Implementing adaptation policies: towards sustainable development

Issue Brief

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1. Introduction

1. The G20 Climate Sustainability Working Group's Adaptation Work Programme (2018-19) aims to share country experiences to promote enhanced efforts for adaptation and increase resilience. This note identifies challenges and opportunities for adaptation to increase resilience, with a focus on infrastructure, agriculture, health and gender. Particular attention is given to the role of ecosystem-based approaches to adaptation.

2. Climate change adaptation is fundamental for building resilient socio-economic and ecological systems. It is an important part of efforts to implement not only the Paris Agreement and Sendai Framework for Disaster Risk Reduction, but also the 2030 Agenda for Sustainable Development (Table 1). Achieving zero hunger will require increasing agricultural productivity in the face of climate variability and longer-term change. Additional investments in climate-resilient infrastructure are needed to deliver universal access to safe water in the face of changing patterns of precipitation. Health systems need to be prepared for changes in the burden of disease, as well as the impacts of climate extremes. Meanwhile, progress towards the Sustainable Development Goals (SDGs) will strengthen our capacity to adapt to a changing climate: for example, eliminating poverty will also reduce vulnerability to climate.

Table 1. Indicative estimates of climate impacts and potential adaptation measures for selected Sustainable Development Goals

	Potential impacts	Potential adaptation measures
1: No poverty	An additional 35 – 122 million people living in poverty by 2030 as a result of climate impacts (Hallegatte et al., 2015)	- Adopt inclusive development pathways - Encourage climate-smart agriculture - Implement social protection programmes
2: Zero hunger	Increase in prices of key agricultural commodities by 30% in 2050 under a high climate scenario (Ignaciuk and Mason-D'Croz, 2014)	- Adopt drought-tolerant crops - Adopt more productive agricultural practices - Reduce food waste
3: Good Health	Additional 250 000 deaths per year from malnutrition, malaria, heat stress and diarrhoea between 2030 to 2050 (WHO, 2014)	- Strengthen resilience of health infrastructure to extreme events - Improve surveillance of infectious diseases - Increase access to sanitation and clean water - Expand urban green space
5: Gender equality	Women disproportionately (and differently) affected by climate impacts (UN Women, 2018)	- Increase women's voice in the political process - Ensure women's inclusion in adaptation planning and implementation - Monitor climate impacts by gender
8: Decent work and economic growth	Reduction in average global GDP by 1 – 3.3 % by 2060 (OECD, 2015)	- Mitigate climate change - Implement national adaptation plans or strategies - Increase investment in adaptation
11: Sustainable cities and communities	Increase in average global flood losses in coastal cities to USD 1 trillion per year with constant spending on flood defences (Hallegatte et al., 2013)	- Improve land-use planning - Increase investment in ecosystem-based and traditional coastal defences - Adopt improved building standards

Note: This table summarises the results of recent studies that provide an indication of the range and scale of potential climate impacts. The results from these studies are not directly comparable, due to differences in methodologies, coverage and underlying assumptions.

3. The implementation of a broad and coherent set of adaptation measures can help to manage these potential impacts. For example, increased investment in coastal defences could reduce global annual expected losses of flooding in coastal cities from USD 1 trillion to around USD 60 billion globally.[1] Implementing adaptation will require taking action at different geographic scales and involving the public and private sectors. Governments, businesses and communities all have an essential role in building resilience to the impacts of climate change. International co-operation is also vital, for example, in building the capacity of Least Developed Countries and other developing countries to adapt to climate change.

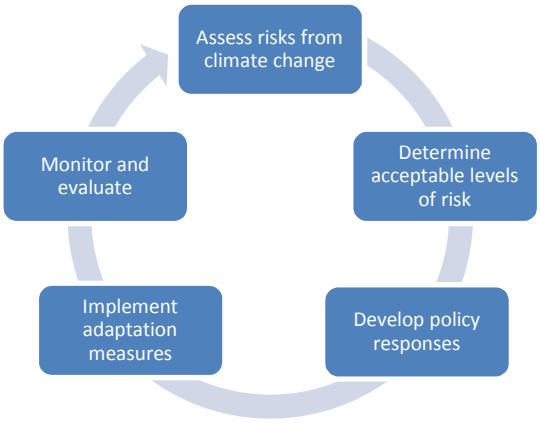
4. Countries are developing strategic responses to climate change through a variety of mechanisms suited to their national circumstances. These include national adaptation strategies and local-level initiatives, such as city adaptation plans. The challenge now for countries is to translate planning into successful implementation, building on examples of good practices that have emerged to date.

