Underfinanced. Underprepared.

Inadequate investment and planning on climate adaptation leaves world exposed

Adaptation Finance Gap Update 2023

Adaptation Gap Report 2023

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1. Introduction and context

Lead author: Paul Watkiss (Paul Watkiss Associates)

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Introduction

The Adaptation Gap Report (AGR) 2023 has undertaken a comprehensive assessment of the literature and commissioned new studies to provide updated estimates of the cost of adaptation and current adaptation finance flows, and thus the adaptation finance gap for developing countries (the non-Annex I countries defined under the United Nations Framework Convention on Climate Change [UNFCCC]).[1] This report, the **Adaptation Finance Gap Update** (2023), provides a more detailed write-up of this analysis.

The adaptation finance gap is defined as the difference between the estimated costs of meeting a given adaptation target and the amount of finance available for adaptation (United Nations Environment Programme [UNEP] 2014). In practice, this is a simplification since estimating the finance gap is challenging, both conceptually and quantitatively (UNEP 2016). Furthermore, while a monetary metric helps communicate the scale and urgency of the gap, finance is a means rather than an end as the availability of funds does not guarantee that they will be used efficiently and effectively, and there will be 'soft' and 'hard' limits to adaptation (see glossary). Nevertheless, a widening gap indicates a deepening climate crisis, with greater consequences for higher loss and damage, whereas a closing gap would indicate significant progress.

The new estimate of the adaptation finance gap has been based on three evidence lines:

- It has produced an updated modelled cost of adaptation, using sector models and new analysis to estimate adaptation costs for developing countries (see chapter 2).
- It has reviewed adaptation finance needs reported in the nationally determined contributions (NDCs) and national adaptation plans (NAPs) of developing countries and analysed and extrapolated these to derive an estimate of finance needs for all developing countries (see chapter 3).
- It has reviewed the latest data on global adaptation finance flows to developing countries where possible at the country level to derive new adaptation finance flows (see chapter 4).
- Based on these evidence lines, it compares the adaptation costs/finance needs against current adaptation finance flows to estimate the size of the adaptation finance gap (see chapter 5).
- The report also considers the gender equality and social inclusion dimensions of adaptation costs and finance (see chapter 6).
- Finally, the report discusses ways to potentially bridge the adaptation finance gap (see chapter 7).

This new adaptation finance gap estimate is relevant in the discussion of the nature and size of the new collective, quantified goal on climate finance, to be set prior to 2025 by the Parties to the UNFCCC, and which will be fundamental to closing the adaptation finance gap in the least developed countries (LDCs) and for more vulnerable developing countries. It is also relevant to the decision taken at the twenty-sixth session of the Conference of the Parties to the UNFCCC (COP 26) in Glasgow to urge developed countries to at least double their collective provision of finance for adaptation to developing countries from 2019 levels by 2025 (decision CMA.3).

The framing of the costs of adaptation

The costs of adaptation can be defined as the costs of planning, preparing for, facilitating and implementing

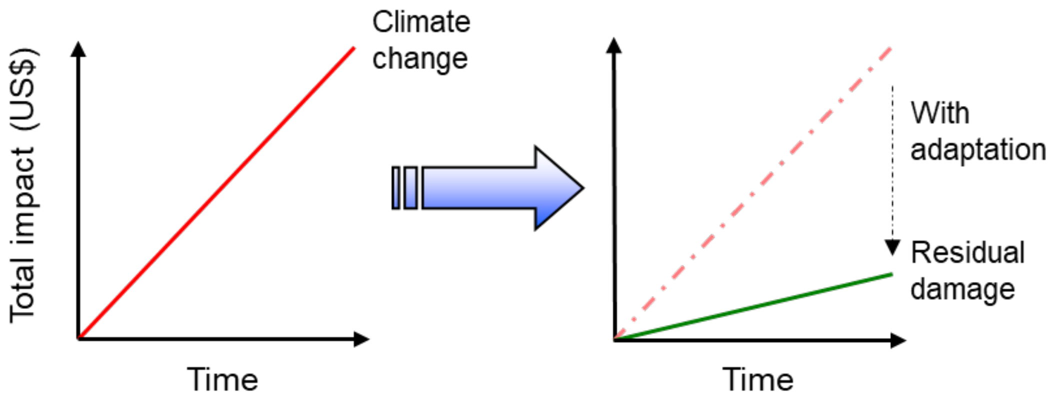
1 See www.unfccc.int/process/parties-non-party-stakeholders/parties-convention-and-observer-states.

adaptation measures to moderate harm or exploit beneficial opportunities arising from climate change (Intergovernmental Panel on Climate Change [IPCC] 2007; UNFCCC Adaptation Committee 2022).

In simple terms (UNEP 2015), the costs of adaptation can be assessed by estimating the current and future impacts of climate change, then assessing the reduction in these impacts (the benefit of adaptation) and its associated cost. However, there is a trade-off involved in how much adaptation to undertake, hence the residual damage costs after adaptation (see figure 1.1). This reflects the fact that adaptation is rarely completely (100 per cent) effective and that it usually becomes more costly (and less cost-effective) to reduce impacts towards zero. This residual damage closely relates to the concept of loss and damage.

This is shown in the simple schematic in figure 1.1. Increasing the quantity of adaptation implemented will lead to greater reductions in climate impacts, and thus greater adaptation benefits, as well as lower residual damage (and loss and damage). However, it will lead to higher adaptation costs.

Figure 1.1 Simple schematic of climate change impacts, adaptation and residual damage



Source: Adapted from Metroeconomica (2004).

It is highlighted that the trade-off between adaptation costs and residual damage involves ethical as well as scientific considerations, and that different actors may have different views on these issues (UNEP 2016; see also discussion of adaptation objectives in the following section).

Why do estimates of the costs of adaptation vary?

In practice, estimating the costs of adaptation is extremely complex (UNFCCC 2009; UNEP 2016). There is no single definitive estimate, i.e. the costs depend on the objectives chosen, the method used and the assumptions made (UNFCCC 2022). There are many reasons why different studies can produce very different adaptation costs, which are set out in the following section. These issues are important in interpreting the updated adaptation costs in this report as well as other estimates.

Framing issues

- **Objectives:** There is no single agreed quantitative goal or objective for adaptation (UNFCCC 2022), either at the global level (the equivalent of the Paris Agreement Goals) or the national level (e.g. as with country net zero goals or NDC mitigation targets). The costs of adaptation therefore vary with the objectives set for it (see figure 1.1; UNEP 2016) and whether this is based on economic efficiency, levels of acceptable risks, reducing impacts to current levels, etc. (for examples, see Ward *et al.* 2017 and Nicholls *et al.* 2019). This objective also determines the residual damages after adaptation, which is relevant for loss and damage.

- **Uncertainty:** There is high uncertainty around the future level and risks of climate change and thus the amount of adaptation needed (Wilby and Dessai 2010). This includes uncertainty due to alternative future emission scenarios (i.e. whether the goals of the Paris Agreement will be achieved, or for alternative representative concentration pathways (RCPs), as well as from alternative socioeconomic scenarios (such as alternative shared socioeconomic pathways [SSPs]). This is compounded by the uncertainty from different climate models for given RCP scenarios, i.e. from hotter, wetter or drier models, as well as uncertainty around levels of (physical) risks for a given level of climate change. Consideration of this uncertainty determines the central estimate and range for adaptation costs, but can also influence the overall framing of adaptation (see later discussion on adaptive management).

- **Coverage:** Adaptation costs vary with the sectors and the risks considered (UNFCCC 2022), and greater coverage will mean higher adaptation costs. Many studies focus on a small number of sectors/ risks and all studies have partial coverage (of all possible risks).

- **Boundaries**: Adaptation costs vary with the boundaries and definitions set. Higher adaptation costs arise if existing adaptation deficits are included (i.e. actions that tackle existing natural climate variability and extremes) (Parry *et al.* 2009; UNEP 2016). Similarly, adaptation may include or exclude development options (and their costs) (Klein and Persson 2008), such as activities that increase household income, thus building general resilience.

To help address these issues, the Adaptation Finance Gap Update uses different evidence lines to help capture alternative perspectives, notably comparing modelled studies of the costs of adaptation and country submissions of adaptation costs. It also undertakes sensitivity analysis where possible (e.g. for the modelling analysis, using different objectives, scenarios and models). It also provides a central range rather than a single central number.

Methodological issues and assumptions

- Estimating adaptation costs is challenging (UNFCCC 2009: UNFCCC 2022). It requires the analysis of the site- and context-specific nature of risks (hazard, vulnerability and exposure) and the effectiveness of adaptation, which changes non-linearly over time (Chambwera *et al.* 2014). The approach to these factors influences adaptation cost estimates.

- Adaptation costs vary with the method used and the assumptions within the modelling or analysis framework, as well as with the assumed effectiveness of adaptation (in reducing climate risks). There are various methods that can be used for estimating the costs of adaptation, all of which have strengths and weaknesses (UNFCCC 2022) and influence the size of adaptation costs.

- Adaptation costs vary with the level of effectiveness assumed, i.e. the reduction in climate risks, noting this varies on a site- and context-specific basis (Watkiss 2016).

- The incremental level of climate impacts, and the level of adaptation and costs, depend on the historical reference period chosen (e.g. 1961–1990 or 1981–2000). More recent reference baselines will reduce the level of impacts, thus reducing adaptation needs and costs.

- Adaptation costs vary subject to whether a static baseline (current society and economy) or a future socioeconomic baseline is applied, since changes in development, the economy and the population affect the stock at risk, including its exposure and vulnerability.

- Adaptation costs vary depending on whether autonomous adaptation is included in the analysis of impacts (for example, from natural acclimatization to heat, or from changes in prices in markets) (Parry *et al.* 2009).

- Adaptation costs are usually higher if real-world implementation is considered, and associated opportunity and transaction costs, as well as design, management, implementation and monitoring costs, are included (UNEP 2018), as compared to studies that consider technical costs only.

- Adaptation costs are lower if learning and innovation are included. They are also lower if soft options (such as early warning) are considered, as these have potentially lower costs when compared to engineered options (UNEP 2018).

- Adaptation costs vary with the US$ metric used. Some estimates are reported in purchasing power parity (PPP) and some as absolute (nominal) values. Different studies have different price years, and there is a need to adjust such values to compare them in equivalent terms.

- Adaptation is often described as a process (IPCC 2014). An adaptive management approach frames climate risks iteratively over time, then uses decision-making under uncertainty to help develop adaptation interventions (Watkiss *et al.* 2014). This uses a completely different framing for adaptation, thus leading to very different costs as compared to a static, linear least cost optimization.

These issues are acknowledged in the AGR and their influence on reported values is analysed.

Additional factors and key gaps

While there has been significant progress in estimating adaptation costs, even since the last Adaptation Finance Gap Update (UNEP 2016), there are several areas that are still not well captured in the literature:

- Most adaptation costing has been focused on incremental adaptation (IPCC 2022), but the need for transformative and transformational adaptation is needed and will involve very different costs. However, there is very little literature on the costs of transformational adaptation, constituting a key research gap.

