made toward the areal component of Aichi target 11. The PA estate has increased by 2.3% on land and 5.4% in the oceans since 2010. It now covers 15% of land and inland freshwater globally and 7% of the oceans (Visconti *et al.*, 2019). However, as species population abundance within and outside PAs continues to decline, the placement and resourcing of the majority of PAs have been poor, and many PAs are suffering increased human pressure (Jones *et al.*, 2018; Visconti *et al.*, 2019; UNEP-WCMC, IUCN and NGS, 2020).

Furthermore, the establishment of many PAs has failed to fully integrate important factors, such as social and cultural local impacts, and contend global and regional political and economic forces driving biodiversity loss (Andrade and Rhodes, 2012).

Opportunity: Communities have an important role to play in biodiversity conservation (Berkes, 2007). Community-based conservation promotes the idea that long-term conservation success requires engaging with and providing benefits for local communities (Brooks, Waylen and Mulder, 2013). However, community-based conservation is not a panacea and addressing indirect drivers of deforestation remains paramount.

Securing tenure and human rights for local communities is an integral part of successful community-based initiatives. The question of collective as opposed to individual rights is pertinent in the forest context since a substantial percentage of forest-dependent communities, especially in the global South, rely on community-based tenure systems (formal or informal) in order to control and access land (Arora-Jonsson and Sijapati, 2018). It can be argued that the effect of increasing land tenure security on forests is context-dependent (Lawlor *et al.*, 2019). However, there is evidence that supporting secure collective land tenure has positive impacts on forest conservation (Blackman *et al.*, 2017; Robinson, Holland and Naughton-Treves, 2017; Blackman and Veit, 2018).

Supporting human rights protection for communities also remains of special importance, particularly under the current scenario where violence against social leaders has increased as a strategy for territorial control and capital expansion in the global South (Prem *et al.*, 2018).

Role for development cooperation: Development cooperation can support the establishment of and compliance with collective and secure land tenure rights in forest-dependent communities. It has also been argued that supporting non-conditional conservation basic income, a novel strategy for funding biodiversity conservation that moves beyond widely promoted market-based instruments, can further support communities and prevent forest degradation (Fletcher and Büscher, 2020). This also highlights the importance of development cooperation supporting in-situ conservation actions outside protected areas, such as Other Effective area-based Conservation Measures (OECMs).

Strengthen the role of indigenous and local knowledge for the conservation and sustainable management of natural resources

Context: Over the past decades, large parts of the terrestrial and marine environment have been significantly altered by human actions, with several indicators related to ecosystems and biodiversity showing a rapid decline. On average, these trends have been less pronounced in areas managed by indigenous peoples and local communities (IPLCs). Yet, for many years, indigenous-led conservation has been largely ignored in favour of top-down conservation schemes (IPBES, 2019).

Opportunity: IPLCs have a long history of managing their land and coastal areas in ways that were adjusted to local conditions over many generations. They often manage these areas based on culturally specific world views, applying principles and indicators, such as the health of the land and reciprocal responsibility. Such management techniques usually remain compatible with, or even support, biodiversity conservation. Hence, the recognition of knowledge and practices of IPLCs and their inclusion and participation in environmental governance can help enhance nature conservation, restoration and sustainable land management, which has relevance for the broader society (IPBES, 2019).

Role for development cooperation: Development cooperation can support the positive contributions of indigenous peoples and local communities to sustainability through actively advancing and recognising different types of knowledge, including indigenous and local knowledge. In this context, the establishment of robust and inclusive governance frameworks and decision-making processes can be supported to enable systematic processes of knowledge generation, collection and synthesis. This can therefore facilitate the incorporation of indigenous and local knowledge into land and coastal area management systems at larger scales (IPBES, 2019).

Evidence from German development cooperation

BMZ is supporting a breadth of mitigation activities focusing on REDD+ and biodiversity conservation in the largest tropical deforestation hotspots, including the Amazon basin, the Congo basin and Indonesia. It also includes the conservation and restoration of mangroves, especially in South-East Asia (e.g., Bangladesh and Vietnam). These activities focus on supporting governments in implementing policies and reforms for ecosystem conservation and protection. In addition, BMZ is working closely with Mexico to support the integration of biodiversity conservation into policy for the agriculture, forestry, fishery and tourism sectors. Regarding adaptation activities, BMZ focuses its support on finance, green and grey infrastructure, food security and on strengthening a climate-resilient agricultural sector (BMZ, 2019a).

An example of how German development cooperation successfully promotes climate action and sustainable development in the forest sector is the project "Getting results from REDD+ to save Indonesians and biodiverse forests" in Indonesia (Box X).

Box X Development cooperation in the action area of forestry and ecosystems — good practice evidence from Indonesia

INDONESIA: Getting results from REDD+ to save Indonesians and biodiverse forests

Key facts[25]

UPPER-MIDDLE INCOME COUNTRY

GDP PER CAPITA (PPP, 2019)
- USD 12,335

HDI (2019):
- 0.718 (107th)

GHG EMISSIONS (2018)
- 1.7 $GtCO_2e$ (total)
- 6.4 tCO_2e (per capita)

ND GAIN INDEX (2018)
- 97 (of 181)

Region

Country context

Indonesia is the world's largest island country. It is located in South-East Asia and Oceania and includes 17,000 islands spread across the Indian and Pacific Oceans. Forest areas cover 94.1 million hectares of Indonesia, which is about 70% of the country's land area, and possess some of the world's most extensive and biologically diverse tropical forests.

With a population of 270 million people, Indonesia is the world's fourth most populous country and was the fifth largest emitter of GHGs in 2017. While most of its emissions result from land-use change and forestry activities (66%), Indonesia's economic growth is largely dependent on land-use activities driving deforestation such as agriculture expansion for palm oil, pulp and paper production (13% of GDP). Mining for coal, copper, gold, tin, bauxite and nickel also makes up 5% of GDP. However, in its NDC, Indonesia has committed to reduce its GHG emissions by 29% below BAU by 2030, which would require sustainable forest management as well as sustainable agricultural supply chain policies.

25 Data for the key facts is taken from the following sources: Income group, taken from World Bank Country and Lending Groups (World Bank, 2020); GDP per capita, expressed as purchasing power parity (PPP) in current international dollars, taken from World Bank Data (World Bank, 2021); Human Development Index (HDI) value and ranking, taken from 2020 Human Development Report (UNDP, 2020b); GHG emissions, total and per capita, taken from Climate Watch/ CAIT database (WRI, 2021); Notre Dame Global Adaptation Index (ND GAIN), taken from ND GAIN website (ND GAIN, 2020).

Challenges and opportunities

Uncontrolled expansion of agriculture and extractive activities is one of the main drivers of deforestation. The necessary GHG emission reductions to achieve the temperature goal of the Paris Agreement require a fundamental change in how forests are used and regulated. The changes must avoid deforestation and peat decomposition and reduce forest degradation while increasing carbon stocks by planting trees and rehabilitating forests. Indonesia faces the challenge to sustain economic growth in rural areas while at the same time preventing unsustainable use of its natural resources.

Furthermore, due to the COVID-19 pandemic and the travel restriction bans, on-the-ground monitoring of forests decreased in 2020, resulting in a sharp increase in illegal logging and deforestation, particularly in the last remaining intact forest landscapes of Eastern Indonesia.

Engagement of German development cooperation

To address weak land rights in forests, the governance structure for forest management in Indonesia was decentralised. It now requires national, regional and local institutions to increase their capacity and receive additional financial resources to strengthen the new institutional framework.