2. Adaptation planning for resilience

5. Adaptation planning requires a long-term and system-wide perspective, accounting for uncertainty about the future. The risks from climate change arise from the interaction of socio-economic trends and climate impacts, both of which are inherently uncertain. Adaptation measures undertaken in isolation may lock-in vulnerability in the longer term, preclude the use of more cost-effective options, or increase the vulnerability of neighbouring communities. Adaptation plans that do not account for uncertainty may lead to costly mistakes when projections diverge from reality. There is a need to package and sequence interventions in ways that account for systemic interactions and are robust to uncertainty.

6. The five-step process below provides a simplified framework for how countries can use a process of iterative risk management to support flexible adaptation planning:

Figure 1. Iterative risk management of climate impacts



Source: OECD, 2015 – Adapting to the Impacts of Climate Change

7. The aim of the adaptation planning process is to ensure that climate-related risks are identified, assessed and then reduced to an acceptable level. In general, it becomes increasingly technically difficult and expensive to achieve higher levels of resilience. The cost-effectiveness of adaptation and the benefits of higher levels of resilience must be balanced. Given uncertainty about the future, planning should favour the use of strategies that are flexible, that deliver co-benefits and avoid lock-in. A continuous process of monitoring and evaluation can then assist with changing course in response to new information and changing circumstances.

8. Given that it will not be possible to eliminate all risks from climate change, policy packages should also include measures that enhance people's ability to "bounce back" after an adverse shock. Examples include improved contingency planning as well as increasing access to financial protection such as insurance and social protection programmes. Facilitating rapid recovery can reduce the risk of negative shocks leading to long-term reductions in productivity, and reduce the welfare impacts of this negative shocks.[2] It is, however, important that measures to address shocks do not inadvertently hinder adaptation to longer-term trends.

9. Most G20 countries are using adaptation plans or strategies to implement co-ordinated, national responses to climate change adaptation (Table 2). These strategies are used to

communicate the governments' objectives, raise awareness of adaptation amongst stakeholders and identify priority actions in key sectors. In addition to these national efforts, city- and regional-level adaptation plans are also being adopted to address climate risks at these scales. In Japan, for example, the Climate Change Adaptation Act came into force on 1st December 2018. It requires the national government to formulate a National Adaptation Plan, which is to be updated every five years. Local governments are also asked to develop their local adaptation plan.

Table 2. Plans and strategies for adapting to climate change by G20 members

	Name	Year
Argentina	*Under development*	-
Australia	National Climate Resilience and Adaptation Strategy	2015
Brazil	National Adaptation Plan	2016
Canada	Pan-Canadian Framework on Clean Growth and Climate Change	2016
China	National Strategy for Climate Adaptation	2013
France	2nd National Adaptation Plan	2018
Germany	Adaptation Action Plan	2011
India	National Action Plan on Climate Change	2008
Indonesia	National Action Plan on Climate Change Adaptation (RAN-API)	2013
Italy	National Adaptation Strategy	2014
Japan	Updated National Adaptation Plan (Based on the new Adaptation Act)	2018
Mexico	Special Climate Change Programme	2014
Russia	*Under development*	-
Saudi Arabia	-	-
South Africa	National Adaptation Strategy	2016
Republic of Korea	2nd National Adaptation Plan	2016
Turkey	National Adaptation Plan	2011
United Kingdom	National Adaptation Plan	2013
United States	-	-
European Union	EU Adaptation Strategy	2013

10. The details of these plans vary but, in general, they aim to build capacity to understand and manage climate risks across all policy areas. Many plans refer to the need to build in flexibility and avoid lock-in. Measures for these plans include:

- Signalling political commitment to managing the risks from climate change, through the adoption of strategies, legal frameworks and policy statements.
- Producing and disseminating climate data and projections, combined with efforts to make that information easily accessible to end users. This includes the development of online platforms to provide access to reliable data sources, such as the EU Climate-ADAPT[3], Asia-Pacific Adaptation Information Platform (AP-PLAT)[4] developed by Japan's National Institute for Environmental Studies, and the World Bank's Climate Change Knowledge Portal[5].
- Integrating climate-resilience into policy and regulations, based on national priorities and circumstances. This includes revisions to the design and implementation of spatial planning frameworks to improve disaster risk management, reducing vulnerability and preventing the construction of new infrastructure in exposed areas.