- Adaptation costs will vary with assumptions made about adaptative capacity and its influence on the effectiveness of adaptation (Watkiss and Cimato 2016).
- Adaptation costs will vary with soft and hard limits to adaptation (IPCC 2022). This also has a direct bearing on residual damages. However, there has been little analysis of how these limits could affect adaptation costs. This is another key research gap.
- Most studies have focused on the adaptation to direct climate change impacts. There is increasing awareness of cascading and compounding risks (Jaroszweski, Wood and Chapman 2021) and the need to adapt to these, but there is very little literature on costing adaptation to address these interdependencies.
- Adaptation that considers gender, equity, social inclusion or distributional analysis will give different weight to different groups and can affect costs.
- Mitigation and adaptation can involve positive synergies, but also potential trade-offs (Klein *et al.* 2007; IPCC 2018). If these synergies and trade-offs are considered, this can change adaptation options and affect costs.
- Adaptation is often delivered through a mainstreaming approach, i.e. integrated in existing policies and programmes (Organisation for Economic Co-operation and Development [OECD] 2015) rather than as a stand-alone policy or primary objective, which can also affect adaptation costs. There can also be synergies (or sometimes conflict) with other policy objectives, which can affect the costs of adaptation.

These are priorities for future research and, in turn, future adaptation finance gap updates.

Noting these issues, the Adaptation Finance Gap Update 2023 has identified indicative ranges of adaptation costs using alternative evidence lines and metrics.

Adjustment and reporting of values

This study brings together information on costs and finance flows from many different sources. It is therefore important that these costs are expressed in comparable terms.

Most of the studies and model outputs used in this Adaptation Finance Gap Update report cite values in United States dollars (referred to here as US$ for consistency with the AGR 2023). However, these values are often not directly comparable. For example, some models provide adaptation costs in 2005 US$, some NDCs may report $ values for a recent year (2015), and finance flows are reported in 2021 US$.

There are conventions on how to produce comparable values[2] and adjust for different currencies or values in different countries.[3] However, the exact approach used varies with the objective of the study.

For the Adaptation Finance Gap Update 2023, we are interested in the gap between current flows of international finance for the most recent year available (which is 2021) in comparison with how much finance is needed, based on studies of the costs of adaptation/adaptation finance needs, expressed in equivalent terms. This requires an analysis of adaptation costs and finance flows in equivalent constant 2021 US$ values, without purchasing power parity (PPP) adjustments.

Regarding the base (price) year, all values in this report are reported in constant 2021 prices (to year end 2021), which was the most up-to-date gross domestic product (GDP) deflator data set when the analysis was started and aligns with the method used for inflation in the Organisation for Economic Co-operation and Development (OECD) Development Assistant Committee (DAC) database set and the latest figures reported therein.[4]

2 Values or prices can be expressed either in nominal (current) or real terms. Nominal terms are the values expected to transpire at the point that relevant transactions take place, hence they are sometimes referred to as 'money of the day' prices. Real prices attempt to strip out the effects of inflation. This can be useful when comparing the relative size of resource flows associated with a time series of costs or values. However, there are different ways to adjust for inflation, either using consumer price indices or GDP deflators, and there are choices on whether these are applied at the country level or using global values.

3 When converting between values in different local currency units, conversions can be made using either (expected) market exchange rates or PPP-adjusted exchange rates. This is potentially important when expressing values in per capita- or GDP-equivalent terms. The use of PPP exchange rates adjusts for difference in price levels between economies, therefore effectively providing a measure of what a local currency can buy in another economy. Some adaptation modelling studies express results with a PPP adjustment.

4 The index was constructed such that adjustment to 2021 US$ was inclusive of the inflation rate in 2021 in line with OECD methodology. This method was used both for new source data and to update previous estimates of adaptation costs and finance needs.

Price level adjustments were made based on the World Bank's GDP deflator series (World Bank, 2023). GDP deflators were considered more representative of the types of expenditure needed for adaptation than consumer price indices (CPI), though it is noted that GDP deflators exclude imports, which might be important for some sectors. There was a further choice on whether to use country level series or the global series. For modelled studies, cost estimates are based on international cost values, and the same is true for the adaptation finance flows, thus the global values are considered more appropriate. For the country submissions of financial needs, there will be a mix of international and national cost values, but since there is insufficient information to allow separation of these, global values are also used.

All values are reported using market exchange rates rather than PPP values.[5] In the context of the Adaptation Finance Gap Update 2023, the relevant cost of providing adaptation finance to a developing country is that using market exchange rates, so it would not be relevant to make a PPP adjustment.[6] When expressing adaptation costs/finance needs as a percentage of GDP, it is important to be consistent. It would therefore not be appropriate to adjust either the GDP or the adaptation cost for PPP without adjusting the other. We therefore report both the adaptation cost and GDP using market exchange rates.

Cost and financial flows are presented as annual finance flows or annual costs, with no discounting applied. This makes it easier to compare the likely resource needs for adaptation in different time periods while reflecting that underlying studies (modelled studies or NDCs/NAPs) do not typically provide detailed cost streams that allow estimation of present values. We note that, in many analytical contexts, such as in economic project appraisal, it would be appropriate to discount costs arising in future years. It should be noted that the modelled adaptation costs for the 2050s are also undiscounted for the same reasons.

Finally, when considering the residual damages after adaptation, there is an issue of comparing values across countries, especially as the negative impacts from climate change are generally considered to disproportionately arise in developing countries (Tol 2018). The challenge concerns how to compare the welfare losses from climate impacts (before and after adaptation) across those with disparate incomes and consumption levels: in simple terms, a dollar (of lost production, for example) to a poor person is not the same as a dollar to a rich person. In theory, it is possible to use some form of distributional or equity weighting when comparing or aggregating welfare losses to explicitly address these differences. However, this is challenging, and the values here do not make any adjustments for equity or distributional effects. Nevertheless, these issues are important and further work on this is a priority.

5 Where source data was provided in PPP terms, the values were first converted to US$ nominal for the price year in which they were presented using the World Bank's county-level series for the ratio of PPP conversion factor to market exchange rate (World Bank 2023). Values were then inflated to 2021 US$ using the World Bank's GDP deflator series for GDP referenced above.

6 However, we note that converting to PPP might provide an indication of the relative value for money that international finance flows could produce (for some types of domestic action).

2. The modelled costs of adaptation

Lead authors: Paul Watkiss (Paul Watkiss Associates), Kelly de Bruin (Economic and Social Research Institute [ESRI]), Shouro Dasgupta (CMCC Foundation), Kristie Ebi (University of Washington), Jochen Hinkel (Global Climate Forum), Alistair Hunt (Paul Watkiss Associates and University of Bath), Daniel Lincke (Global Climate Forum), Julie Rozenberg (World Bank), Pieter Sayer (Paul Watkiss Associates), Ammara Shariq (World Bank), Timothy Sulser (Consortium of International Agricultural Research Centers [CGIAR]), Timothy Tiggeloven (Vrije Universiteit [VU] Amsterdam), Jenny Tröltzsch (Ecologic Institute), Philip Ward (VU Amsterdam), Anita Wreford (Lincoln University)

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Key messages

- The Adaptation Finance Gap (AFG) Update 2023 has undertaken an updated modelling assessment of the cost of adaptation for developing countries. This analysis has used a suite of global sector assessment models, complemented by new analysis in additional sectors.
- The update analysis estimates the plausible central costs of adaptation at approximately US$240 billion per year this decade (up to 2030), with a range of US$130–415 billion per year. The central estimate is equivalent to 0.56 per cent of the gross domestic product (GDP) (2021) for all developing countries (or approximately US$33 per capita/per year).
- The highest adaptation costs are for river flood protection, infrastructure and coastal protection, and for the regions of East Asia and the Pacific and Latin America and the Caribbean.
- The highest absolute costs are for the upper- and lower-middle-income countries. However, when expressed as a percentage of GDP, adaptation costs are much higher for low-income countries (3.5 per cent) than for lower-middle-income (0.7 per cent) and upper-middle-income (0.5 per cent) countries.
- The costs for lower-income and lower-middle-income countries are estimated at US$76 billion per year this decade: the costs for small island developing States (SIDS) alone are estimated at US$4.7 billion per year (0.7 per cent of their GDP) and for least developed countries (LDCs) at US$25 billion per year (2 per cent of their GDP).
- The modelled costs of adaptation are estimated to increase significantly by 2050, especially for high-warming scenarios.
- These updated costs show a significant increase compared to previous similar studies. This not only reflects the more negative impacts of climate change reported in the literature (for the sectors previously modelled), but also a wider range of risks and sectors.

Introduction

For the AFG Update, a detailed review and synthesis of the literature on costs of adaptation has been undertaken, along with the development of new modelled estimates.[1] This updates the previous modelling analysis undertaken for Adaptation Gap Report 2016 (United Nations Environment Programme [UNEP] 2016a).

Global modelling assessments

Since the AFG Update 2016, there have been a significant number of additional studies on the global economic costs of climate change. This expanded literature was reported in the Intergovernmental Panel on Climate Change Working Group II *Sixth Assessment Report* (IPCC WGII AR6) (O'Neill *et al.* 2022). Most of the earlier literature on the economic costs of climate change available at the time of the AFG Report (UNEP 2016a; UNEP 2016b) was produced using a small number of integrated assessment models (IAMs). There are now other modelling approaches used in addition to these IAMs, including structural models (such as computable general equilibrium modelling (CGE)) and econometric (statistical) studies.

While this has led to a greater number of studies, it has also significantly increased the range of published estimates (of the economic costs of climate change and the social cost of carbon). The IPCC (O'Neill *et al.* 2022) reported that the wide range of estimates and lack of comparability prevented identification of a robust range of estimates with confidence.

Nonetheless, the results of these new studies, especially some statistical ones, report much higher estimates of economic costs of climate change. Furthermore, updates to existing IAMs are leading to higher economic costs (e.g. as reported in social cost of carbon estimates [see Rennert *et al.* 2022; Tol 2023]). These higher economic costs of climate change are likely to suggest higher adaptation costs.

However, while more studies have been published on the economic costs of climate change, much less progress has been made in producing new estimates of global adaptation costs. Indeed, adaptation remains poorly represented in current global modelling frameworks and models (van Maanen *et al.* 2023). The IPCC AR6 WG II (New *et al.* 2022) reviewed the global costs of adaptation for developing countries. In addition to the previous AFG reports (UNEP 2016a; UNEP 2016bl; Chapagain *et al.* 2022), it identified only one additional global study on the costs of adaptation (Markandya and González-Eguino 2019). A review for the AFG Update 2023 has identified only a limited number of additional global adaptation studies since the IPCC report. These include an IAM study for Africa (de Bruin and Ayuba 2020) and an IAM global study (van der Wijst *et al.* forthcoming). There are also more CGE studies that look at adaptation (for a recent review, see Wei and Aaheim 2023), though most of these are focused on autonomous adaptation at the global level, with most planned adaptation studies at the sectoral or regional level.

Sector modelling assessments

Due to the challenges involved in integrating adaptation into global economic models, and the low number of published studies, an alternative approach is to aggregate adaptation costs produced at the sector level.

This includes use of sector IAMs, sector economic models and sectoral assessments. This approach allows for an improved representation of adaptation compared to global economic assessments, though it does not capture the wider economic and cross-sectoral linkages the latter can provide.

Ideally, these sector studies are run using consistent scenarios and assumptions, which can be aggregated to produce global figures, or subsequently input into integrated global economic models. Such a sectoral modelling approach was used in earlier studies, including the World Bank Economics of Adaptation to Climate Change (EACC) study (World Bank 2010; Narain, Margulis and Essam 2011).