The Forest and Climate Change (FORCLIME) Programme plays a crucial role in supporting this reform process by pursuing a multi-level approach that focuses on capacity development at the national, provincial and district levels. It also supports local governments in setting up forest management units and demonstration activities for the UNFCCC-anchored process on Reducing Emissions from Deforestation and Degradation (REDD+). In doing so, the programme successfully integrates biodiversity conservation, climate change mitigation and sustainable economic development. As a result, Indonesia has established Forest Management Units (FMU), which formally manage over 90 million hectares of forests, contributing to the reduction in annual deforestation from approx. 0.9 million hectares per year in the period between 1990 and 2012 to under 0.5 million hectares per year in 2019. This achievement was recently rewarded with large-scale performance-based payments as part of the REDD+ climate finance mechanism.

Main take away

FORCLIME has strengthened the institutional framework and capacity to enhance local forest governance in Indonesia, contributing to significant reductions in deforestation and GHG emissions, thereby successfully addressing the global climate and biodiversity crises.

Authors: Gerd Buchholz / GIZ.
Photo: Forest inventory activity in Desa Benua Tengah, Kapuas Hulu. Photo by Dominik Schwab.

Water

Introduction

Water is a critical resource for life on earth. Like land and climate, it is an integral part of the 'safely operating biosphere', which is required for the achievement of social and economic goals (Rockström and Sukhdev, 2016). Through their provisioning, supporting and cultural ecosystem services, water and aquatic ecosystems, are essential for human survival and development (Grizzetti *et al.*, 2016).

Climate change will affect future water availability through increased seasonal variability of precipitation as well as increased mean evaporation (Konapala *et al.*, 2020). This holds true, even though regional variation in climate change impacts needs to be taken into account. Rising temperatures already result in more variable peak flows and will reduce base flow in glacial rivers in the longer term (UNESCO and UN-Water, 2020). Moreover, rising temperatures (including water temperatures) affect water quality by increasing pollutant and pathogenic contamination (UNESCO and UN-Water, 2020). A 2°C rise in global temperature could increase the number of people suffering from water scarcity by an additional 40% compared to the effects of population growth alone (Kerres *et al.*, 2020).

Global water use increased by a factor of six over the past 100 years and continues to grow at a rate of about 1% per year. This is driven by population increase, economic development and shifting consumption patterns (UNESCO and UN-Water, 2020). At the same time, over 2 billion people, primarily in Northern African, Western, Central and Southern Asian regions, live under water stress (UN, 2017a). In contrast, another estimate concludes that about 4 billion people suffer from seasonal water scarcity (Mekonnen and Hoekstra, 2016). Climate change will exacerbate existing and increasing water scarcity

Woman filling up canisters with clean water. Photograph: SOPA Images Limited

trends and risk undermining economic growth and human health and well-being, especially of poorer populations (IPCC, 2018a). Such water scarcity can prompt migration and act as an aggravator of violent conflicts.

SDG6 – Clean Water and Sanitation linkages

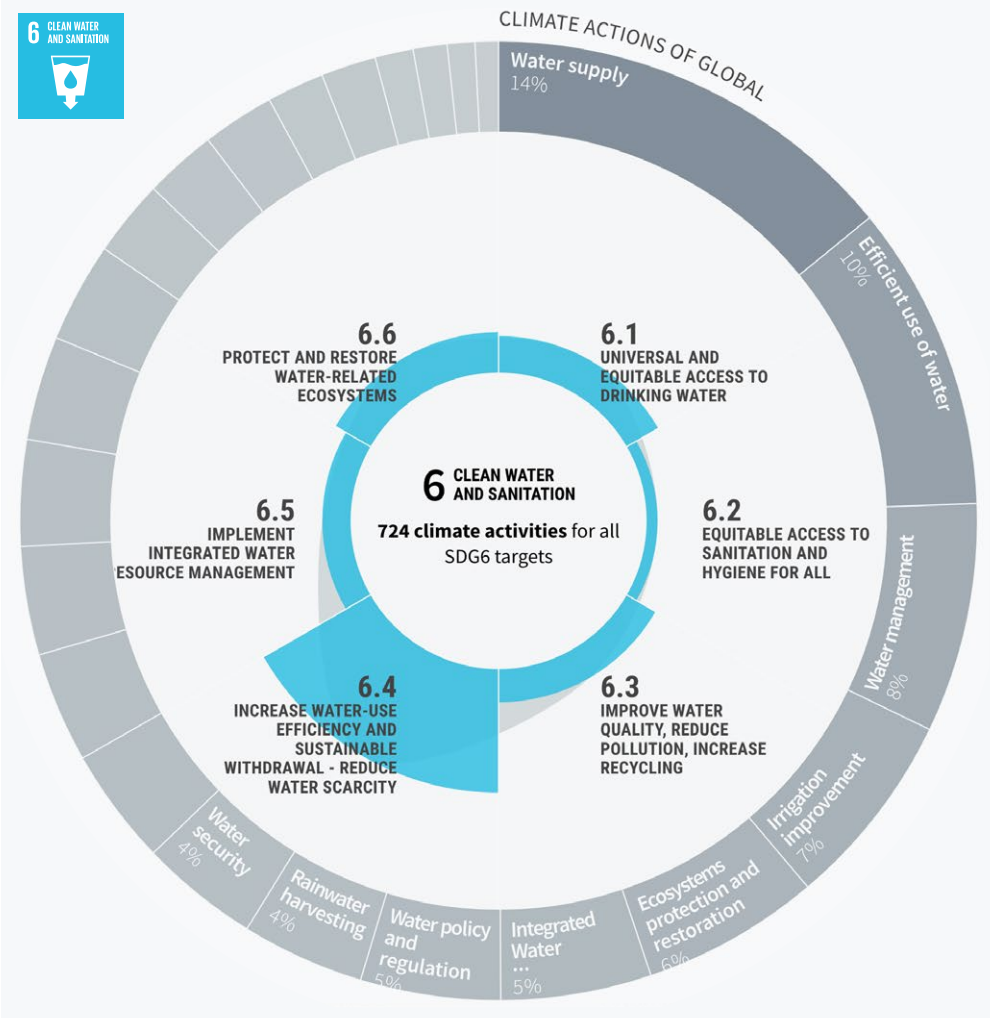


Figure 29
Climate activities in NDCs globally and their link to the water sector. The inner coloured bars indicate the share of NDC activities relevant to the SDG targets and the outer circle indicates the shares of these activities corresponding to specific action types (based on NDC–SDG Connections tool, www.ndc-sdg.info).

Moreover, water use is inextricably linked to energy use. Abstraction of water from its source (ground or surface) and treatment of wastewater from various domestic, agricultural and industrial sources are all energy-intensive to varying degrees. Accordingly, the water sector offers enormous potential for emissions reductions. Since energy consumption in the water sector is currently primarily based on fossil-fuels, any improvement in water-use efficiencies in different sectors will reduce emissions. Besides, water-efficient irrigation techniques will also result in reduced methane emissions, particularly for rice, by up to 48% (Richards and Sander, 2014). At the same time, water scarcity and climate variability also pose a threat to the reliability of thermoelectric power generation, which needs water to spin turbines and for cooling (van Vliet *et al.*, 2016).

Unequal distribution of water resources may increase the marginalisation of the poor and eventually affect overall economic and human development. In conjunction with poor water quality this also leads to an increase in direct health risks, including increased morbidity and mortality from infectious diseases such as diarrhoea. These are transmitted through contaminated water, contaminated food or vector-borne diseases such as malaria (Bonk, 2020). In addition, climate change through extreme weather events, floods or sea-level rise leads to a number of secondary health risks (i.e., food shortages) and tertiary health risks (e.g., through loss of housing or displacement) (Smith *et al.*, 2014; WHO, 2017). Water-related extreme events, the frequency of which is projected to increase because of climate change, will therefore directly affect public health (SDG 3). Moreover, insufficient water, sanitation and hygiene (WASH) infrastructure may further lead to aggravated outbreaks of communicable diseases and pandemics like COVID-19 (Baldwin *et al.*, 2016).