- Facilitating horizontal and vertical co-ordination within the public sector to build capacity for adaptation and address risks that lie across sectoral or geographic boundaries.

Some plans include an action plan with devolved tasks set on a clear timeline, along with a financing strategy.

3. Implementing climate change adaptation in key areas

11. The risks from climate change are diverse, and the challenges and opportunities for adaptation vary by sector and policy area. This section identifies the challenges and opportunities for adaptation in areas that are fundamental for the achievement of the SDGs: infrastructure, gender, health and agriculture. Action across these policy areas can be underpinned by coherent planning (discussed in Section 2), and mechanisms for financing and monitoring progress (Sections 4 and 5).

3.1. Using ecosystem-based approaches to provide resilient infrastructure

12. The recent OECD report "Climate-Resilient Infrastructure"[6] provides an overview of how countries are ensuring that their infrastructure networks are adapted to climate change. Complimentary OECD work provides guidance on the governance of critical infrastructure resilience.[7] This section builds on these reports, focussing on the potential contribution from ecosystem-based adaptation (EbA)[8].

13. The measures needed to increase the climate resilience of infrastructure networks are context specific, depending on the type of infrastructure, its location and the potential hazards from climate change. However, in general, increasing climate resilience will require a package of structural and management measures, implemented throughout the lifespan of an asset:[9]

- Structural measures - changes to the design or location of the asset, such as raising the height of a bridge or relocating electricity substations away from flood risk zones. Structural measures can also include the provision of additional infrastructure to manage climate risk, including ecosystem-based approaches such as wetland restoration;
- Management measures - changes to the management of the asset to reduce the likelihood or consequences of failure in response to climate risks. Possible measures include changes to maintenance regimes and the development of contingency plans to assist recovery in the event of system failure. These can also include the use of insurance against climate events, such as drought insurance for hydropower producers.

14. Governments are increasingly recognising the potential of EbA to contribute to the resilience of infrastructure networks. There are explicit references to EbA in 23 countries' Nationally Determined Contributions (NDCs)[10]; a further 109 NDCs show similar concepts of working with nature to build resilience to climate change.[11] These approaches involve the protection, management or restoration of ecosystems to support adaptation. EbA can be used as a replacement or a complement for "grey" infrastructure. For example, green roofs and urban parks can be used to lower urban temperatures, reducing the impact of the Urban Heat Island effect and consequent negative health impacts. Coastal salt marsh restoration can be used to manage the increasing risks of flooding resulting from sea-level rise.[12]

15. Working with nature in this way has the potential to provide a cost-effective and flexible component of adaptation responses. EbA can also give rise to a range of co-benefits,

such as biodiversity conservation, carbon sequestration and amenity value for local residents. For example, in addition to flood abatement, the restoration of coastal salt marshes can create new species habitats, with benefits for both fisheries and biodiversity conservation.[13] Sustainably managing and capturing the multiple benefits of local resources and ecosystem services is central to the Satoyama Initiative[14] and Japan's concept of Circulating and Ecological Economy.[15] This is a comprehensive policy approach that integrates the concept of a low-carbon society, resource circulation and a society in harmony with nature.