In the AFG Update 2023, a sectoral approach has been used to produce new estimates of the costs of adaptation for developing countries. This has taken adaptation cost estimates from established sector models and their recently published studies, working with modelling teams to extract relevant adaptation cost information and updating this to current prices (to allow presentation of values as annual undiscounted adaptation costs). It has also updated previous sectoral assessments and derived indicative values for several key gaps. The resulting sectoral estimates have been aggregated to provide a new indicative cost of adaptation for developing countries. This approach has allowed a comprehensive update of the costs of adaptation. However, the Adaptation Gap Report 2023 did not commission a new suite of harmonized modelling from each team. While the analysis has aimed to harmonize wherever possible, this

1 This chapter was co-financed by the ECONOGENESIS project funded by UK aid from the UK government and by the International Development Research Centre, Ottawa, Canada as part of the Climate Adaptation and Resilience (CLARE) research programme. The views expressed herein do not necessarily represent those of the UK government, IDRC or its Board of Governors.
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means that some differences exist in the exact reference periods, the representative concentration pathways (RCPs) and shared socioeconomic pathways (SSPs) considered, as well as in the climate model projections used. For the central numbers reported here, the RCP4.5 scenario was chosen, though in the period up to 2030, there is relatively little difference between RCPs: the greater differences arise from alternative climate models and adaptation objectives.

Coastal zones

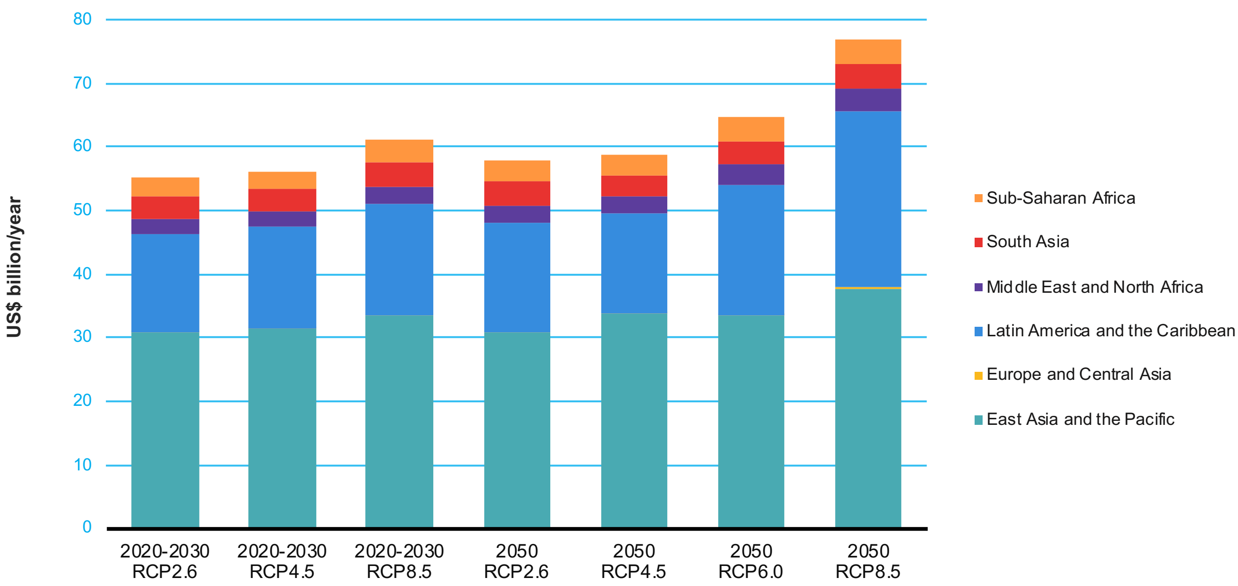
In addition to containing high population densities and significant economic activity, coastal zones provide important ecosystem services. Sea level rise and changes in storm surges have the potential to increase risks to coastal areas, which could in turn lead to increased flooding, loss of land, coastal erosion, salt water intrusion and impacts on coastal wetlands and the services they provide (Glavovic *et al.* 2022).

Adaptation to these coastal risks includes different strategies, including protect, accommodate or retreat, but also with the potential to use ecosystem-based adaptation, or to advance (IPCC 2018). Most adaptation cost studies have focused on protection to address flood risks (e.g. using dikes) and measures to reduce erosion (e.g. beach nourishment). However, even with coastal protection, a residual risk remains.

Modelling of the global costs of sea level rise, and of the costs (and benefits) of coastal adaptation, are the most covered sector in the literature. There are multiple models and estimates (e.g. Narain, Margulis and Essam 2011; Hinkel *et al.* 2014; Diaz 2016; Nicholls *et al.* 2019; Tamura *et al.* 2019, Tiggeloven *et al.* 2020; Brown *et al.* 2021). Several of these have been based on the Dynamic Interactive Vulnerability Assessment (DIVA) model (Hinkel *et al.* 2013, Hinkel *et al.* 2014), the results of which have been widely published in academic literature (Lincke and Hinkel 2018; Brown *et al.* 2021; Lincke and Hinkel 2021).

For this analysis, the AFG Update 2023 has collaborated with the DIVA team to derive updated values. These are based on recent, updated modelling runs from the Co-designing the Assessment of Climate Change (COACCH) project (Lincke *et al.* 2018). The updated values from DIVA for the adaptation costs for developing countries are presented in figure 2.1 as the annual undiscounted cost of adaptation only, excluding residual damage (2021 prices). The analysis has also been run with a selection of RCP scenarios up to 2050, with the additional adaptation costs presented relative to the reference period 1985–2005. All these climate scenarios use the SSP2 socioeconomic scenario with 'medium' estimates for the rate of ice melting, apart from RCP8.5, which uses a high level of ice melting and SSP5.

Figure 2.1 Costs of coastal adaptation for developing countries from the DIVA model for a selection of RCP scenarios in the period 2020–2030 and for 2050



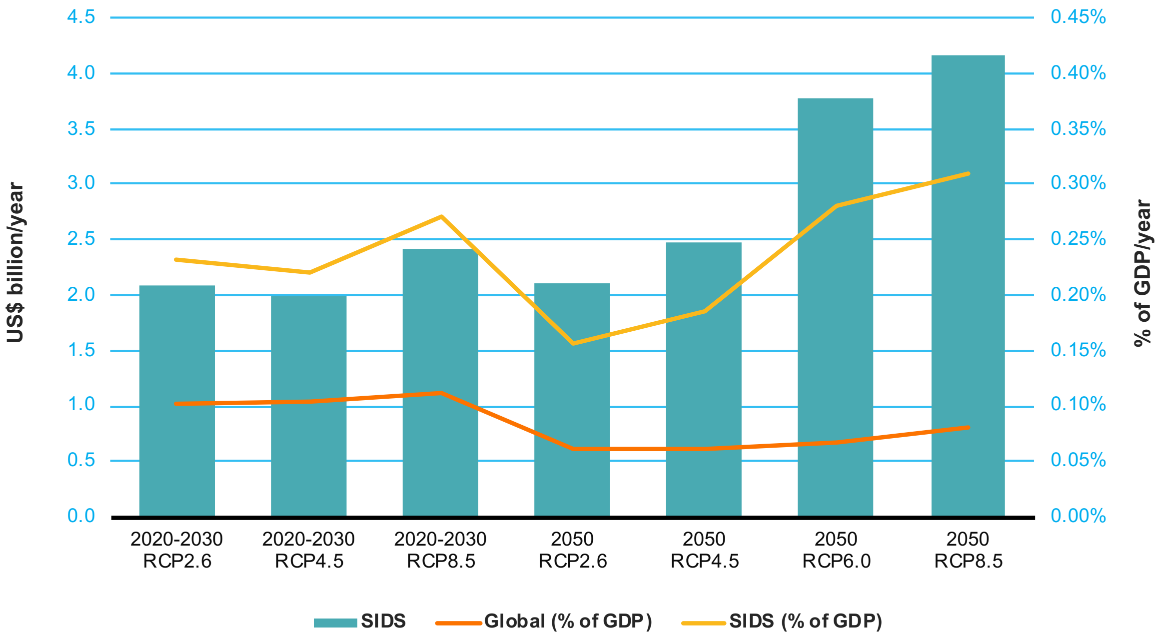
Source: DIVA model team; Lincke *et al.* (2018).

These indicate current adaptation costs of approximately US$56 billion per year for developing countries for the period 2020–2030 (using the average of the three five-year time steps from 2020 to 2030 for RCP4.5). These values increase for higher emission scenarios by 2050, especially for RCP6.0 and RCP8.5, and increase rapidly after the 2050s (not shown) due to rapid acceleration of sea level rise rates in high emission scenarios. The largest (total) costs are in Latin America and the Caribbean and East Asia and the Pacific. Together, these two regions account for over 80 per cent of the total costs across all climate and time-horizon scenarios.

It should be noted that the figure only shows the costs of adaptation. There is residual damage after adaptation, and the inclusion of these damage costs would significantly increase the values shown in figure 2.1. The current estimates from the model (for the period 2020–2030) are that the residual damages for developing countries would be several hundred billion US dollars per year. These residual damages are highly relevant to loss and damage. Although reducing residual damages is possible, this would significantly increase the adaptation costs.

Coastal adaptation is particularly important for SIDS.[2] The costs of coastal adaptation for these countries from the DIVA model (for the period 2020–2030) total US$2 billion per year, but rise significantly in future higher warming scenarios, as shown in figure 2.2. These costs are significant as a percentage of the GDP of these countries (0.3 per cent of current GDP on average, or 0.2 per cent of GDP in 2021), but higher than this for some very low-lying pacific countries (e.g. Vanuatu and Samoa). This is much higher as a proportion for all developing countries (where coastal adaptation is typically 0.1 per cent of GDP).[3]

Figure 2.2 Costs of coastal adaptation in SIDS from the DIVA model for a selection of RCP scenarios in the period 2020–2030 and for 2050



Source: DIVA model team; Lincke *et al.* (2018).

Other studies have run the DIVA model using different objectives for coastal projection (Nicholls *et al.* 2019), including maintaining constant protection levels, absolute flood risk levels, constant relative flood risk levels, high risk protection levels (risk intolerant) and economic (cost-benefit) analysis. Each of these scenarios changes the amount of adaptation undertaken and the residual costs after adaptation (and thus losses and damages). This finds higher costs of adaptation in a risk intolerant scenario, due to higher protection levels (however, this also produces lower residual damages). The study also highlights the growing importance of maintenance costs, and thus the need to have robust institutions for monitoring and maintenance in place in addition to upfront capital investment.

2 The list of SIDS includes 39 countries and is based on recent United Nations lists. See https://www.un.org/ohrlls/content/list-sids.

3 It should be noted that in the figure, the costs of coastal adaptation as a percentage of GDP fall in the RCP2.6 and RCP4.5 scenarios for the 2050 period (when compared to 2020–2030) due to rising GDP.

The values shown in figure 2.1 can be compared to those in other studies. The DIVA model was also used in the original World Bank EACC study. This estimated the costs of adaptation for coastal zones (World Bank 2010; Narain, Margulis and Essam 2011) at US$28 billion per year in 2005 prices (for the period 2010–2050) which is US$49 billion per year in current prices (constant 2021 US$). However, the earlier EACC values are much lower than the values in the AFG Update 2023, since the EACC values included residual damage in the reported adaptation costs. In figure 2.1, only adaptation costs are presented (residual damage would be additional). The higher costs reflect a combination of updates to the model (Hinkel *et al.* 2018) and higher projections of sea level rise (IPCC 2018).