The combination of current trends in water use, its unequal distribution and the projected increase in scarcity of freshwater, as well as these trends' links with land use, agriculture and the health and energy sectors, will pose incremental challenges to the implementation of the 2030 Agenda. Achieving the SDGs, therefore, requires strategies for increasing the water sector's resilience to climate change as well as for reducing the GHG emissions in the development and use of water resources across sectors. The importance of the water sector to combat and adapt to climate change is evident in the direct interlinkages of 639 climate actions (NDCs) with SDG 6-related targets (Figure 29). Of these, 41% contribute to the target of increasing water-use efficiency across all sectors, which is a key mitigation measure in the water sector (Figure 29).

There are many facets to capitalising on the links between climate policy and sustainable water governance. In Chile, for instance, interactions between national government policy and regional and local levels yield substantive institutional innovation to enhance climate change adaptation in relation to the water sector and, specifically, urban water governance in the Santiago de Chile metropolitan region (Patterson and Huitema, 2018; Patterson, de Voogt and Sapiains, 2019). Chile is thus proactively responding to the challenges of reconciling urban water priorities and related adaptation needs with national water governance and pertinent socioeconomic challenges (Patterson and Huitema, 2018).

Climate-development linkages in the water sector

Links between climate and water resources are affected by a variety of anthropogenic factors, including but not limited to land use and land cover change (LULC), water regulation and withdrawal systems and water contamination (UNESCO and UN-Water, 2020). All of these linkages are crucial for social and economic development. The 2030 Agenda, with its goals and targets, provides a comprehensive framework for action to achieve social, ecological and economic sustainability.

As per Nilsson *et al.*'s (2016) framework for identifying interdependencies among SDGs and their targets, technical and institutional solutions in the water sector that improve water availability, quality and its use-efficiency in other sectors have an 'indivisible', 'reinforcing' and 'enabling' influence on the achievement of SDG 6 (clean water and sanitation). It also enables equitable water access to multiple users for multiple uses (Hall, Ranganathan and Raj Kumar, 2017). Furthermore, they also have a 'reinforcing' influence on the following SDGs:

- SDG 1 — no poverty
- SDG 2 — no hunger
- SDG 3 — good health and well-being
- SDG 5 — gender equality
- SDG 8 — inclusive growth, and
- SDG 10 — reduced inequalities.

Sustainable solutions in the water sector are further considered to have indirect 'enabling' influence on:

- SDG 4 — education
- SDG 7 — energy
- SDG 9 — resilient infrastructure
- SDG 11 — resilient cities
- SDG 12 — sustainable consumption and production
- SDG 13 — climate change mitigation and adaptation, and
- SDG 14 and 15 — sustainable ecosystems. (Hall *et al.*, 2017).

Beyond the synergies between climate and sustainable development agendas, it is important to understand the interdependencies among various SDGs that depend on water resources. Existing food, water and energy insecurities and projected increase (40 to 50% by 2030) in their demand will increase the competition for water and land. Analysis of interdependencies among targets of SDGs 2 (food), 6 (water) and 7 (energy) based on their input and infrastructure needs as well as risks and benefits reveal that SDG 6 (water) has the highest number of potential synergies (Fader *et al.*, 2018). Therefore, it is important to improve the resilience of water resources to climate change in order to achieve SDGs associated with different sectors.

Simultaneously, adopting low-emission strategies for water development and use in order to achieve other SDGs can significantly contribute to climate change mitigation. As a result, it is important to develop coherent strategies by tapping synergies and avoiding trade-offs while implementing multiple global agendas on climate, sustainable development and disaster risk reduction. The following tables (Table 11 and Table 12) depict key interlinkages of mitigation and adaptation measures in the water sector with different SDGs and their targets.

Advancing decarbonisation

Table 11
Synergies (green circles) and trade-offs (red circles) between climate mitigation action and SDGs in the water sector (own compilation, based on Gonzales-Zuñiga *et al.*, 2018c).

Water use efficiency to reduce emissions from soils and energy demand	
●	Improved food security as a result of increased availability and access to water for irrigation.
●	Improved health and sanitation as a result of improved access to freshwater.
●	Better employment opportunities resulting from increased water availability as a result of improved efficiency.
●	Improved access to basic services (water).
●	Protection of soils from degradation and reduction of GHG emissions release, for instance from rice paddies.
●	Reduced water-related energy demand.
Solar irrigation pumps	
●	Increased share of clean, reliable and modern energy sources in the energy mix.
●	Increased agriultural productivity leading to better incomes for farmers.
●	Increased agricultural productivity leading to improved food security.
●	May lead to over-extraction of groundwater in regions facing high water scarcity.
Effective control and abatement of water pollution	
●	Sound management of chemicals and wastes.
●	Treated wastewater agriculture leading to food security in peri-urban areas.
●	Improved access to basic services (water) leading to better health and hygiene.
Ecological methods of wastewater treatment	
●	Protection and sustainable management of water ecosystems.
●	Reduced energy demand for wastewater treatment.
●	Protection and sustainable management of land ecosystems.
Nature based conservation of natural wetlands	
●	Protection of soils and ecosystems on land and an increase in carbon storage.
●	Livelihood security for people depending on wetlands for freshwater and food.
●	Protection of coastal wetland ecosystems.

Boosting resilience

Table 12 Synergies (green circles) between climate adaptation action and SDGs in the water sector (based on Gonzales-Zuñiga *et al.*, 2018b).

Rainwater harvesting and water conservation measures	
● Improved health and hygiene due to imroved access to water and sanitation services.	
● Improved food security due to increased availability of water for irrigation.	
● Increased incomes from agriculture due to availability of water for irrigation and increased resilience to climate variability.	
● Improved access to quality education due to improved access to water and sanitation.	
Nature based conservation of natural wetlands	
● Protection of soils and ecosystems on land and an increase in carbon storage.	
● Livelihood security for people depending on wetlands for freshwater and food.	
● Protection of coastal wetland ecosystems.	

Main challenges and obstacles

Insufficient knowledge on water resources and lack of capacities to monitor and manage water resources

In a World Bank review of surveys conducted on hydro-meteorological monitoring capacities of developing countries, only 9% of countries were found to have adequate capacity and 80% of countries had inadequate or poor and declining capacities to monitor water resources (World Bank, 2018). Accordingly, the lack of capacity to monitor and manage water resources is identified as a key constraint to Integrated Water Resources Management (IWRM), second only to financial constraints for infrastructure development and management (UNEP, 2018). Moreover, the density of observation networks and data quality on water resources are often particularly low in areas that are most vulnerable to the impacts of climate change (Kerres *et al.*, 2020). Furthermore, conflicts of interest between agencies hinder data accessibility and national competencies for data management often fall behind international requirements *(ibid.)*.

Institutional misfit — fragmented and ineffective governance

Although water stress and resulting crises manifests at local or sometimes also national and transboundary levels, its drivers are linked either directly to global water-intensive consumption patterns or indirectly when these patterns affect water availability through climate change (Herrfahrdt-Pähle *et al.*, 2019). While such spatial, temporal and inter-sectoral links exist among water availability,

quality and management, and global social and economic development, its governance is often fragmented along sectoral and jurisdictional boundaries (Herrfahrdt-Pähle *et al.*, 2019). Policy instruments designed to promote water conservation may be offset by policy instruments that promote indiscriminate use of water. For example, electricity subsidies for water-intensive crops are counterproductive as they promote over-extraction of groundwater in regions of high water scarcity. Further, only 59% of the transboundary basins, which account for more than 60% of the global freshwater flows, are currently governed by a transnational cooperative operational arrangement between concerned countries, which is essential for their socially and ecologically sustainable management (UN, 2020). The IWRM framework, which is one of the targets (6.5.1) under SDG 6, still suffers from very low, low or medium-low implementation levels in 60% of the countries that reported in 2018 (UN, 2020). The SDG Report 2020 indicates that coordination in practice does not occur in managing the water resources. In some cases, such coordination may exist at the national level, but does not percolate to the ground level implementation (UN, 2020).