16. Recent analysis demonstrates that, in some cases, ecosystem-based approaches can be cheaper than relying solely on conventional infrastructure, particularly when considering the value of potential co-benefits:

- The City of Copenhagen found that adopting a portfolio of measures (including EbA) would be DKK 7 billion (EUR 940 million) cheaper than reliance upon grey infrastructure alone.[16]
- Restoration of mangroves and salt-marshes can achieve reductions in flooding and erosion at one-third to one-fifth of the cost of grey infrastructure.[17]
- Portland found that achieving improvements in water quality through ecosystem restoration would be 51-76% cheaper than a treatment plant.[18]

17. There are, however, a number of challenges and potential trade-offs to be addressed when using EbA:

- Technical – EbA is not a "plug-in" replacement for grey infrastructure, as it has different characteristics and requirements than traditional approaches to provision. For example, the use of wetlands to treat water requires significantly more land than conventional treatment. As such, it will not be appropriate for all circumstances.
- Regulatory requirements – permitting processes and technical standards have evolved over time to manage the use of "grey" infrastructure approaches. Proponents of EbA are faced with the transaction costs of demonstrating that EbA complies with these standards. Engineering norms and standards may need to be updated to allow for the use of non-conventional approaches.
- Financial – EbA tends to be reliant upon public funding. For example, global payments for watershed protection were estimated at USD 25 billion in 2015, and 97% of this came in the form of subsidies from the public sector.[19] The underlying challenge for private investment is to create suitable revenue streams, even when many of the potential co-benefits are not traded in the market.

Box 1. Mobilising private finance for EbA

• Natural Capital Financing Facility – The European Investment Bank and European Commission have created a blended financing facility to support projects including EbA through loans or equity investments. The initial facility was EUR 100-125 million for 2014 - 2017. Borrowers must be able to demonstrate sufficient revenues or cost savings to repay the loan. This facility is intended to test and demonstrate the viability of different models for commercially-viable funding of natural capital

• Flood management in Cartagena, Colombia – Funding from Germany's International

Climate Initiative was used to initiate a programme for ecosystem restoration to reduce flood risk in Cartagena. This project also included the development of a funding mechanism to sustain the interventions from domestic resources. This will be funded through a ring-fenced rainwater drainage levy on businesses and a voluntary fee on organisations hosting events in the city.

- Dow Chemical's "Valuing Nature" initiative – Dow Chemical now screens all new capital, R&D and property decisions to identify opportunities for increasing the use of nature in their operations. In 2017, they estimated that the implementation of nature-based solutions under this initiative had led to savings or new cash flows of USD 120 million. Initiatives included the installation of "green" retaining walls at their site in Aratu, Brazil instead of concrete walls. This approach helps to combat erosion while also reducing surface run off. This programme is being funded through the company's own resources.

- Quintana Roo, Mexico's "Coastal Zone Management Trust" – This funding mechanism uses taxes from the local tourist industry and local government funding to preserve and restore coastal reefs. These reefs play an essential role in protecting against storm surges, absorbing up to 97% of the wave energy. The fund undertakes improvement works to maintain the reefs. It also purchases insurance against damage to the reef, which then covers additional restoration activities following particularly severe storms.

Sources: OECD/The World Bank/UN Environment (2018); EIB (2014); GIZ (2018).

3.2. Ensuring gender-inclusive adaptation

18. Understanding gender dynamics and addressing gender inequalities is fundamental for building adaptive capacity. Women and girls will often be affected disproportionately by the impacts of climate change, for example, when they have fewer financial resources, less access to education or face discriminatory social norms or practices.[20] Studies have shown that disaster fatality rates are often higher for women – women accounted for 61 percent of fatalities caused by the 2008 Cyclone Nargis in Myanmar, and 91 percent caused by the 1991 cyclone in Bangladesh.[21] In the aftermath of a climate-related disaster, women and girls face a higher risk of physical, sexual, and domestic violence, as well as of mood disorders and poor economic recovery.[22]

19. Women can be agents of change in managing climate impacts. Progress towards *SDG 5: Achieve gender equality and empower all women and girls* will facilitate women's active role in adapting to climate change. Adaptation decisions need to be informed by a nuanced understanding of gender dynamics to avoid entrenching inequalities and vulnerabilities. Gender dynamics are context-specific, varying across countries, cultures, ethnicities and communities.

20. Adaptation strategies can offer new opportunities to address gender inequality. For example, changes in livelihood strategies in response to climate change can create new spaces for women and men to engage differently with each other, shifting roles and responsibilities. In Kenya, for example, increased water and fuel wood scarcity has led men to participate in their collection, tasks previously seen as belonging to girls and women only.[23]

21. Building on broader efforts to achieve gender equality, a number of steps can facilitate gender-inclusive adaptation. These include:[24]

- Building capacity of women's groups to participate in decision-making.