There are other studies that use alternative models and report global costs of adaptation estimates (Diaz 2016; Tamura *et al.* 2019; Tiggeloven *et al.* 2020) and studies that assess overall macroeconomic costs (Parrado *et al.* 2020; Schinko *et al.* 2020). These studies differ widely in their assumptions about damages and adaptations. Analysis of these different studies, while challenging due to use of different metrics and scenarios, indicates significant differences between model results: Hinkel *et al.* (2021) found that there was a factor of 20 (or higher) difference in flood impacts depending on how coastal societies are assumed to adapt to sea level rise.

A sensitivity analysis on coastal adaptation costs using the GLObal Flood Risk with IMAGE Scenarios (GLOFRIS) model was also undertaken. This produced similar values for SIDS (as the DIVA model, reported above), but led to a lower estimate of the total cost of adaptation for developing countries, at approximately US$20 billion per year for RCP2.5 in the period up to 2030.

Flood protection and water

As one of the most important weather-related loss events, floods have significant economic impacts. In addition to affecting hydrological cycles, climate change has the potential to increase the magnitude and/or frequency of intense precipitation events and flood events, although there will be differences in how these changes take place between regions (Caretta *et al.* 2022). Although there is a wide range of adaptation options for addressing these flood risks, the modelling literature mainly focuses on flood protection structures.

Modelling of the costs of (river) floods and of the costs (and benefits) of adaptation protection are well established in the literature.

For this analysis, the AFG Update 2023 has collaborated with the team of the GLOFRIS flood model (Ward *et al.* 2017), one of the leading global flood risk models for river (fluvial) flooding to produce updated adaptation cost values for developing countries. This has drawn on recent global model runs and results for flood costs (expected annual damage), adaptation investment and residual damage (expected annual damage [EAD]) at the subnational level undertaken in the COACCH project analysis (Lincke *et al.* 2018). The outputs from the model were updated to ensure consistency with other AFG Update 2023 numbers and the subnational data were aggregated to the national level. Furthermore, the values were updated from the model (which produces values in 2005 purchasing power parity (PPP) US$) to 2021 US$ constant.[4] The output from the model, produced as investment and maintenance costs over a defined period (2010–2050), was also annualized to allow presentation of results in a format similar to those used in other sectors. The costs are presented relative to a baseline for 1960–2000, for both historical climate and historical investment.

The data included a range of RCP–SSP combinations (RCP2.6–SSP2, RCP4.5–SSP2 and RCP8.5–SSP5) and climate models (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM and NorESM1-M). Three adaptation scenarios were also considered: (1) protection constant, which keeps future protection levels the same as current protection levels, (2) absolute risk constant, which calculates future protection standards when the absolute value for EAD is kept the same as the current value and (3) relative risk constant, which calculates future protection standards when EAD as a percentage of GDP is kept the same as the current value.

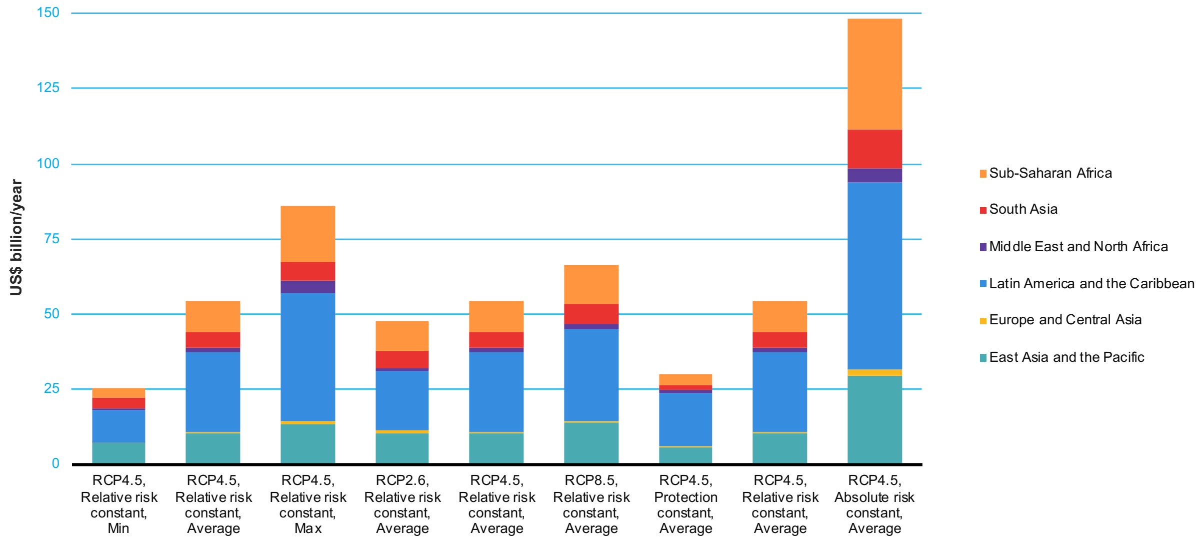
The relative risk constant, RCP4.5-SSP2 was taken as the indicative central value. **This central scenario estimates annual global costs of US$54 billion per year for developing countries for the period 2010–2050**. The largest costs (in total) are in Latin America and the Caribbean and East Asia and the Pacific, as well as sub-Saharan Africa.

However, there is a large range around these central estimates, as shown in figure 2.3. Adaptation costs vary across the climate models ('min' and 'max')[5] and across RCP scenarios (noting that the variance between the climate models is greater than between the RCPs). In addition, the choice of adaptation objective significantly affects the results, with the highest costs from the absolute risk scenario, although this would lead to lower residual damage. It should also be noted that inclusion of residual damage costs would significantly increase the total values.

4 First, values were converted to 2005 US$ nominal using the World Bank's 2005 country-level series for ratio of PPP conversion factor to market exchange rate. Values were then uplifted to 2021 US$ nominal using the World Bank's series for the international GDP deflator.

5 The 'min' and 'max' values refer to the minimum and maximum estimates provided across the five climate models, respectively.

Figure 2.3 Adaptation river flood costs for developing countries for different RCPs, climate model runs and objectives for the period 2010–2050 (constant 2021 US$)



Source: GLOFRIS model team.

These values can be compared to other studies. The values are significantly higher than the previous EACC values (World Bank 2010). Narain *et al.* (2011) used a very simple approach based on costs of several past infrastructure projects. This reported values of US$7 billion/year in 2005 prices (for the period 2010–2050) which is US$12 billion/year in current prices (US$ 2021 constant).

Several global, regional and national flood models and modelling assessments have also been undertaken. These highlight the further importance of model choice on uncertainty, as there can be a large difference in flood costs depending on the models used (due to differences in models and methods, inclusion of both surface and river flooding and levels of existing protection assumed, as well as spatial resolution). This has been found in multi-model comparison studies. For example, Aerts *et al.* (2020) compared eight global flood models with a case study in China and found substantial variability, up to a factor of 4, between the flood hazard maps in the modelled inundated area and exposed GDP, and therefore in expected annual exposed GDP. These differences in expected damage will lead to very different adaptation levels and thus adaptation costs.

Finally, some omissions in these adaptation costs have been highlighted. The GLOFRIS model does not include pluvial flooding (flash floods and surface water flooding). The inclusion of adaptation to address these surface water and flash floods would increase costs. In addition, the analysis does not include the future impacts of climate change on water supply. Previous analysis has assessed the costs of adaptation for water supply for municipal and industrial water (Ward *et al.* 2010).[6] Straatsma *et al.* 2020 assessed the annual adaptation costs to reduce the future global water gap (water demand minus water supply) and report much higher annual adaptation costs (globally), including in Asia. However, the addition of water supply involves overlap with irrigation costs in the agriculture sector in figure 2.5, and with water sanitation and health infrastructure in the health sector, and are therefore not included in figure 2.3, although there would be additional adaptation costs associated with these other aspects of water supply and demand, including integrated water resources management, which could be significant.

Infrastructure

Infrastructure plays a key role in social and economic development. There is growing demand for new infrastructure, especially power, transport, telecommunications and water and sanitation, in developing countries. However, this new infrastructure is vulnerable to climate change, especially given its long lifetime (Dodman *et al.* 2022). There is therefore a need to address these risks during design, often known as 'climate proofing' (Asian Development Bank 2020).

Previous studies have analysed the costs of adaptation for enhancing the resilience of future infrastructure (see Organisation for Economic Co-operation and Development 2015). The starting point for such assessments is projections of infrastructure investment levels over time. The additional

6 The reported costs in Ward *et al.* (2010) estimate water supply costs (met through increased reservoir yield and backstop measures) to be US$12 billion per year globally in both wet and dry scenarios.

costs of adaptation can then be derived using markups (i.e. the per cent increase for climate proofing investment) or through more detailed subsector modelling analysis.

Such an analysis was published by the World Bank in a series of reports (Hallegatte, Rentschler and Rozenberg 2019a; Rozenberg and Fay 2019; Hallegatte *et al.* 2019b). These reported that strengthening infrastructure assets in low- and middle-income countries would increase investment needs in power, transport and water and sanitation by between US$11 billion and $65 billion per year by 2030 (discounted present values), which is estimated at 3 per cent of baseline infrastructure investment needs (on average, taking account of variations between sectors and regions). This analysis drew on the technical and engineering approaches identified in Miyamoto International (2019) and the associated cost of making assets stronger in the face of natural hazards, as well as the additional quality control needed to ensure these assets are built and maintained to the expected standards.

Hallegatte *et al.* (2019b) highlight large uncertainties in estimating the costs of making infrastructure more resilient, not least due to future uncertainty regarding climate change, levels of disruption and repair and maintenance costs. The Hallegatte *et al.* (2019b) analysis assessed two scenarios to consider these aspects: one where there is perfect site-specific knowledge on hazards (now and in the future) and thus design and standards are targeted only at vulnerable infrastructure, and another where this information is unknown and general standards are applied to all infrastructure. The latter involves much higher additional costs.