Inequitable access to water resources

Water governance frameworks in many developing countries favour the capture of water resources by the powerful, with marginalised sections of the population struggling for access. Accordingly, huge disparities in water access persist and efforts need to focus beyond water availability and on to water equity (Calow and Mason, 2014). There are spatial and temporal variations in interactions among human interventions to address water scarcity (Calow and Mason, 2014). Human interventions to address water scarcity in the upstream regions of rivers is causing water scarcity in the downstream regions. Reforms towards privatising water resources have only led to further alienation of marginalised sections of society. To establish common property regimes for water, efforts to devolve water resource management to a community level have also proved insufficient (Bues and Theesfeld, 2012; Meinzen-Dick, 2014).

Access to finance

Insufficient finance is one of the main reasons for the lack of integrated governance frameworks for water. Budgets for infrastructure maintenance and capacity development for monitoring and service delivery do not match the demand for these services. In 20 developing countries, there is a funding gap of 61% for achieving their water and sanitation targets (SDG 6) (UN, 2020). Increased financial capacities are also crucial for achieving SDG target 6.5 on sustainable water resource management, which is linked to all other targets under SDG 6 on access to water and sanitation. Yet, three-quarters of all countries report insufficient funds for planned investments in IWRM at national and sub-national levels (UNEP, 2018). Accordingly, the water sector warrants an increasing allocation of climate finance to realise the full potential of sectoral emissions reductions.

Leveraging transformational change

The water crisis continues to be one of the top five global risks according to the 2019 World Economic Forum (WEF, 2019). Accordingly, the water sector has been receiving increasing attention in development cooperation over the past decade and a half. Although there was an increase in the share of the water sector in the total ODA flows from 2006-07 until 2012-13 (7.2%), the ODA flows to the water sector decreased both in absolute terms and in relative terms (5.5%) in the total ODA flows in 2014-15. The increase in the overall official financial flows is attributed to a consistent increase (13% annually) in the Other Official Flows (OOF)[26] to about USD 6 billion in 2014-15 (OECD, 2017). While low- and middle-income countries (LMICs) received 40% of the official flows, upper middle-income countries (UMICs) and least developed countries (LDCs) received 33% and 22% respectively in 2014-15. Regionally, Asia has been the largest recipient with 45% of the official flows, followed by 27% for Africa and 18% and 6% for Americas and Europe respectively (OECD, 2017). The majority (59%) of all the interventions were to build and improve water supply (20%), sanitation (20%) and water and sanitation (19%) infrastructure. Water policy and resource conservation received 14% and the development of river basins benefited from 2% of the overall flows (ibid.). Moreover, a lot remains to be tapped in the water sector mitigation potential, which received only 1% of the total climate financing allocated to mitigation (93.8%) in 2016 (UNESCO and UN-Water, 2020).

On balance, current approaches seem to prioritise climate change adaptation and thereby respond to the relatively higher vulnerability of many least developed countries to climate risks. However, the enormous mitigation potential of the water sector must not be overlooked. As water transects sectoral boundaries, some of the mitigation options are addressed in other sectors, notably energy and agriculture. Yet, it is important to ensure coherence with the strategies and capacities within the water sector, too.

Technologies and policies for water use efficiency across sectors

Context: There is currently insufficient support to increase the adoption of water-efficient technologies, policies and practices in different sectors. The agricultural sector, which is currently dominated by smallholder farmers and accounts for over 70% of the total freshwater usage globally, has a huge potential to increase its water use efficiency. Unsurprisingly, this is the area where support is most required as the farmers need technical and financial support to adopt water-efficient irrigation technologies. The so-called 'tragedy of the commons' also often applies to freshwater supplies. Therefore, any technological solution will not be sustainably adopted and maintained unless

26 Grants to developing countries for representational or essentially commercial purposes; official bilateral transactions intended to promote development, but having a grant element of less than 25%; and, official bilateral transactions, whatever their grant element, that are primarily export-facilitating in purpose' (Source: https://data.oecd.org/drf/other-official-flows-oof.htm)

they are supported by a conducive institutional environment (that supports the judicious use of irrigation water). Similar technical measures (e.g., low-cost water meters) are also suitable for promotion among urban households to inform better planning, pricing and maintenance of water supply systems (UN, 2017b).

Opportunity: There are several options to increase water use efficiency in different sectors. For example, efficient irrigation technologies and practices, policies that promote water-use efficiencies (e.g., reallocating incentives from water-intensive to water saving crops) can reduce the demand for water and therefore energy, thereby avoiding the related emissions. Further, a water efficient irrigation regime for crops such as rice will reduce the CH_4 and N_2O emissions, which currently amount to at least 2.5% of the total GHG emissions.

Role for development cooperation: As indicated by Figure 29, several NDCs are already aligned with the SDG 6 target on water use efficiency. However, owing to the governance challenges that follow from the 'common pool resource' that water is, technical measures are insufficient to improve water use efficiency in different sectors. Therefore, while promoting the adoption and maintenance of water-use efficiency across sectors, the piloting and upscaling of suitable combinations of organisational and technological innovations also need to be considered. As long as incentives to overuse water persist due to inappropriate institutions and governance mechanisms, technical solutions are unlikely to be sustained beyond the external financing period.

Development cooperation to advance water governance reform must also emphasise the avoidance of trade-offs among different sectoral policies that may harm water use efficiency. Moreover, stakeholders in partner countries should be assisted in accessing climate finance for mitigation strategies that maximise water use efficiency.

Capacity development for monitoring of water resources and maintenance of water resources infrastructure

Context: LDCs typically lack the capacity to monitor their water resources adequately. However, monitoring is crucial for developing and implementing water management plans (World Bank, 2018). Initiatives addressing the capacity needs have not penetrated so far into important water-use sectors such as agriculture, environment and urban planning (UNEP, 2018). Furthermore, lack of monitoring and updating data on water resources also constrains the countries' preparedness for disasters. This exposes already vulnerable groups to increased risks of climate-induced disasters.

Water development and supply infrastructure also suffers from poor maintenance leading to deterioration and ultimately dysfunction of the infrastructure. Hence, the need to support the development and implementation of specific need-based capacity development plans for different water-use sectors is increasingly urgent in many developing countries.

Opportunity: While water supply infrastructure is receiving the required attention, the inclusion of infrastructure and capacities for monitoring the water resources at various levels could lead to generation of better data and analysis. A decision support system that encompasses all water use sectors would lead to better planning and implementation of strategies based on risk assessment. IWRM is implemented in many countries to varying degrees depending on their social, political and ecological complexities. Strengthening the capacities of different governmental and non-governmental stakeholders in monitoring water resources and maintenance of related infrastructure at various levels of IWRM would facilitate effective planning and implementation of water management.

Role for development cooperation: Capacity development plans, elaborated and adapted to local conditions and taking into account local knowledge and expertise, should support IWRM implementation. Programmes aimed at improving the water sector should seek to develop and implement a monitoring network based on different needs in different locations and with commensurate capacity to integrate data from various sources. It also needs to ensure commitment from partner countries to create required institutional arrangements and financial allocations to maintain monitoring networks and infrastructure.