- Providing gender-disaggregated data (e.g. on climate vulnerability) to inform decision-making.
- Promoting efforts to reduce broader gender inequalities, for example by addressing unfair legal frameworks and social norms governing legal rights, access to public services and economic activities.
- Integrating women's perspectives, experiences and skills in the development and implementation of adaptation plans.
- Integrating gender perspectives into national and international climate change finance mechanisms.

22. While there is more work to be done and many challenges to be overcome, good practices in achieving gender-inclusive adaptation can serve as examples:

- *Cambodia's Strategic Plan on Gender and Climate Change* – Cambodia's Ministry of Women's Affairs (MoWA) has developed a strategic plan to contribute to the development and implementation of gender-responsive climate policies. This is a cross-cutting strategy that has been integrated into the implementation processes of the Cambodia Climate Change Strategic Plan as well as sectoral climate change plans.
- Gender into Urban Climate Change Initiative – Through its International Climate Initiative, Germany is supporting integration of gender considerations into urban climate change planning in 14 pilot cities across four countries: India, Indonesia, Mexico and South Africa. The project has developed and is applying a Gender Assessment & Monitoring of Mitigation and Adaptation (GAMMA) methodology to examine local climate policies for their gender responsiveness, identify possible gender entry-points and develop recommendations for integrating gender into planning procedures.

3.3. Addressing the health impacts of climate change

23. Recent modelling by the WHO found that climate change could lead to 250 000 excess deaths per year by 2030, unless adaptation action is strengthened.[25] These health impacts will fall disproportionately on poor and marginalised groups, people with disabilities, the elderly, young children, and women.[26] For example, young children and the elderly are more sensitive to dehydration during extreme heat events, and pregnant women are especially susceptible to mosquito-borne diseases.[27]

24. Climate change will have direct and indirect health impacts: the direct impacts refer to injuries or deaths caused by the climate itself, including heat strokes and deaths and injuries from climate extremes.[28] Indirect impacts refer to health outcomes caused by climate change effects on ecosystems, economies, and social structures: food- and water-borne illnesses, vector-borne diseases, poor nutrition, occupational health problems, mental health problems and effects of bad air-quality and conflict. Impacts themselves can also be interlinked, with a single climate event affecting health through multiple channels. Munich Re estimated that the 2010 heatwave in Russia and Eastern Europe lead to 56 000 excess deaths, due to the direct impact of high temperatures as well as the air quality impacts from forest fires caused by the high temperatures.[29] The impacts of climate change on health may be exacerbated by other environmental pressures, such as air pollution. [30]

25. Many of the potential impacts of climate change on health are avoidable with the right policies and measures. Adapting to health impacts includes responding to impacts themselves

as well as to drivers of risk. Key measures within the health sector include increasing access to health care, expanding the use of early warning systems for identifying new health risks, and increasing the resilience of health service provision. Managing the underlying risks will require action in others sectors: for example, reducing the urban heat island through improved spatial planning and green infrastructure will help to reduce the impact of heat-related mortality. Improved access to clean water and sanitation would help to offset the spread of disease, as would efforts to improve hygiene standards throughout the food chain.

26. Countries are implementing a range of measures to tackle health impacts from a changing climate:

- *Plan Canicule*, France: The heatwave in 2003 was estimated to have caused 15 000 excess deaths, predominantly among the elderly.[31] In response, each department was required to develop a heatwave plan. Weather reports are used to generate a level of alert, which is communicated to the public and used to inform the public health response.
- *Food- and water-borne infectious disease surveillance*, New Zealand: Bacteria and parasites, which that contaminate food and water and cause serious illnesses, are influenced by temperature and other climate variables. In New Zealand, the incidence rates of these illnesses are monitored to assess the health risks related to climate change and better prepare for disease outbreaks.[32]
- *VectorNet*, European Union: Vectors – such as mosquitoes, ticks, flies or fleas – transmit infectious diseases. Major shifts in vector-borne diseases and appearances are predicted as a result of climate change.[33] VectorNet is a joint initiative of the European Food Safety Authority and European Centre for Disease Prevention and Control, which provides a common database on vectors of diseases affecting humans and/or animals across Europe.[34]