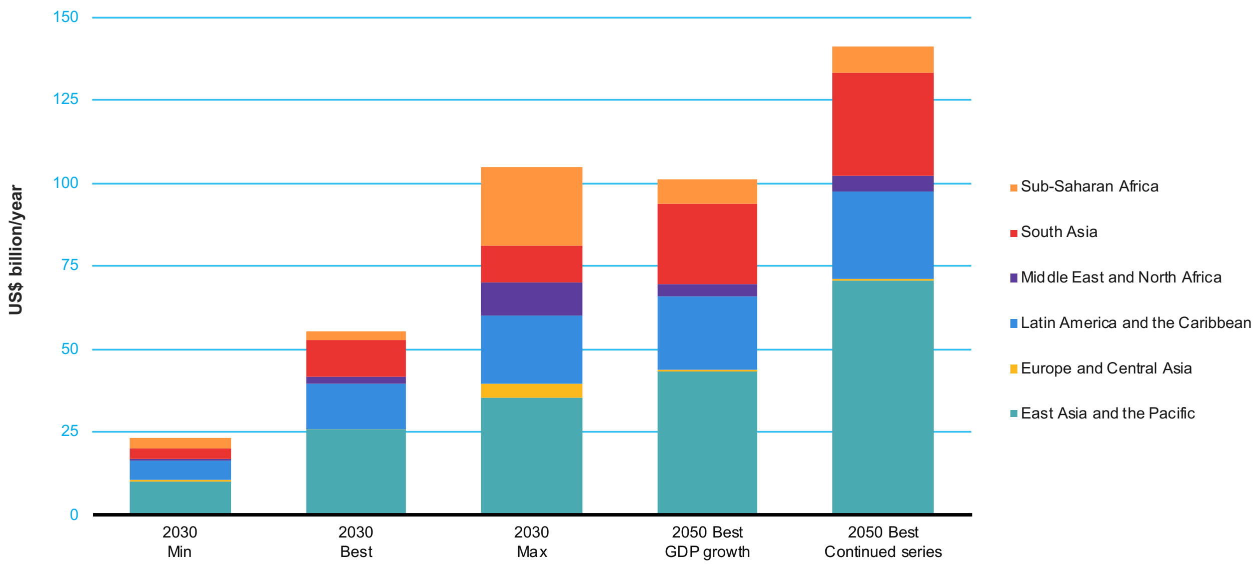
For this analysis, the AFG Update 2023 has collaborated with the World Bank team to harmonize their estimates (from Rozenberg and Fay 2019; Hallegatte *et al.* 2019b) to allow comparison with other sectors.[7] The estimates include the costs of making infrastructure resilient for the transport and energy sectors, as well as the costs associated with additional water, sanitation and hygiene (WASH) (presented in the later Health section). In addition, while these studies produced costs for flood protection investments (river and coastal) and costs for making irrigation investments resilient, these overlap with other AFG sections (for coastal zones, river floods and agriculture) and are thus not included here. Therefore, the focus is on the energy and transport subsectors. This includes urban public transport, but no other urban infrastructure.

The costs of adaptation for making energy and transport infrastructure resilient for developing countries (2015–2030) were estimated at US$9–27 billion per year for energy (up to 2030) and US$860 million to US$35 billion per year for transport. These estimates assume that hazards are known and the range reflects the variation in future infrastructure investment. If the alternative scenario is used, where this information is unknown, and standards are built into all infrastructure in all locations, costs rise very significantly (by approximately an order of magnitude). For the AFG Update 2023, we have used the first scenario. The values are updated to 2021 prices and presented as undiscounted costs. **These indicate a central value of US$56 billion per year, with a range from US$23–105 billion per year for the period up to 2030.** These indicate the highest costs in East Asia, followed by South Asia.

The AFG Update 2023 team also undertook a sensitivity analysis to extend these estimates to 2050, based on the projected increase in infrastructure investment. This used projected increases in GDP and assumed proportional increases in energy and transport investments over time. The same coefficients were then used to derive the additional adaptation costs for this future investment stock. These numbers for 2050 should only be considered indicative. Two extrapolation methods were used (figure 2.4). In the central case, a real GDP growth rate series based on the International Institute for Applied Systems Analysis' central SSP2 scenario was applied (International Institute for Applied Systems Analysis 2018). In the alternative scenario, the country-specific annual growth rates of adaptation costs from 2026 to 2030 (which are constant over time in the World Bank estimates) were used. These indicate a central value of US$107 billion per year, with an upper value of US$146 billion per year for developing countries. In practice, however, the values in 2050 will differ according to whether the Paris Agreement goals are met. This is because infrastructure built after 2030 will be exposed to very different hazards (over the asset lifetime) under a RCP2.6 scenario as compared to a RCP6.0 or RCP8.5 scenario.

7 Estimates for these sectors were available for 109 of the 154 non-Annex I countries. These 109 countries account for 88 per cent of the combined GDP of the 154 non-Annex I countries. The countries excluded are mostly Middle Eastern nations (including Saudi Arabia). If these countries were to be included, the Hallegatte estimates would be even larger.

Figure 2.4 Costs of adaptation for infrastructure (power and energy) for developing countries



Source: 2030 values from World Bank; 2050 values from AFG Update 2023 team based on extrapolation; Rozenberg and Fay (2019); Hallegatte *et al.* (2019b).

As reported in the original World Bank study (Hallegatte, Rentschler and Rozenberg 2019a), investing in more resilient infrastructure in low- and middle-income countries has low additional costs and is very cost-effective, with benefits four times greater than the costs. It is therefore robust and profitable, but also urgent.

Nonetheless, the measures do not reduce all risks to zero, i.e. there would still be residual damage. Hallegatte *et al.* (2019b) report that resilience measures assumed would reduce the risk of damage by a factor of 2–3 for new energy infrastructure assets and by a factor of 2 for transport infrastructure.

These values can be compared to those in previous studies. The costs of adaptation for infrastructure were among the highest in the original EACC study, reported at US$13.0–27.5 billion per year in the period up to 2050 (World Bank 2010; Narain, Margulis and Essam 2011). This is US$23–48 billion per year in current prices (constant 2021 US$). Approximately half of this was for urban infrastructure and approximately one third was for (road and rail) transport.

Finally, while the updated numbers are comprehensive, there are some key omissions, which suggest that they are underestimates. First, the analysis does not capture all infrastructure, excluding public, household and private investment in urban areas, which is an extremely large future infrastructure investment stream. Second, it only integrates resilience in new infrastructure and does not include the costs of retrofitting existing (long-lived) infrastructure. These retrofit costs can be high, though this can present an opportunity for countries to 'build better with new'.

Agriculture

Climate change has the potential to affect the agriculture sector (Bezner Kerr *et al.* 2022) both negatively (e.g. from changes in temperature, rainfall and extremes affecting suitability and productivity) and positively (e.g. from carbon dioxide [CO_2] fertilization and extended seasons in some locations). These will include direct effects from gradual climate change and extreme events, but also indirect effects, such as those caused by changes in prevalence of pests and diseases. In turn, these changes will affect yields and therefore production, consumption, prices, trade and land-use decisions.

There is a wide range of potential adaptation options for addressing these risks (Bezner Kerr *et al.* 2022), ranging from farm-level management and climate-smart agriculture to national policies and strategies. There is also information on the costs and benefits of these options (Vermeulen 2016).

For this analysis, the AFG Update 2023 has collaborated with the International Food Policy Research Institute (IFPRI). This team previously assessed the global costs of adaptation for developing countries (Nelson *et al.* 2009).

IFPRI have recently updated this analysis (Sulser *et al.* 2021) using biophysical crop models and a global agricultural supply and demand projection model. The new analysis focuses on a key dimension and indicator of adaptation to climate change: the number of people facing chronic hunger. In a scenario without climate change, the study estimates that the number of people facing chronic hunger could fall from the present global number of over 800 million to just over 400 million in 2050. However, climate change would reduce this fall, and the study estimates that an additional 78 million people could face chronic hunger in 2050 due to climate change, over half of whom would be in sub-Saharan Africa.[8]

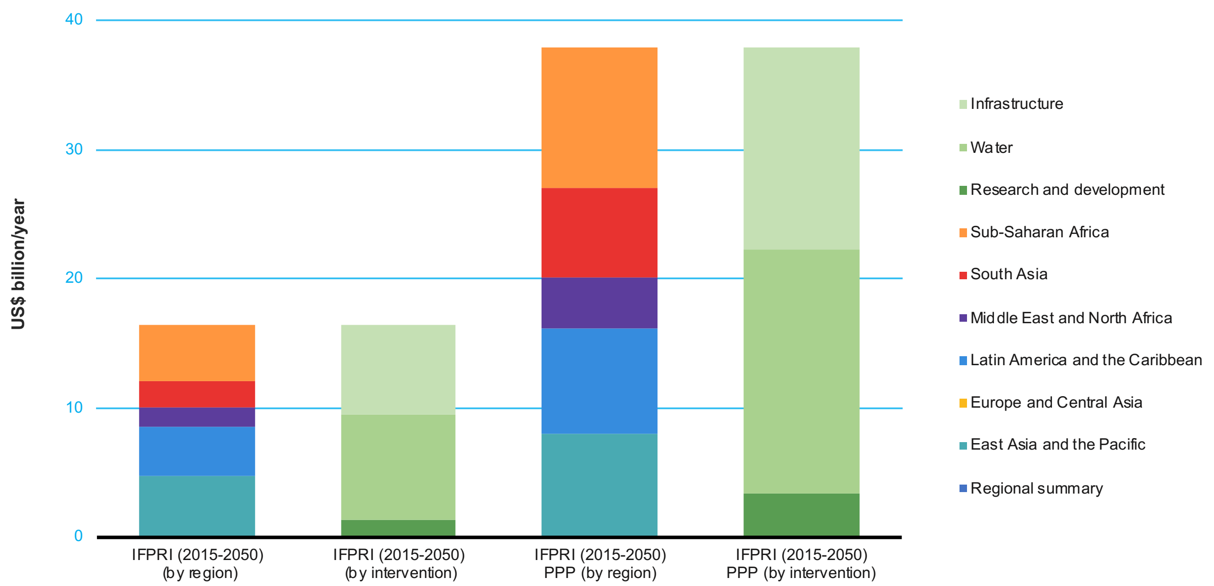
The study also estimates the additional investment costs in adaptation to reduce these additional climate impacts, with investments in international agricultural research, water management and infrastructure. The analysis reports that these adaptation measures could reduce future impacts almost completely (i.e. with adaptation, residual impacts would be below 5 per cent). The total public investment in these three adaptation areas in developing countries is estimated to average US$42.6 billion per year between 2015 and 2050 in the reference scenario, with an additional US$25.5 billion per year needed to offset the impacts of climate change on hunger (US$2005, PPP). The additional annual (undiscounted) costs include an additional investment of US$$2.0 billion per year in agricultural research and development, an additional US$12.7 billion per year in water investment and an additional US$10.8 billion per year in infrastructure investment (RCP8.5-SSP2, US$2005, PPP). A recent analysis by the IFPRI team (Rosegrant *et al.* 2023) on the research and development component finds very high benefit-cost ratios.

The adaptation investments offer a suite of options. For water management, these include climate-smart agriculture (sustainable soil and water conservation) and irrigation. For infrastructure, they include infrastructure along the value chain to enhance trade (imports and exports). CO_2 fertilization is not included in this. The costs include adaptation for agriculture and livestock, but not fisheries, and thus do not duplicate the subsequent fisheries section.

While the AFG Update 2023 has used these values, it has updated them to enable direct comparison with other sectors. The IFPRI values are reported in 2005 US$ PPP and have thus been updated to constant prices (constant 2021 US$).[9] This conversion was carried out as follows. First, regional 2005 US$ PPP values were converted to 2005 US$ nominal values using the 2005 GDP-weighted regional PPP to market exchange rate conversion based on World Bank data.[10] These values were then inflated to constant 2021 US$ using the World Bank international GDP deflator series.

This leads to adaptation costs of US$16 billion per year (2021 prices) for the period 2015–2050 for developing countries. The values are shown in figure 2.5. The highest regional costs are in East Asia, followed by sub-Saharan Africa.

Figure 2.5 Costs of adaptation for the agriculture sector in developing countries



Source: IFPRI model team (updated to constant 2021 US$ and 2021 US$ PPP-adjusted values), Sulser *et al.* (2021).