Technical and institutional solutions for wastewater reduction, treatment and reuse

Context: More than 80% of the wastewater in the developing countries is discharged back into the water resource system untreated (Kundzewicz and Krysanova, 2010). It is currently irrigating 36 million hectares (equivalent to the size of Germany) of cropland in the peri-urban areas globally (Thebo *et al.*, 2017; UNESCO and UN-Water, 2020). This poses a risk to public health and increases the required expenditure in the sector. Furthermore, to access safe water resources, including across long distances, securing freshwater to urban areas with polluted surface water and groundwater aquifers requires expensive infrastructure. It may also cause additional carbon emissions as such distribution is often based on fossil-fuel energy.

Opportunity: Decentralised technical solutions to treat wastewater at the source, such as constructed wetlands, have been found to be successful (Capodaglio *et al.*, 2017; Kaushal, Wani and Patil, 2019). Yet, they vary depending upon the type of pollutants and other biophysical and social, economic and political contexts. Incentives for private actors in developing countries to participate in wastewater treatment are also very low (for India, see (Never and Stepping, 2018). Untreated wastewater and sludge also emit high amounts of GHGs, making their treatment eligible for climate finance directed at funding mitigation. Significant reforms of the governance of water pollution abatement are required in order to provide the right incentives for different actors (state, industry, civil society and academia) in identifying and implementing solutions for reducing, treating and reusing wastewater.

Role for development cooperation: Ecological methods of wastewater (sewage) treatment, such as constructed wetlands, should be supported where suitable as they yield co-benefits for climate and local natural resources. Development cooperation could also support stakeholders in partner countries in accessing climate finance for the treatment of wastewater. The new supply chain regulation ("Lieferkettengesetz"), could be leveraged to also account for virtual water trade or the water footprint involved in the supply of agricultural commodities and other raw materials.

Water governance reform

Context: Owing to cross-sectoral and cross-scale linkages of water and other social, ecological and economic goals, successive SDG Reports show that while dialogue and cooperation across sectors occurs at the national level, it does not percolate down to lower levels of governance and implementation, often owing to lack of capacities. Poor implementation of IWRM, which also depends on cross-sectoral coordination, is also primarily attributed to a lack of capacities at different levels of water resources management. Hence, capacity development for monitoring water resources, sharing data among relevant stakeholders in different sectors and broad-based planning and implementation needs to be prioritised.

Opportunity: Most SDGs either depend on water resources or affect water availability and quality. Integrated strategy development and implementation needs to overcome sectoral fragmentation, existing power structures and vested interests across levels, and include marginalised social groups. To achieve this, there is a need for significant reforms in water governance which considers "well-defined and publicly available reform objectives; transparency in decision-making and public access to available data; water valuation of uses and non-uses to assess trade-offs and winners and losers; compensation for the marginalized or mitigation for persons who are disadvantaged by reform; reform oversight and "champions"; capacity to deliver; and resilient decision-making" (Grafton *et al.* 2019).

Role for development cooperation: Further to assisting partner countries with the development of infrastructure for efficient water supply and sanitation services, it is also important to make such assistance conditional on climate-resilient land use planning, especially in urban areas, as the increasing frequency of extreme rainfall events increases the risk of fluvial flooding (Andimuthu *et al.*, 2019; Ramachandran *et al.*, 2019). This adversely affects the water supply and sanitation infrastructure and services, especially in informal urban settlements. Therefore, any assistance to improve water supply and sanitation services needs to be planned and implemented in close collaboration with other sectors that focus on sustainable, climate-resilient urban development. Initiatives to strengthen the capacities of urban local bodies in understanding the implications of climate change on their water security would enable them to negotiate their water rights in a better way.

Evidence from German development cooperation

Germany is one of the three largest donors for water sector improvement, providing on average EUR 600 million annually between 2014 and 2017 (BMZ, 2019d). Water supply and sanitation infrastructure and services received USD 1.7 billion of the total USD 8.4 billion of bilateral ODA that Germany allocated to social infrastructure and services in 2018 (OECD, 2020). BMZ's Water Strategy aims to provide a guiding framework for all its activities and puts them in the context of achieving the 2030 Agenda, Paris Agreement and other relevant global agreements. The strategy is centred on the human rights-based approach to water and adherence to the 'leaving no one behind' principle of the 2030 Agenda. It further identified six separate strategies for managing the cross-sectoral interlinkages, highlighting interdependencies with the water sector (BMZ, 2019b). Each strategy addresses the interlinkages among different sets of SDGs and targets, including climate goals (SDG13). As a result, 94% of Germany's bilateral assistance in the water sector had climate (80%) or other environmental (14%) focus in 2018, either as principal or significant objective, which is the highest of all sectors (OECD, 2020).

An example of how German development cooperation successfully engages in climate action and sustainable development in the water sector is the project "NDC support and reducing emissions from energy use and wastewater management" in Zambia, which began in 2019 (Box XI).

Box XI
Development cooperation in the water sector — good practice evidence from Zambia

ZAMBIA: NDC support and reducing emissions from energy use and wastewater management

Key facts[27]

LOWER MIDDLE-INCOME COUNTRY

GDP PER CAPITA (PPP, 2019)
- USD 3,624

HDI (2019)
- 0.584 (146th)

GHG EMISSIONS (2017)
- 93.2 $MtCO_2e$ (total)
- 5.4 tCO_2e (per capita)

ND GAIN INDEX (2018)
- 136 (of 181)

Region

Country context

Zambia is a landlocked, resource-rich country with sparsely populated land in the centre of Southern Africa. After 15 years of significant socio-economic progress and achieving lower middle-income status in 2011, Zambia's economic performance has stalled in recent years. In 2019, economic growth declined significantly.

The country is located within the watersheds of two of Africa's major river basins — the Congo, which is the second longest after the Nile, and the Zambezi, which is the fourth longest river in Africa. Approximately 40% of the Zambezi Basin lies within Zambia. Although Zambia's economy has not been carbon-intensive, it is very vulnerable to the impacts of climate change. Agriculture is predominantly rainfed and is the main source of rural livelihoods in the country and therefore increasingly vulnerable under the predicted increased frequency of droughts and dry spells. Therefore, adaptation to climate change and water are key areas for development cooperation between Zambia and Germany. This includes drinking water, wastewater and water resources management.

27 Data for the key facts is taken from the following sources: Income group, taken from World Bank Country and Lending Groups (World Bank, 2020); GDP per capita, expressed as purchasing power parity (PPP) in current international dollars, taken from World Bank Data (World Bank, 2021); Human Development Index (HDI) value and ranking, taken from 2020 Human Development Report (UNDP, 2020b); GHG emissions, total and per capita, taken from Climate Watch/ CAIT database (WRI, 2021); Notre Dame Global Adaptation Index (ND GAIN), taken from ND GAIN website (ND GAIN, 2020).

Challenges and opportunities

Zambia has been experiencing adverse impacts of climate change, including a decrease in rainfall, an increase in frequency and severity of seasonal droughts, occasional dry spells, flash floods, extreme temperatures and changes in the growing season. These increases in climate variability and weather extremes have a direct impact on water supply, water resources and sanitation systems as well as hydropower electricity production. Zambia's National Determined Contribution (NDC), its current National Development Plan and the National Policy on Climate Change all aim at climate resilient and low- carbon development. Adaptation measures include the promotion of irrigation and efficient use of water resources, strengthening early warning systems and preparedness.

Engagement of German development cooperation

The Reform of the Water Sector Phase II (RWS II) Project supports Zambia's climate-smart transformation by developing improved GHG emissions reporting for six selected Commercial Utilities through the implementation and use of the Energy Performance and Carbon Emissions Assessment and Monitoring (ECAM) Tool. "ECAM" is an open-source tool developed by the GIZ Water and Wastewater Companies for Climate Mitigation (WaCCliM) Regional Project and the International Water Association (IWA). It enables utilities to quantify their GHG emissions and contributions to NDCs. In addition, it offers solutions for reducing emissions from energy use and wastewater management. It also provides an opportunity to leverage climate funding for the commercial utilities to strengthen resilience. The project runs from September 2019 to December 2022 with funding of EUR 11.5 million. The political partners are the Ministry of Water Development, Sanitation and Environmental Protection (MWDSEP) and the Ministry of Higher Education (MoHE).