27. Actions to address climate change-related health impacts are often no-regrets, in terms of managing immediate health risks and supporting progress towards the Sustainable Development Goals. However, they will require increased finance and collaboration to address risks that cut across sectoral boundaries.[35] [36]

3.4. Adapting agricultural systems to climate change

28. The global food and agriculture system faces the challenge of responding to the growing demand for agricultural commodities. In 2017, there were 812 million people suffering from malnourishment, and this figure is expected to increase with population growth.[37] Adaptation of agricultural systems is needed to achieve zero hunger, while meeting these rising demands and other policy goals including climate change adaptation.

29. Adapting agriculture and broader food production systems to climate change will be instrumental in achieving *SDG 2: Zero Hunger* as well as the goals of the Paris Agreement. Climate change is projected to negatively affect growth rates of yields for most crops by the second half of the century, especially at higher levels of temperature rise and at low latitudes.[38] In OECD countries, climate change could reduce production of maize by 10%, wheat by 7% and rice by 6% by 2050, compared to a scenario where current climate conditions prevail.[39] In addition to the impact on yields, climate change may also reduce the nutritional value of some crops.[40] Livestock farming will also be affected, both directly, as a result of mortality during droughts, floods and other extreme events, and indirectly, through heat stress, which can increase the vulnerability of livestock to diseases and reduce fertility and milk production.[41]

Risks to agriculture can lead to broader food security and socio-economic concerns, such as climate change related water scarcity for agriculture driving foreign land purchases.[42]

30. Farmers are already responding to these changes by adopting new practices, such as changed cropping dates or crop varieties, economic diversification and more efficient use of agricultural inputs. However, there are a number of barriers to adaptation in the agricultural sector, including lack of information, policy distortions and market failures[43]. Governments can support adaptation efforts through a range of measures:

- *Research and development (R&D):* The public sector has a role in advancing knowledge on the vulnerability of agriculture to climate change, and in developing new technologies and solutions for strengthening the resilience and efficiency of agriculture and food systems. In addition to delivering public R&D, governments can facilitate private innovation e.g. by addressing investment barriers and supporting research collaborations.
- *Provision of tools to help farmers assess and manage their risks:* the provision of tools such as weather forecasts and early warning systems can help farmers to anticipate and plan for the negative effects of climate variability and extreme events.
- *Agricultural extension services, training and education:* improved access to information through training, education and demonstration projects can help farmers to make rational decisions and undertake appropriate adaptation actions.
- *Policy alignment and removal of disincentives for adaptation:* a key role for governments is to review existing policy measures, such as subsidies and insurance, to ensure that they do not hinder adaptation responses.
- *Planning and investment in quality infrastructure:* agriculture depends on infrastructure for irrigation, energy, storage, transport, and trade. Investing in the right type of infrastructure can help enhance the resilience and efficiency of agricultural systems. Approximately one-third of food is lost or wasted before being consumed,[44] with the bulk of losses coming from production or transport.

31. Countries are adopting new approaches and initiatives to better integrate climate change adaptation into their agricultural systems. Examples include:

- *SAFE, France:* The government-led SAFE (Silvoarable Agroforestry for Europe) programme supports farmers to shift from monoculture systems to agroforestry systems. This creates natural shelter for crops to help reduce damages from high spring temperatures, and improves soil and water quality, reducing erosion and flood damage. In addition to being more resilient, this type of agro-forestry can be up to 40% more productive per hectare than monocultures. To support agroforestry extension, the national chamber of Agriculture in France established a network of agroforestry system demonstration plots and provided guidance to farmers on the potential for silvoarable agroforestry.[45]
- *Regional Climate Hubs, USA:* The U.S. Department of Agriculture has established ten Regional Climate Hubs for risk adaptation and mitigation to climate change. The Hubs provide region-specific information and tools to inform farmers' adaptation decisions. This includes conducting and communicating assessments and regional forecasts for hazard and adaptation planning, providing technical support to help farmers prepare for drought, heat stress, floods, pests and changes in the growing season, and outreach and education.[46]