8 This is based on an RCP8.5 scenario from a hot model, relative to the 2005 climate. Note that alternative SSPs, RCPs and climate models lead to significant differences in these numbers in 2050 (for example, alternative SSPs affect future people at risk, potentially negatively or positively, while a RCP4.5 scenario would only lead to around half the additional impact).

9 Converting the 2021 US$ nominal values into 2021 US$ PPP using the 2021 GDP-weighted regional PPP to market FX exchange rate conversion based on World Bank data shows that, in PPP terms, costs are US$37.9 billion per year (US$3.4 billion per year for agricultural research and development, US$18.9 billion per year for water infrastructure and US$15.6 billion per year for infrastructure).

10 See https://data.worldbank.org/indicator/PA.NUS.PPP.

Since the values are based on a 2005 baseline and presented for the period 2015–2050, they do not include the existing adaptation deficit (or account for the adaptation costs already incurred to address warming caused by anthropogenic climate change throughout the twentieth century). Separate studies have estimated that the existing adaptation deficit is very large (Vulnerable Twenty Group and Climate Vulnerable Forum 2022). Countering this, the numbers in figure 2.5 are presented for a high-warming scenario in 2050 and would be lower for alternative warming scenarios. Although a single scenario is shown in figure 2.5, adaptation costs vary with underlying projections and productivity changes, around which there is very high uncertainty, as well as additional issues of CO_2 fertilization.

The study assumes that trade plays a role in addressing productivity reductions. The switch to greater imports is assumed to be frictionless and does not take full account of trade policy or barriers (Watkiss and Hunt 2018) or factor in the costs borne by local farmers, impacts on the wider multifunctionality of agriculture, or the importance of domestic targets for food security. This accounts for some of the differences in adaptation costs reported in nationally determined contributions (NDCs) and national adaptation plans (NAPs) (see chapter 5), as countries prefer options that address domestic productivity losses.

These values can be compared to those of previous studies. The previous IFPRI study (Nelson *et al.* 2009) estimated that agricultural productivity investments to offset the negative impacts of climate change (for calorie availability and child malnutrition) would be US$7.1–7.3 billion per year in the period 2010–2050 (US$2005 prices) in developing countries, with most costs in sub-Saharan Africa. This would be approximately US$12–13 billion per year in current prices (US$2021).

There are other estimates of the costs of adaptation in the literature (Mosnier *et al.* 2014; Baldos, Fuglie and Hertel 2020; Iizumi *et al.* 2020), some of which report significantly higher costs than the revised IPFRI study above, but some which report much lower costs (including the original World Bank EACC study, which reported the cost of adaptation (US$2005) for developing countries at US$2.5–3 billion per year (US$2005 prices) (World Bank 2010; Narain, Margulis and Essam 2011).

It is also highlighted, as acknowledged by the IFPRI authors, that the analysis focuses on one element (number of people at risk of chronic hunger) and a full analysis of adaptation to climate change in agriculture would require inclusion of many other social, economic and environmental dimensions, therefore implicitly involving additional costs. This includes additional adaptation needed to address the potential impact of climate change on pests and diseases.

Fisheries, aquaculture and marine resources

Climate change may significantly impact the fisheries and aquaculture sector (Barange *et al.* 2018; Cooley *et al.* 2022). These impacts are expected to result from several changes in the abiotic (i.e. temperature, oxygen levels, salinity and acidity) and biotic (i.e. primary production and food webs) conditions of the sea and inland waters, affecting reproductive success, growth, size and disease resistance, as well as the distributional patterns and composition, of species. Climate change may also impact critical habitats for fisheries (e.g. corals) and fishers and fishing operations (vessels, cages and infrastructure), including through changes in the intensity and frequency of storms and extreme weather events. Finally, there are potential impacts of sea level rise and extremes on infrastructure and value chains associated with the fishing industry. However, these changes must be seen against the backdrop of existing human activities, which affect the abundance and distribution of many marine organisms and fish stocks. In other words, climate change is an additional threat multiplier to fisheries and aquaculture sustainability.

For the AFG Update 2023, a new analysis has been undertaken to look at fisheries in more detail.[11] This has revised previous estimates of costs of adaptation to address changes in marine fish catch potential, but also extended to several other areas (safety at sea, inland fisheries, aquaculture and marine protected areas [MPAs]).

For marine fisheries, the analysis has used updated estimates of marine fish catch potential from the Food and Agriculture Organization of the United Nations (Barange *et al.* 2018). This provides country-specific changes in the distribution of fish biomass and productivity with climate change, and thus catch potential, and shows (in general terms) that fisheries' productivity will increase in high latitudes and decrease in mid- to low latitudes, primarily due to species shifts. This tends to produce more negative impacts for developing countries.

The analysis used detailed sectoral adaptation costs, as set out in countries' NDCs and NAPs, as well as other climate finance projects, including the Strategic Programme for Climate Resilience. This identified 32 national cost estimates specific to fisheries. These costs were used to build a linear regression model of total fish catch weight and adaptation costs. This was used to extrapolate to all developing countries based on landed fish catch.

11 The fisheries analysis was funded by the Food and Agriculture Organization of the United Nations (FAO) under the Norwegian Agency for Development Cooperation (NORAD)-funded Project on Assisting partner countries and key stakeholders to adapt to climate change effectively (GCP/GLO/352/Nor, component 2). The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

To complement this, the data on changes in marine fish catch potential from Barange *et al.* (2018) to 2050 was used. Then, complementary adaptation strategies were analysed to address the change in fish catch potential projected. This assessed the costs associated with livelihood diversification programmes in areas negatively impacted by fish biomass loss caused by climate change. The analysis also considered the increase in MPAs needed to offset the loss of catch potential in developing countries' marine economic exclusion zones. The cost of this expansion of MPAs was estimated based on the costs of MPAs in the 30 by 30 target by 2030 from Waldron *et al.* (2020) and UNEP (2022) and the costs from Binet, Diazabakana and Hernandez (2015). Finally, an analysis estimating the potential adaptation costs for improving safety at sea was undertaken, reflecting the higher hazards in the marine environment (notably from tropical windstorms), but also the increased time at sea (due to species shifts) with climate change.

The analysis led to a total estimate for developing countries of **US$4.8 billion per year by 2030**. The costs are projected to rise significantly by 2050, in line with the increased shifts projected in Barange *et al.* 2018.

These values can be compared to previous studies. The synthesis report of the EACC included fisheries as part of agriculture (World Bank 2010: Narain, Margulis and Essam 2011) and thus assigned low adaptation costs to the fisheries sector. However, there were additional sector-specific values for fisheries that were included in the study; this included estimates in the underlying detailed analysis that estimated costs of adaptation for fisheries at US$2.6 billion per year (2005 prices) (equivalent to US$4.5 billion per year in current $2021) and a further separate fisheries report (Sumaila and Cheung 2010), which estimated the adaptation cost for fisheries at between US$7 billion and US$30 billion per year (2005 prices) (equivalent to US$12–53 billion per year in current 2021 US$).

While the values in this update are more comprehensive, in that they include safety at sea and in MPAs, they do not capture the full impacts of climate change on the marine environment, or on aquaculture. In particular, the impacts of ocean acidification, and the potential adaptation response to this, are not included.

Health

Climate change is increasing health burdens (IPCC 2022a), including those caused by direct impacts, such as heat-related mortality, and from indirect impacts such as from changes in the range, seasonality and intensity of vector-borne, food-borne and waterborne disease transmission. There are also risks caused by climate change to the delivery and demand for health systems and services, including on health infrastructure or supply chains, as well as disruption to access.

Many impacts projected in the short term can be avoided through effective and timely adaptation. Recent reviews have identified more information on health adaptation, but this includes little information on adaptation costs (Berrang-Ford *et al.* 2021; Scheelbeek *et al.* 2021).

The AFG Update 2023 used the projections from the World Health Organization (WHO) quantitative risk assessment of the impacts of climate change (WHO 2014), which estimated that between 2030 and 2050, climate change is projected to cause approximately 250,000 additional deaths per year from malnutrition, malaria, dengue, diarrhoea and heat stress (for the A1B scenario). The AFG Update 2023 team assessed the adaptation costs to reduce or prevent these additional health outcomes, using a similar approach to previous studies (Ebi 2008; Markandya and Chiabai 2009) but with updated costs of prevention.

While rates declined in recent decades in low-income and middle-income countries, currently 1 in 10 deaths of children under 5 years old is attributable to diarrhoea (Local Burden of Disease Diarrhoea Collaborators 2020). Diarrhoeal disease transmission is known to be affected by temperature and rainfall, and future climate-related fatalities were assessed in the WHO study (WHO 2014). These data were combined with the detailed country-level information on fatalities and cases from the GBD (GBD Diarrhoeal Diseases Collaborators 2017; GBD 2017 Diarrhoeal Disease Collaborators 2019). These impacts are largely preventable with existing interventions of rotavirus vaccine, safe water and sanitation, nutrition supplementation and use of oral rehydration solution (Local Burden of Disease Diarrhoea Collaborators 2020). Costs of prevention for these treatments were assessed based on the literature (from Walker *et al.* 2011; Horton 2017; Debellut *et al.* 2019).

The potential costs of making WASH investment climate-resilient were based on Rozenberg and Fay (2019) and Hallegatte *et al.* (2019b) (see Infrastructure section). These report that for future investment profiles, the cost to make water and sanitation systems more resilient would be between US$0.9 billion and US$2.3 billion per year for developing countries. These values were updated to 2021 prices. It is noted that they do not include the costs of making existing WASH systems resilient.

While major progress has been made in reducing the health burden of malaria, more than 600,000 people still die of this disease each year (WHO 2022). Climate change can potentially affect the geographic range and prevalence of malaria. The analysis combined the WHO projections on climate-related fatalities (WHO 2014) with the detailed country-level information on fatalities and cases from the *World Malaria Report* (WHO 2022). To estimate adaptation costs, it used updated information from recent cost-effectiveness reviews on preventative costs including insecticide-treated nets and indoor residual spraying (Conteh *et al.* 2021; Ralaidovy *et al.* 2021) and analysis from the WHO Global Technical Strategy for Malaria (WHO 2021).

Dengue is one of the most common vector-borne diseases worldwide, with an increasingly high economic burden (Shepard *et al.* 2016). There are projections that the dengue burden will increase due to climate change (Messina *et al.* 2019). The analysis used the WHO projections on climate-related fatalities (WHO 2014) with a detailed analysis of country-specific fatalities and cases from Zeng *et al.* (2021). These were combined with estimated costs for disease prevention (Mendes Luz *et al.* 2011; Fitzpatrick *et al.* 2017; Brady *et al.* 2020). These indicate high cost-effectiveness and positive benefit-cost ratios.

The analysis here has not considered health burdens caused by malnutrition/undernutrition, as the cost to reduce chronic hunger has already been assessed in the agriculture analysis.