Main take away

The project is pivotal in developing monitoring and reporting capacity and implementing Zambia's NDC and national development policies, thereby contributing to the achievement of governmental objectives and the aspirations of the people of the Republic of Zambia. approaches tackling both climate change and wider SDGs are essential to ensure resilience and sustainability of the interventions.

Authors: Peter Kammerer, Doreen Mbalo, Amanda Mallaghan / GIZ.
Photo: Smallholder farmer irrigating his field in Zambia. Photo by Eitan Simanor / Alamy.

3 Conclusions

In view of the multiple crises facing the world, unprecedented efforts are required to achieve resilient, climate-compatible and sustainable development on a global scale. Avoiding unmanageable climate change and managing its unavoidable impacts requires ambitious and coherent action towards the objectives of the Paris Agreement. In this context, the quest of "transforming our world", as stipulated in the 2030 Agenda, presents a universal and cross-cutting challenge, which is further compounded by the ravaging COVID-19 pandemic and its unforeseeable long-term consequences.

Developing countries' emissions are rising

Considering the severity of the climate crisis – particularly for the most vulnerable communities – and the prospects for a successful implementation of the Paris Agreement, it is evident that all countries must pull together to bring the world on track to meeting its targets. Already today, developing countries and emerging economies represent roughly two-thirds of annual global GHG emissions. Moreover, their absolute and relative shares of emissions are projected to increase further in the foreseeable future.

Current commitments are insufficient to achieve the goals of the Paris Agreement

As of May 2021, 190 Parties to the UNFCCC have submitted a first NDC, and 55 countries have updated their NDC target. However, the ambition level of NDCs differs widely across countries and is, on aggregate, insufficient to meet the Paris Agreement's goals. In recognising the projected emissions trend in developing countries and emerging economies, it is important to implement rapid and effective climate action in these countries, notwithstanding the historical responsibility of industrialised nations.

Climate change and sustainable development are strongly interlinked

Missing the Paris Agreement's goals will inevitably undermine sustainable development. On the one hand, climate change exacerbates existing inequalities and makes it increasingly difficult to achieve the SDGs. On the other hand, countries' development pathways have substantial implications for their future GHG emissions and their level of climate resilience. Therefore, it is paramount to consider the climate-development-nexus in the design of climate- and development-oriented action in order to maximise synergies and minimise trade-offs between mitigation, adaptation, and the SDGs.

International cooperation can help countries to achieve climate and development targets

International cooperation is no silver bullet to halting global warming and to accomplish the sustainable transformation of human development. However, it can provide crucial levers to effectively address the various challenges of climate change, sustainable development, and post-pandemic recovery using targeted development policy and coordinated external action. It is crucial to support developing countries and emerging economies in reducing their emissions and in leapfrogging carbon-intensive development patterns while pursuing climate-compatible, sustainable development that leaves no one behind.

Effective international cooperation to this end needs to act upon three premises:

- **The 2030 Agenda and the Paris Agreement must guide all external action:** To make the best use of the levers of international cooperation, it is paramount that the objectives of the Paris Agreement and the 2030 Agenda jointly and effectively guide all external action, including cooperation between developed and developing countries (North-South cooperation) as well as cooperation within and between developing regions (South-South cooperation).
- **Development policy must guide the mainstreaming of climate targets into international cooperation:** In particular, all donor policy needs to consistently reflect the objectives of the Paris Agreement, especially with a view to limiting global warming to 1.5°C and must actively support the mainstreaming of climate targets across different areas of government action and various levels of government. In that sense, all development policy instruments must be examined in light of potential synergies and trade-offs with the Paris Agreement's goals.
- **Post-COVID-19 recovery measures must be employed to better integrate climate and development policy:** The recovery measures that are currently devised and rolled out to respond to the COVID-19 pandemic must be instrumental to the effective implementation of the objectives of the Paris Agreement and the 2030 Agenda. Specifically, these measures need to facilitate comprehensive, transformative change that catalyses green recovery by aligning sustainable development needs with the imperatives of the Paris Agreement.

International cooperation and development policy that follows these principles can foster low-carbon and climate-resilient action as well as increased climate ambition, with due consideration of social and ecological sustainability. Furthermore, it assists the effective ratcheting up of developing countries and emerging economies NDCs under the Paris Agreement with commensurate attention to NAPs and other national development plans, and in close connection to domestically prioritised SDGs and the overarching imperative to leave no one behind.

In the following, priorities for action are presented that may inform all international cooperation and development policy, especially as it seeks to support post-COVID-19-recovery in partner countries and regions of German and European development cooperation.

3.1 Overarching recommendations for international cooperation

Climate change and sustainable development are inextricably linked to the world economy, including international trade and global finance flows. This is where the most powerful levers towards a "new climate economy" (NCE, 2018) can be found. Ultimately, a comprehensive transformation of global economic structures requires a systemic approach that points beyond the grasp and mandate of development policy and towards the wider sphere of international cooperation. Still, forward-looking development policy has strategic methods and instruments at its disposal that are conducive to such transformative change. These can be broadly divided into policy support measures and financial cooperation.

Policy support

Integrating the climate-development-nexus into development planning and bi- and multilateral cooperation can help align policy advice and capacity building in partner countries with the global climate and development goals and leverage important synergies. The following key aspects of Paris-compatible sustainable development actions should be taken into account:

Enhance framework conditions for effective climate and development policy at all levels of governance

- Promote the joint consideration of climate change – with a view to drivers as well as impacts – and sustainable development in all international fora and in all international policymaking.
- Support building favourable framework conditions for the effective implementation of climate and development policy in all partner countries.
- Support capacity development in the public sector to enable evidence-based policymaking towards climate and development objectives in all partner countries.

Mobilise financial support and provide technical guidance to the elaboration and implementation of key documents for national climate and development planning

- Provide broad-based support for the further development and implementation of NDCs, NAPs, and national development plans, as well as for continuous ambition raising guided by climate and development objectives.
- Support the elaboration and implementation of comprehensive, ambitious, and cross-sectoral LTSs in partner countries in close consideration of all sustainable development co-benefits that may result from mitigation and adaptation action.

Roll out adequate programmes to support 'just transition' in partner countries

- Support timely and inclusive planning for the transition of economic sectors based on sound analysis of socio-economic risks and benefits that involves policymakers as well as important stakeholders.
- Strengthen institutions and capacities to plan and implement transition processes in partner countries and implement measures to cushion adverse effects, including social protection schemes.
- Monitor and evaluate key success factors and barriers in partner countries to better understand how transitions impact different political, economic, and social contexts in the developing world.

Support the development of risk management capacities in partner countries

- Incentivise and accompany the development and application of adequate tools for risk analysis and comprehensive risk management, including risk insurance schemes as well as instruments for crisis prevention.
- Promote the systematic integration of comprehensive risk assessments into all development planning.
- Encourage and support the development of strategies for disaster risk reduction, including Climate and Disaster Risk Financing and Insurance (CDRFI) solutions, notably in the context of the Sendai Framework.

Target support activities at the most vulnerable countries and population groups

- Reinforce technical and financial support for those countries that are particularly vulnerable to address climate change and sustainable development domestically.
- Prioritise climate-vulnerable developing countries by redirecting international support for adaptation and resilience to the most vulnerable countries.