- *Building climate change resilience of smallholder farmers, Argentina:* Smallholder farmers in the Northeast of Argentina face increasingly frequent and intense floods, droughts, and water deficits. To enhance their resilience to climate change, the Argentinian Unit for Rural Change implemented a USD 5.6 million project funded by the Adaptation Fund from 2013-2018. The project built cisterns to capture rainwater, improved agricultural practices and set up a Pilot Insurance for Greenhouse Horticulture program aimed at smallholders in the Province of Corrientes. In addition, an improved agro-climatic information system was developed, and institutional capacity was built to aid the implementation of future adaptation measures.[47]

4. Mobilising finance for implementing adaptation

32. There is no comprehensive estimate of the additional financial resources required to build resilience to climate change. These additional costs are highly context specific, varying with factors including the severity of climate change impacts, the "acceptable" level of risk, and socio-economic trends. However, some global studies provide an indication of the scale of potential costs. The most comprehensive study is from the World Bank, which in 2010 found annual costs of USD 70-100 billion for developing countries by 2050, with the majority of expenditure related to infrastructure.[48] Other studies have suggested that the additional costs could be significantly higher than this.[49] [50]

33. At the level of individual projects, the additional costs resulting from climate change adaptation can vary dramatically depending on the context. On average, however, these will tend to be modest percentages of overall project costs. Indicative evidence for infrastructure suggests that, on average, these additional costs are likely to add 1-2 % to project costs.[51] The most significant costs will arise where climate change leads to the demand for additional infrastructure. For example, Hallegatte et al. estimate that annual costs of protecting the largest coastal cities against sea-level rise will be USD 50 billion per year by the 2050s.[52] Other estimates find that global investments in sea walls will rise to USD 12-71 billion per year by the end of the century.[53]

34. Significant efforts are being made to improve the tracking of public and private finance related to climate resilience, but the picture remains incomplete. For infrastructure, public finance is estimated to cover 60-65% of costs in developing countries, compared to 40% in developed countries. [54] A few, predominantly developing, countries have analysed domestic public expenditure related to climate change to understand better how their funding is supporting this objective.

35. While public funding has an essential role for adaptation, it is also necessary to align private finance flows with the aim of building resilience. Integrating climate resilience at the outset can provide users with a more reliable service and increase the useful life of the asset. Increased resilience can reduce the risk of environmental destruction, loss of life or reputational damage. However, these benefits to society are not fully captured by the market, due to information gaps, market failures and policy misalignments. There is a need to address these barriers and translate the benefits of resilience into viable revenue streams.

36. In addition to the general adaptation measures discussed above, the following policy tools can help address barriers to private finance and mobilise resources:

- Ensuring that public procurement processes are conducive to building resilience by considering the lifetime costs and benefits of alternative approaches to infrastructure provision. There are now some examples of the management of climate risks being

considered within public-private partnership contracts. This includes the requirement for increased insurance coverage in the 4th generation of road concessions in Colombia, which are intended to reduce potential government liabilities if risks materialise.

- Using public finance to mobilise private finance for climate-resilient infrastructure. Support for project preparation can help to address capacity constraints relating to climate resilience. Blended finance can be used to improve the risk-return profile of investments where appropriate.
- Increasing disclosure of climate-related risks by key sectors of the economy. This process has been given added impetus by the recommendations of the Task Force on Disclosure of Climate-related Risks. The process of disclosure can help to motivate action to manage those risks by the private sector, as well as support investment decisions by the financial markets.

5. Measuring progress in implementing adaptation to climate change

37. Adaptation is an iterative process, therefore continuous monitoring and periodic evaluations are essential for ensuring that policy development responds to changing circumstances. Many adaptation strategies are adopted on regular (e.g. every 5 years) cycles, with the lessons learnt from the previous strategy intended to inform the next cycle. However, this can only occur if the necessary elements are in place to measure progress, identify barriers to implementation and synthesise lessons learnt. The OECD has identified four tools that can help achieve this goal:[55]

- *Climate change risk and vulnerability* assessments – These can be used to create a baseline of the country's climate vulnerability against which progress on adaptation can be reviewed. If they are repeated on a regular basis (e.g. to inform national planning and budgeting cycles) they can provide a picture of how climate risks and vulnerabilities are changing over time.
- *Indicators to monitor progress on adaptation priorities* – Indicators can facilitate the monitoring of climate risks and vulnerabilities over time and between locations. However, the existence of an indicator framework is not sufficient to understand progress in adaptation.
- *Project and programme evaluations* – These can help to identify which approaches to adaptation are effective in achieving agreed objectives. They can also shed light on the underlying factors enabling the intervention to succeed.
- *National audits and climate expenditure reviews* – These examine if resources for adaptation are being allocated and used in a cost-effective manner.