The AFG Update 2023 team also assessed the costs of adaptation to address heat-related mortality, using data from the WHO (2014) study, and country-level data from the Lancet Countdown (The Lancet undated), while noting there are other quantitative studies (e.g. Gasparrini *et al.* 2017; Bressler *et al.* 2021; Vicedo-Cabrera *et al.* 2021). Preventative costs were based on the costs of heat-alert schemes and supporting health sector responses (Ebi *et al.* 2004; WHO 2009; Hunt *et al.* 2016; Chiabai, Spadaro and Neumann 2018), with effectiveness based on Toloo *et al.* 2013 (noting there is a wide range of effectiveness reported in the literature). The costs included a fixed annual cost component, but also a variable cost associated with health service outreach, capacity-building and end-user engagement. Resource costs were adjusted by country. While the overall costs of these interventions are low, there are residual damages after adaptation. There are also studies in the literature that estimate adaptation costs to address heat-related mortality through the use of air conditioning (e.g. see Carleton *et al.* 2022) or green infrastructure (e.g. Lungman *et al.* 2023), which have higher costs (but also higher co-benefits).

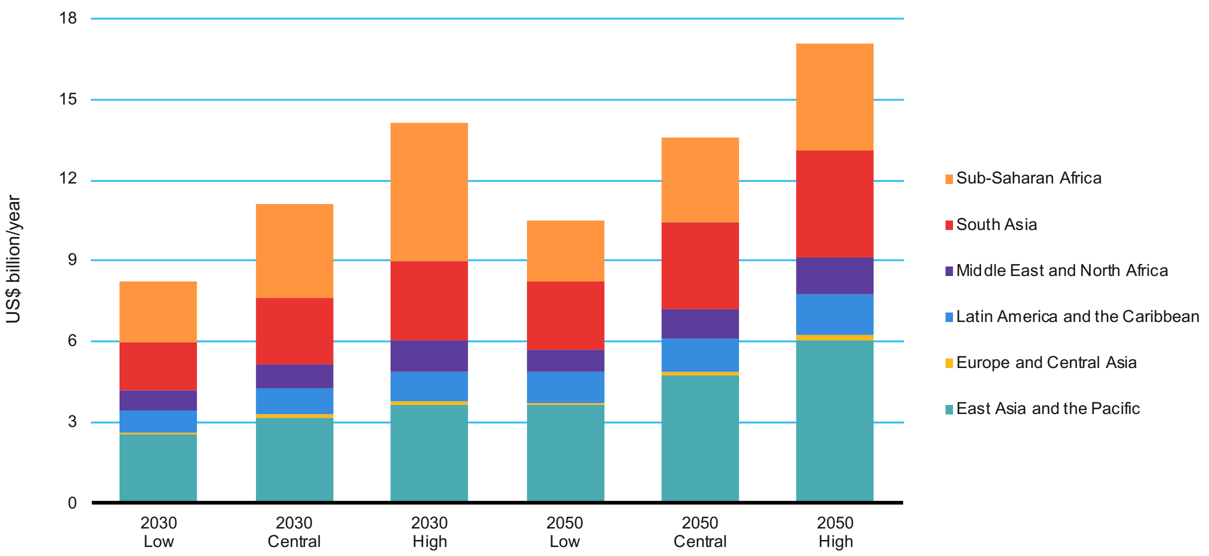
Finally, health adaptation is moving away from a focus on individual outcomes towards consideration of risks to health systems and health services (WHO 2015), with the integration of climate change adaptation (and mitigation) into health programmes and delivery, emergency preparedness and health information systems, supply chains and health infrastructure (hospitals and health facilities, including retrofits and building new infrastructure).

To explore this, indicative adaptation costs were developed. The potential costs of more robust surveillance and detection networks to address climate related risks were estimated, based on the global G20 High Level Independent Panel on Financing the Global Commons for Pandemic Preparedness and Response (G20 High Level Independent Panel 2020). This initiative recognizes that enhanced surveillance is a global public good. The G20 report identified financing needs at US$23.4 billion annually for robust surveillance and detection networks and building resilience in health systems in low-income and middle-income countries. Many of the recent major disease outbreaks cited in the report are climate sensitive, and changing climatic patterns may have facilitated the spread of a number of these, including chikungunya virus, Zika virus, Japanese encephalitis and Rift Valley fever (IPCC 2022a). To derive indicative costs, 5 per cent of the High Level Independent Panel costs was assumed to be adaptation relevant. A further indicative analysis was undertaken on the costs of climate proofing health infrastructure (WHO 2020). The analysis used WHO's Global Health Expenditure Database, which contains data on capital health expenditure.[12] It then separated out capital expenditure and the health infrastructure component of this, using data from several sources, including Organisation for Economic Co-operation and Development (2023). To estimate the additional costs of making these health infrastructure investments climate resilient, the markups from Rozenberg *et al.* (2019b) were applied.

Overall, **the costs of adaptation for the health sectors (for disease burden and health-care systems and health infrastructure) are estimated at US$11.1 billion per year for 2030** (for the A1B scenario). While these numbers update and extend the previous literature, they should only be considered indicative. The results are shown in figure 2.6. The range reflects the low and high estimated values from WHO (2014) which are based on different assumptions and a sampling of different climate models. The highest adaptation costs are in sub-Saharan Africa, and East Asia and South Asia, and predominantly in low-income and lower-middle-income countries (apart from heat, for which there are higher costs in upper-middle-income countries). The overall costs increase by 2050, though the increase is relatively modest due to declining climate-attributed cases of malaria and diarrhoeal disease projected by WHO (2014).

12 As this includes 95 countries, we used this data to interpolate values for the remaining 57 non-Annex I countries not covered in this data set (WHO 2023).

Figure 2.6 Costs of adaptation for health in developing countries



Source: AFG Update 2023 team based on projections from WHO (2014).

One key finding is that the costs of adaptation are low compared with health benefits (with high benefit-cost ratios) and there are potentially high levels of effectiveness. Nonetheless, there would be residual damages, especially for heat-related mortality.

These values can be compared with previous estimates. Ebi (2008) estimated the costs of adaptation (for diarrhoeal disease and malaria) at approximately US$3.5 billion per year for developing countries, equivalent to US$7.5 billion per year in current (2021) prices. The EACC study (World Bank 2010; Narain, Margulis and Essam 2011) estimated lower adaptation costs (US$1.5 billion to US$2 billion [2005 prices], equivalent to US$2.6–5.3 billion per year in 2021 prices) due to the assumption that future development would significantly reduce the baseline health burden. The values estimated in the AGR 2023 are therefore higher than these earlier studies, though this is due to the inclusion of more risks and categories.

Early warning and adaptive social protection to extreme weather events

Extreme weather is already causing significant costs to people and their livelihoods, especially the vulnerable (Birkmann *et al.* 2022) and there has been an increase in unprecedented climate extremes (shocks) in recent years. These events have the potential to increase under climate change, leading to chronic and sudden onset development challenges and potentially exacerbating poverty.

There is a range of adaptation options for addressing these extremes, many of which are covered in previous sectors. However, there are specific adaptation measures that can be directed towards the most vulnerable, and which are additional to the costs above. The AFG Update 2023 team have developed new estimates of adaptation costs in this area, focusing on two key interventions. These are enhanced weather and climate services, including early warning services, and adaptive social protection programming, including shock response contingency funds.

The estimates of the costs of adaptation for early warning services use several evidence lines. This includes the recent Early Warnings for All study (World Meteorological Organization 2022), which investigated the expansion and modernization needed in developing countries and estimated investment costs of US$3.1 billion over a five-year period (2023–2027), split across the four components of the value chain for early warning systems: (1) disaster risk knowledge and management, (2) observation and forecasting, (3) dissemination and communication and (4) preparedness and response.[13]

To complement this, a literature review was undertaken of the costs of modernizing and expanding early warning and hydrometeorological services at the national level to address

13 This is focused on developing countries, though the exact coverage varies. In some places the text refers to a "minimum 100 countries" where 65 are SIDS and LDCs and at least 35 are Official Development Assistance eligible countries, and in other places it refers to 140 countries (assumed to be the non-Annex I countries).

current and future climate change. The review identified 31 projects covering 34 countries across the developing world, including World Bank and Green Climate Fund projects. For each of these projects, the investment costs were analysed and annualized, with investment costs disaggregated into the four components of the value chain. These values were then used to provide weighted costs per country, with the costs for steps 1 and 2 of the value chain extrapolated based on regional surface-area-weighted average costs per km^2 to reflect the necessary observational and infrastructure coverage, and actions 3 and 4 extrapolated using global population-weighted average cost per capita multiplied by national population to reflect the per capita costs of communication and preparedness. A final cost stream was added to reflect management and overhead costs. The resulting investment costs total US$1.5 billion per year for developing countries this decade. As a final set, the potential costs were adjusted to account for changing vulnerability to natural disasters – as reported by the European Commission's INFORM Climate Change Risk Index.[14] This used the index to adjust country-level scores to reflect incidence and severity of natural disasters.

The analysis also looked at the potential costs of adaptation to climate-proof social protection programmes. Social assistance and social protection programmes already play a critical role in building the resilience of the most vulnerable and include a range of interventions, such as cash transfers and public works programmes. These programmes will be affected by climate change, but they also provide an opportunity to deliver support to the most vulnerable in advance of extreme events (Hallegatte *et al*. 2016). Indeed, social protection and social safety net programmes have started to include adaptation, often referred to as adaptive social protection or adaptive social safety nets. This includes shock-responsive contingency funds, which can provide cash transfers to the most vulnerable in advance of a projected extreme forecast for large extreme events, such as a drought, alongside building shock-responsive systems, plans and partnerships in advance of events to better prepare. These systems can also be scaled up after a large climate-related shock occurs.

To develop the costs of adaptive social protection, the AGF Update 2023 identified estimates of total current spending on social assistance in developing countries, using data from the World Bank's ASPIRE database.[15] The analysis focused on the category of social assistance only,[16] excluding social insurance and labour-market support (the other two categories).[17] To estimate the additional costs of adaptation (costs of adaptive social protection), a literature review was undertaken of adaptive social protection programmes from the World Bank and Foreign Commonwealth and Development Office. The review identified 11 national and regional projects with cost estimates for adaptive social protection. On average, it was found that the adaptive social protection component was 24 per cent of development partner project funding, but 4.0 per cent of total social protection spend (development partner and national budget). The latter percentage was applied to the total national costs of social assistance (for each country) using the ASPIRE data (combined national budget and development partner spend). Finally, an analysis was undertaken to adjust country values for vulnerability to natural disasters, to reflect relative risks, using the INFORM Climate Change Risk Index. The resulting investment costs for adaptive social protection total US$14.3 billion per year for developing countries for the period up to 2030.

The resulting combined cost of early warning services and adaptive social protection is estimated at US$15.8 billion per year for developing countries this decade.

It is likely that this value is an underestimate since it reflects development partner programme spend (with budget constraints) rather than demand. This will implicitly mean there are residual damages even with this level of adaptive programming.

As a comparison, the previous EACC study (World Bank 2010) estimated adaptation costs for emergency management and extreme weather events, using a proxy of the costs to educate young women to neutralize increased vulnerability. This estimated that by 2050, an additional 18 million to 23 million young women would need to be educated at a cost of US$12–15 billion per year, although the costs for the period 2010–2050 are reported as US$6.4–6.7 billion per year in the summary (World Bank 2010; Narain, Margulis and Essam 2011). In both cases, these values were reported in 2005 US$ and so inflating them to 2021 US$ such that they are broadly comparable with the AFG Update 2023 estimates, with ranges of US$21–26 billion per year and US$11.2–11.8 billion per year, respectively.