Financial cooperation

Moreover, the alignment of the portfolios and funding lines of public budgets, as well as bi- and multilateral development banks with the goals of the Paris Agreement and the 2030 Agenda, can make a vital difference and help 'shifting the trillions' towards climate-compatible and sustainable development. In this context, development policy can also facilitate enabling framework conditions and build momentum by a host of complementary measures like:

Expand the share of international climate finance relative to overall international development finance

- Mobilise and allocate additional public resources to a growing portfolio of projects that target Paris-compatible sustainable development in partner countries.
- Increase financial contributions to crucial multilateral funding mechanisms that support an integrated approach towards Paris-compatible sustainable development, notably the Green Climate Fund (GCF) and the Global Environmental Facility (GEF).
- Emphasise the external dimension of the European Green Deal and use it as a framework for strong, concerted and coherent climate and development support from European countries.

Align all international funding instruments with the transformation of key action areas

- Align all export promotion instruments with the goals of the Paris Agreement and the 2030 Agenda.
- Finance technology transfer that enables partner countries to implement "just transitions" and to leapfrog carbon-intensive development in key economic sectors (e.g., energy, transport, and industry).
- Prioritise infrastructure development where it supports the decarbonisation of the economy, including through the production and trade of clean energy sources in and between partner countries.

Increase policy-based finance to support structural reforms as a basis for transformation

- Support subsidy reforms that pave the way for decarbonisation, notably by phasing out fossil fuel subsidies.
- Provide finance for the implementation of conditional commitments under partner countries' NDCs to leverage transformational change.

Build enabling environments to mobilise private climate finance

- Provide de-risking instruments to incentivise and leverage private climate finance into Paris-compatible sustainable development projects and programmes.
- Provide capacity building for the private sector to encourage the formalisation of and participation in voluntary carbon markets at national and regional levels.

Encourage bi- and multilateral debt relief instruments for vulnerable developing countries

- Promote debt-for-climate swaps to enable vulnerable developing countries to reduce their external debt while still investing in Paris-compatible sustainable development programmes.
- Develop innovative debt relief instruments to ease the burden of vulnerable countries that are subject to extreme economic or environmental risk due to climate change impacts.
- Support risk premium subsidies to counter climate risk premiums for vulnerable countries.

3.2 Recommendations for action areas

In addition to these overarching approaches, the above analysis of five exemplary action areas offers specific recommendations. Each of these action areas is essential for the climate-development-nexus, yet characterised by different context-specific challenges. Suitable responses to these challenges are often already known yet remain difficult to implement or scale up to leverage their full potential.

International cooperation and domestic ownership are instrumental to meeting implementation challenges

This is where international cooperation and development policy can make a crucial difference. They have an instrumental role in helping partner countries to tackle the obstacles that stand in the way of applying available solutions efficiently and effectively. Challenges may reflect structural and political causes in a country as much as they may result from technical issues, a lack of capacities or resource constraints. Accordingly, it requires domestic ownership, commensurate institutions, and adequate implementation capacity in partner countries to effectively address the challenges and to live up to the multilateral commitments that developed and developing countries have made under the Paris Agreement and the 2030 Agenda.

Priority instruments promise to leverage transformational change in key action areas...

The following table highlights particularly promising priorities for each action area and the means recommended to leverage commensurate transformation. It demonstrates that the opportunities to support climate and sustainable development action jointly are not limited to supplying more aid and finance only. It also highlights important stepping stones to support the development and implementation of appropriate policies, build commensurate capacity, and advance technology transfer and local development.

...and substantial co-benefits with regard to specific SDGs

As the implementation stage of the Paris Agreement officially started in 2020, ensuring effective governance and the capacity to follow through on international commitments and national targets are essential, as is the need to implement policies and strategies domestically. To this end, the table also indicates the key SDGs that stand to benefit the most from the adoption of the recommended climate action. Finally, while the respective measures promise a broad range of benefits, some trade-offs may remain and require special attention to be minimised, managed or avoided.

Table 13 Opportunities for integrated climate and development action and means to leverage transformational change in exemplary action areas

Electricity supply

Enable leapfrogging to decentralised renewable energy systems

Policy support
- Establish an "innovation ecosystem"
- Establish policy environment to enable leapfrogging to renewable energy systems

Finance
- Long-term low-interest loans and grants for decentralised renewable energy projects
- Risk-tolerant finance and de-risking instruments to attract private sector finance

Technology transfer
- Technological equipment for decentralised renewable energy generation and distribution, including smart grid and decentralised storage technologies

Develop alternatives to fossil fuel exploitation and usage

Policy support
- Stimulate the local uptake of alternative technologies
- Stimulate demand for fossil fuel alternatives, including through adjustment of existing policies and international trade agreements

Finance
- Long-term low-interest loans and grants for local infrastructure that enables production and distribution of fossil fuel alternatives, for example green hydrogen

Technology transfer
- Technological equipment for production and distribution of fossil fuel alternatives, for example electrolyser and storage technologies in case of green hydrogen

Support strong institutions and scientific evidence for transition planning and implementation

Policy support
- Train policy makers in transition challenges and planning, including prerequisites for "just transition"
- Raise awareness for technological innovation and enable local entrepreneurship

Finance
- Finance for research projects undertaken by local institutions, including on the political economies of energy transitions and the conditions for "just transition"

Develop climate-compatible eligibility criteria for the electricity supply sector

Policy support
- Integrate Paris-compatible eligibility criteria into project design, practice and evaluation

Capacity building
- Raise awareness for and train policy makers and sector stakeholders on the development and application of Paris-compatible eligibility criteria

Raise awareness, facilitate mutual learning and ensure multiplication of success stories

Capacity building
- Promote knowledge and experience sharing through the establishment of platforms and forums that facilitate a regular and guided exchange

Cities

Promote low-carbon urban mobility

Policy support
- Stimulate local uptake of low-carbon transport technologies
- Promote compact urban development with mixed use areas

Capacity building
- Enable low-carbon transport planning, including forward looking spatial planning
- Institutionalise interlinkages between urban planning and transport planning

Finance
- Finance for low-carbon transport infrastructure

Technology transfer
- Low-carbon transport technology, including technology for low-carbon vehicles, trains, metros, trams and supporting infrastructure

Enable leapfrogging into resilient and low-carbon urban infrastructure and buildings including by upgrading informal settlements

Policy support
- Regulate construction to avoid carbon lock-in
- Prioritise and incentivise low-carbon infrastructure and buildings projects

Capacity building
- Train policy makers on planning of new and sustainable urban settlements and on opportunities to upgrade informal settlements
- Support use of low-carbon construction practices and materials
- Expand training and education in urban planning and respective professions

Finance
- Finance for resilient and low-carbon infrastructure and buildings in new urban settlements
- Finance for upgrading of informal settlements
- Mobilisation of private capital to strengthen municipal financial basis

Make cities more climate resilient

Policy support
- Promote climate resilient urban development
- Promote community-led adaptation action
- Introduce risk insurance schemes, including CDRFI solutions, at the subnational level

Capacity building
- Boost sustainable urban development planning and raise awareness for technical and non-technical solutions
- Empower community-led adaptation projects, including with regard to public spaces

Finance
- Finance for climate resilient infrastructure building
- Finance for adaptation projects and programmes

Prioritise governance and political and social aspects of sustainable urban development

Policy support
- Improve political, legal and institutional frameworks for urban planning
- Foster integrated urban development, including social, political, economic and ecological aspects of sustainable development in cities
- Strengthen governance at national and sub-national level

Capacity building
- Train policy makers in mainstreaming of sustainable construction, land-use planning and infrastructure in urban planning policies and strategies
- Support good governance of sustainable urban development