38. Some G20 countries have implemented national frameworks for measuring progress on adaptation. One of the most challenging feature for this has been choosing suitable sets of indicators. There is no commonly used metric for measuring progress on adaptation, in contrast to other areas such as mitigation (tonnes of CO_2eq) or economic growth.[56] Broad sets of indicators are needed to capture the features of relevance for climate adaptation, but these should be part of existing indicator sets.

39. There is not yet any internationally agreed indicators for measuring progress towards the Paris Agreement's goal of strengthening resilience and building adaptive capacity. However, other elements of the post-2015 agreements have established frameworks that will provide information relevant to adaptation. In particular, the SDGs provide a major

opportunity to improve monitoring of climate change outcomes. The comprehensive indicator framework for the SDGs will provide a rich set of data for understanding adaptation outcomes. The indicators linked to Goal 13 (climate change) provide a high-level overview of the processes being put in place to manage risks. However, the indicators for the other goals (such as health, education and poverty) can provide a rich picture of trends that may be relevant to countries' adaptation priorities. The 2030 Agenda for Sustainable Development calls for disaggregating these statistics by factors including income, sex and age. Efforts to produce disaggregated data are particularly valuable given the links between vulnerability to climate change and socio-economic characteristics.

40. Similarly, the indicator sets used to measure progress towards other international agreements can also facilitate monitoring of adaptation. The Sendai Framework for Disaster Risk Reduction goal G (early warning systems and disaster risk information) also supports understanding of climate risks and adaptive capacity. The Aichi Biodiversity Targets are also relevant in understanding trends in the adaptive capacity of natural systems. Ensuring coherence between the systems used for measuring and reporting progress on the SDGs, Sendai Framework, Paris Agreement and other international agreements will help to facilitate learning and ensure the efficient use of resources.

6. Enhancing implementation of adaptation action

41. Progress towards the objectives of post-2015 agreements both requires, and can support, adaptation to climate change. Growing numbers of good practices are emerging in planning, implementing, financing and monitoring adaptation. Political commitment to the topic is increasing, through initiatives such as the InsuResilience Global Partnership, the Global Commission on Adaptation and the G20's Adaptation Work Programme.

42. There is now a need to scale-up these good practices and accelerate efforts to build resilience and adapt to climate change. Building on the progress made through the G20 Climate Sustainability Working Group's Adaptation Work Programme (2018-19), the G20 could support work in the following areas:

- *Strengthening coherence between the Paris Agreement, Aichi Biodiversity Targets, Sendai Framework, and SDGs:* The aims of these agreements are closely linked, but responsibilities sit with different ministries, implementation relies upon different funding streams and they are subject to different monitoring requirements. Increasing coherence has the potential to achieve greater efficiency and effectiveness in implementation, and minimise potential trade-offs.
- *Scaling-up funding models for adaptation infrastructure, including ecosystem-based adaptation*: Viable and scalable funding models are required to meet the growing need for resilient infrastructure. The appropriate mechanisms will need to be tailored to the types of infrastructure to be funded and linked to suitable financing instruments. Further guidance could help to maximise the impact of funding streams such as Official Development Assistance.
- *Developing and implementing strategic "pathways" for climate change adaptation:* Sequenced, packages of adaptation measures can be realised at lower cost and with more flexibility to respond to changing circumstances. Building on experiences gained in using "pathways" in planning infrastructure for flood management, there is the potential to broaden the application of this approach to support implementation in other sectors.

- *Increasing access to science-based information on climate-related risk projection and guidance on adaptation practices:* the development and dissemination of accurate climate change impact projections, relevant datasets and information can facilitate effective adaptation planning, implementation and decision making across sectors and geographic scales (including the local level).

References and notes

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