Empower cities as key drivers of subnational climate exchange

Policy support
- Create enabling environment for climate action in cities
- Promote new town-twinning partnerships and strengthen existing partnerships and city networks

Capacity building
- Provide incentives for cities to engage in climate action
- Demonstrate good practices for replication
- Support exchange with science, private sector and civil society

Agriculture

Enable the adoption of climate-resilient technologies and low-emission practices

Policy support

- Incentivise private sector investment in sustainable land management technologies and practices
- Reform land tenure systems
- Apply multilevel approach that integrates targeted programmes, policy advise and finance

Capacity building

- Train farmers on how to access credits, insurance and other financial resources for sustainable land management
- Empower farmers to plan and implement sustainable land management practices
- Facilitate knowledge transfer between smallholders

Finance

- Finance for smallholders to purchase sustainable and climate resilient land management technologies and seeds

Technology transfer

- Technologies that allow for sustainable and climate resilient land management and improve soil carbon sequestration, including integrated soil fertility management, livestock management, water harvesting and water management, etc

Support sustainable intensification of meat and dairy production in low-income countries and a shift towards plant-based alternatives in high- and middle-income countries

Policy support

- Incentivise changes in consumption patterns, decrease demand for meat and dairy products and increase plant-based alternatives (in HIC and UMIC)
- Support regulation and reforms of international trade and markets of meat and dairy products
- Incentivise sustainable intensification of livestock systems or promote the transition of the livestock industry away from the traditional livestock value-chain

Capacity building

- Raise consumer awareness on health and environmental consequences of meat and dairy products
- Empower farmers to adopt sustainable intensification measures

Coordinate efforts to reduce post-harvest food losses and food waste

Capacity building

- Raise consumer awareness on sustainable food use and reduction of food waste
- Train policy makers (primarily in HIC and UMIC) on demand reduction measures for imported food products with high environmental footprints

Finance

- Finance for storage equipment, including cooling facilities

Forests and ecosystems

Stronger link between climate and biodiversity action

Policy support

- Integrate climate, biodiversity and equity criteria into project design, practice and evaluation
- Mainstream biodiversity conservation into climate finance and climate actions into biodiversity finance

Capacity building

- Provide information for policy makers and sector stakeholders on the design of nature-based solutions that jointly address mitigation, adaptation and biodiversity conservation
- Share knowledge on long- and short-term implications of nature-based solution for ecosystems' health and service provision

Finance

- Finance for projects that jointly address climate mitigation, adaptation and biodiversity protection

Propose regulation of global markets for primary commodities that cause deforestation

Policy support

- Reform and regulate EU demand and trade of palm oil, soybean and beef and develop ambitious international industry standards for commodity supply chains driving deforestation
- Design forest conservation strategies and policies that address both the demand and supply sides and tackle international drivers of deforestation

Technology transfer

- Real-time remote sensing techniques to effectively monitor and protect forested areas

Support collective and secure land tenure rights for forest-dependent communities

Policy support

- Secure tenure and human rights for forest-dependent local communities
- Facilitate well-functioning community-based initiatives

Capacity building

- Facilitate in-situ conservation actions outside protected areas, including Other Effective area-based Conservation Measures (OECMs)

Finance

- Finance for non-conditional conservation basic income (a novel strategy for funding biodiversity conservation that moves beyond widely promoted market-based instruments)

Water

Provide technologies and policies for water use efficiency

Policy support
- Conducive institutional environment to avoid 'tragedy of the commons' situations with freshwater
- Promote water efficiency, including through incentives for water-saving crops

Capacity building
- Empower farmers to adopt water-efficient irrigation systems

Finance
- Finance for upscaling and maintenance of water-efficiency technologies across relevant sectors

Technology transfer
- Water efficiency technologies in the agricultural sector
- Water meters, in particular in cities, to better inform planning, pricing and maintenance

Develop capacity for monitoring of water resources infrastructure

Policy support
- Develop water management plans in important sectors such as agriculture, environment and urban planning
- Create institutional arrangements for development and maintenance of monitoring networks and infrastructure

Capacity building
- Train policy makers and sector stakeholders on planning and implementation of water resource monitoring at various levels of integrated water resource management
- Facilitate monitoring of available water resources, also in view of (climate-related) disaster preparedness

Finance
- Finance for development and maintenance of monitoring networks and infrastructure

Technology transfer
- Water resource monitoring technology based on different needs in different locations

Provide technical and institutional solutions for wastewater reduction, treatment and reuse

Policy support
- Promote water pollution abatement through adequate incentives for different actors (state, industry, farmers, civil society, and academia)
- Account for virtual water trade as water footprint of agricultural commodities and other raw materials

Finance
- Finance for wastewater treatment solutions, including mobilisation of private sector finance

Technology transfer
- Decentralised water treatment technologies, including constructed wetlands that treat water at the source

Promote water governance reforms

Policy support
- Link water-related assistance to climate resilient land use planning, especially in informal settlements in urban areas
- Assess benefits and trade-offs of water reforms for various stakeholders
- Compensate those who are disadvantaged by water reforms

Capacity building
- Train policy makers and sector stakeholders on cross-sectoral coordination of water resource management, including planning, implementation, monitoring and evaluation
- Provide information on adequate implementation of integrated water resource management and inclusion of marginalised stakeholders
- Support policy makers to deliver on policies and ensure resilient decision-making

3.3 Outlook

International cooperation is essential to deal with climate change.

Development policy tackles the causes and impacts of climate change. Promoting climate-compatible development and supporting partner countries in responding to global warming helps ensure sustainable development pathways for all. It also responds to the needs of the poor and most vulnerable who suffer the brunt of climate change impacts while contributing proportionally little to its causes. Consequently, the question is not whether developing countries should be supported to raise their climate ambition but how to support them in an efficient, expedient and coherent way.

Given the interconnected nature of sustainable development and climate change, it is essential to ensure policy coherence across and among agents of international cooperation.

The ongoing 'BMZ 2030' strategy process of the pertinent line ministry, the BMZ, and the relevant set of issue-specific thematic strategies ('Kernthemenstrategien') currently being developed in this context provide an opportunity for development policy to lead this effort. By extension, this also applies to the structuring of international support for post-pandemic recovery in the developing world, including by Germany and the EU.

Indeed, the demand for international support with a view to aligning climate policy objectives, post-COVID-19 recovery and sustainable development is high.

The large international uptake of the NDC Partnership, which was originally initiated in 2016 by the German and Moroccan governments, together with other countries, is a case in point. Likewise, the NAP Global Network supports coordination between all actors engaged in NAP processes at a country level, including with pertinent bilateral donors. It can be assumed that such demand will be further amplified as partner countries seek to respond to the socio-economic crisis prompted by the COVID-19 pandemic. Indeed, international cooperation has a role to play in supporting partner countries to recover better and to facilitate leapfrogging toward more resilient, ecologically, and socially sustainable economic systems.

Responding to this demand is not only a matter of credibility and international solidarity.

It is also in the rational geopolitical self-interest of Germany and its European partners. The geopolitical relevance of climate and energy policies and related resource conflicts is striking. Likewise, it stands to reason that recurring and overlapping crises pertaining to economic instability, environmental pressures, migration flows or the current pandemic require substantial adjustments of the institutions and structures of international cooperation.

Ultimately, a stable climate is a global public good.

Ensuring this global public good entails challenges for international cooperation of a scope and magnitude that cannot be met by development policy alone. Therefore, foresighted development policy by Germany and the EU will thrive with much closer coordination and coherence with other portfolios of external action. These include, among other things, diplomacy and foreign policy, finance, trade, agriculture and transport. This cross-cutting systemic approach in development policy will best enable it to leave no one behind as it leverages significant change in partner countries and thereby delivers on the objectives of the Paris Agreement and the 2030 Agenda for Sustainable Development.

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