Terrestrial biodiversity and ecosystem services

Climate change is already leading to rapid, broad-scale ecosystem changes, with significant consequences for

14 See https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Climate-Change.

15 See https://www.worldbank.org/en/data/datatopics/aspire.

16 This includes cash transfers, non-contributory social pensions, food and in-kind transfers, school feeding, public works and food for work, fee waivers, and other social assistance programmes. See https://www.worldbank.org/en/data/datatopics/aspire/indicator-glance.

17 This provides country-level estimates for social assistance programmes in 107 developing countries. These country-level estimates were also scaled up to the regional level to interpolate values for countries not covered by ASPIRE, based on per capita costs.

biodiversity (and the ecosystem services these provide) and these impacts will increase with future climate change (Dasgupta 2021). This includes very large risks to terrestrial biodiversity (Parmesan *et al.* 2022). It will shift geographic ranges, seasonal activities, migration patterns, reproduction, growth, abundance and species interactions and will increase the rate of species extinction. As well as terrestrial ecosystems, there are potentially large impacts on marine ecosystems, including from ocean acidification, ocean warming and sea level rise (captured in the fisheries and marine section earlier), as well as impacts on freshwater ecosystems (rivers and lakes).

A critical omission in previous global studies has been the costs of adaptation to address these potential impacts. It is noted that these adaptation costs are different to the use of nature-based solutions for adaptation (ecosystem-based adaptation), as it is focused on the actions and costs needed to conserve and protect biodiversity, and maintain ecosystem services, under a changing climate (although nature-based solutions can support such adaptation).

However, the quantification of the impacts of climate change on biodiversity and ecosystems services in physical terms, let alone in monetary terms, makes the analysis of impacts and subsequent adaptation needs and costs extremely challenging. While there are no robust estimates in the literature of the costs of adaptation for biodiversity and ecosystem services for developing countries, the continued omission of a value understates the importance of this impact and the need to assign potentially significant resources to adaptation. This is also closely related to the goal to guide global action through 2030 to halt and reverse nature loss – part of the goals and targets of the 2022 United Nations Biodiversity Conference.[18]

For this reason, the AFG Update 2023 has developed some indicative costs of adaptation for terrestrial ecosystems and similar indicative costs for marine ecosystems (the latter included in the fisheries and marine section above). These estimates cannot be cited with confidence, and they are acknowledged as underestimates, but they signpost the need to include such costs in global assessments. It is stressed that further work to improve these estimates is an urgent research priority. The indicative analysis used two alternative approaches.

The first draws on the costs of the draft post-2020 Global Biodiversity Framework proposals for an expansion of conservation areas to 30 per cent of the earth's surface by 2030 (the '30 per cent target'),[19] using protected areas and other effective area-based conservation measures (OECMs). The costs of achieving this target have been recently assessed by Waldron *et al.* (2020) and also by UNEP (2022). Waldron *et al.* (2020) estimates the global current spend on protected areas and OECMs to be US$24.3 billion per year (globally, all countries), and show that this needs to increase to US$68 billion per year to properly protect these existing systems (i.e. because of underfunded current systems). They then estimate that to achieve the 30 per cent target would require a total annual investment of US$103–178 billion (globally all countries). Much of the investment need is in low- and middle-income countries.

A similar approach was used in this analysis to derive country-specific values using data from the Protected Planet initiative[20] which holds an open access global database on the current size and distribution of protected areas. This was then combined with data on each country's landmass to estimate the additional coverage needed to deliver effective management of existing protected areas and to expand and manage the area needed to achieve the 30 per cent target by 2030 (as undertaken in Waldron *et al.* 2020; and UNEP 2022). The costs associated with this improved and expanded coverage of protected areas were estimated using the costs per km² derived from Waldron *et al.* (2020) and ICF (2021) to provide representative individual country-specific values. The attribution of the proportion of these costs to climate change was made on the analysis of relative importance of the different drivers of ecosystem degradation as assessed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and reported in the *Global Assessment Report on Biodiversity and Ecosystem Services* (IPBES 2019). This estimates that 15 per cent of global degradation of ecosystems can be attributable to climate change. This was used to assign the relevant share of total costs that could be attributable to adaptation.

Noting that marine areas are captured in the fisheries section above, the resulting indicative costs of adaptation for **terrestrial biodiversity (protected areas only) are estimated at US$1.5 billion per year for developing countries in 2030. However, it is stressed that these values are a significant underestimate** as they are limited to protected areas only and do not consider the impacts on wider terrestrial ecosystems (and the ecosystem services they provide, for both protected and non-protected areas)[21]. They also do not consider the more proactive adaptation likely to be needed to address the climate challenge. This

18 See https://www.cbd.int/article/cop15-cbd-press-release-final-19dec2022.

19 See https://www.cbd.int/doc/c/e6d3/cd1d/daf663719a03902a9b116c34/cop-15-l-25-en.pdf.

20 See https://www.protectedplanet.net/en/about.

21 It is noted that the goals and targets of the 2022 United Nations Biodiversity Conference include to raise international financial flows from developed to developing countries, in particular LDCs, SIDS, and countries with economies in transition, to at least US$ 20 billion per year by 2025, and to at least US$ 30 billion per year by 2030.

includes the potential for refugia, buffer zones, increasing connectivity, habitat corridors, additional protected areas and potentially even translocation. Many of these will take time (as well as resources) to develop and would need to be scaled up even by 2030 to address the challenges of future decades (ideally as part of an iterative adaptative management framework).

A second analysis has been undertaken. This uses global studies on the impacts of climate change on biodiversity loss as defined through mean species abundance. This gives a measure of intactness (of an ecosystem) relative to a natural, undisturbed state. These global climate change-induced changes can be converted to biome hectare-equivalents and then adaptation costs are estimated using the costs of restoration or creation of areas. The approach here follows a previous assessment using the values for terrestrial biodiversity loss (attributed to climate change) as generated by the GLOBIO model (Alkemade *et al.* 2009; Schipper *et al.* 2019) and unit costs from a previous application of this type of approach (Hunt *et al.* 2020). This generates indicative **adaptation costs of US$13–19 billion per year for 2050 (globally)**. Again, these are considered a significant underestimate, but they highlight that likely financing needs for adaptation to terrestrial ecosystems will be significant.

Built environment (cooling) and labour productivity

There are a set of risks related to higher average temperatures and extreme heat (hot and very hot days, heatwaves), which are additional to heat and health impacts above, and which primarily fall on households and businesses. These have usually been omitted in global adaptation cost studies, but they do involve additional adaptation costs for developing countries, and they will often need public intervention to build capacity or create the enabling conditions for adaptation.

Temperature is one of the major drivers of energy demand globally, affecting cooling and heating demand for residential and business/industry properties (de Cian and Sue Wing 2017). Climate change will influence this demand, potentially increasing cooling demand in many regions and countries, but also reducing heating demand. These responses are often autonomous and can be considered as an impact or an adaptation. In the context of adaptation costs, climate change will increase indoor temperatures in the built environment (increasing cooling degree days and potentially cooling demand). This will lead to either increased discomfort from higher temperatures in homes and business buildings or alternatively the use of increased mechanical cooling (air conditioning, noting this can increase greenhouse gas [GHG] emissions) or alternatives (planned adaptation using passive ventilation techniques for buildings, green infrastructure or urban planning).

Higher temperatures and extreme heat also have potential impacts on the labour force, and on productivity. This has emerged as a major impact category over recent years and relates to the reduced working time and output at higher temperatures (though there are also some potential benefits for some colder regions or countries). There are now numerous studies of the economic costs of climate change on labour productivity (for example, Dasgupta *et al.* 2021) that use a variety of methods (for a review, see Zhao *et al.* 2021). These studies assess the impacts of climate change on both outdoor work and indoor work, though the latter is also influenced by cooling demand and air conditioning. The focus to date has been on the estimation of the economic costs of these effects, but there are also a set of potential adaptation options, which include a range of regulatory, behavioural, technical and other options (Day *et al.* 2019) and can include heat alerts, work practice change, and moving labour activities to different times of the day (Parsons *et al.* 2021), as well as air conditioning and other options for the indoor environment.

In the AFG Update 2023, it has not been possible to develop adaptation costs for these categories, though it is a priority for future updates. However, the inclusion of cost estimates for these categories would increase the overall adaptation costs of adaptation reported below.

Business and industry

Climate change will impact business and industry that is based or operating in developing countries. These risks will vary with subsector and location, and sites and operations will be affected differently. These risks also extend along supply chains, potentially affecting the production and transport of raw materials and intermediate goods and will also lead to shifts in demand for goods, services and trade (noting the additional impacts on the labour force and output described above). All of these may affect business costs, profitability, competitiveness, employment and sector economic performance (de Bruin *et al.* 2019). There is also the potential for climate risks to affect the financial markets, including banking, insurance, stock markets, bond markets, international financial flows, although these involve complex transmission pathways (Zhou, Endendijk and Botzen 2023). There are therefore potential adaptation costs for companies and for financial services in developing countries to address these risks. A review for this update has found no aggregated estimates of these adaptation costs, and most of the literature focuses on climate risks, an issue that is becoming more important in light of the Task Force on Climate-related Financial Disclosures (2017).

There are some studies for specific subsectors, which includes the potential impacts of climate change on tourism (both beach tourism and winter sports tourism), and some adaptation cost estimates to address these risks at the local, national or regional scale.

In the AFG Update 2023, it has not been possible to develop adaptation costs for these categories, though it is a priority for future updates. However, the inclusion of cost estimates for these categories would increase the overall adaptation costs of adaptation reported below.

Capacity-building, governance and implementation

As highlighted in chapter 3, there are financing needs submitted by developing countries (in their NDCs and NAPs) that include capacity-building and many other non-technical measures, and these are also represented in existing adaptation finance flows (chapter 4). However, these capacity building and 'soft' options are often omitted in modelling studies of the costs of adaptation (as in some of the sectoral assessments above). Adaptation costs will also vary with the assumptions made about baseline adaptative capacity and its influence on the effectiveness of delivering adaptation (Watkiss and Cimato 2016). Related to this, there is increasing awareness of the role of governance in delivering adaptation (see Andrijevic *et al.* 2020). There are therefore a set of additional costs that are relevant for scaling up adaptation in developing countries, that cover these capacity building and institutional strengthening (and governance) aspects. While these costs may not be as large as some of the more technically based sectors above, they are important in delivering adaptation efficiently and effectively, and there is a need to include these costs as part of future assessments. These would add to the adaptation cost values reported below.

There is also a further issue on the additional costs of adaptation to deliver and implement adaptation. As highlighted in earlier AGRs (UNEP 2018), there is now good quantitative information on the programming and implementation costs of adaptation, owing to the increased flows of international public climate finance. This involves additional costs of design (including safeguards) and implementation (project management, reporting, monitoring and evaluation, and oversight) and these costs are significant, typically ranging between 10 per cent and 15 per cent of the total costs. These costs are often omitted, or only partially captured, in the sectoral modelling estimates above and these would add to the adaptation cost values reported below.

Social sectors and socially contingent effects

A final set of adaptation costs will arise for social sectors, including education. While there has been less focus on climate and education, and this has not been included in modelling costs studies, climate change can affect education (UNICEF 2019). For example, the risk of overheating on educational attainment, the effects of climate extremes on the functioning of and access to infrastructure and more. At the same time, education can have an important role in providing the knowledge and skills to support adaptation (Sims, 2019). A review for this update has found no global aggregated estimates of these adaptation costs, but they are highlighted as an important gap.

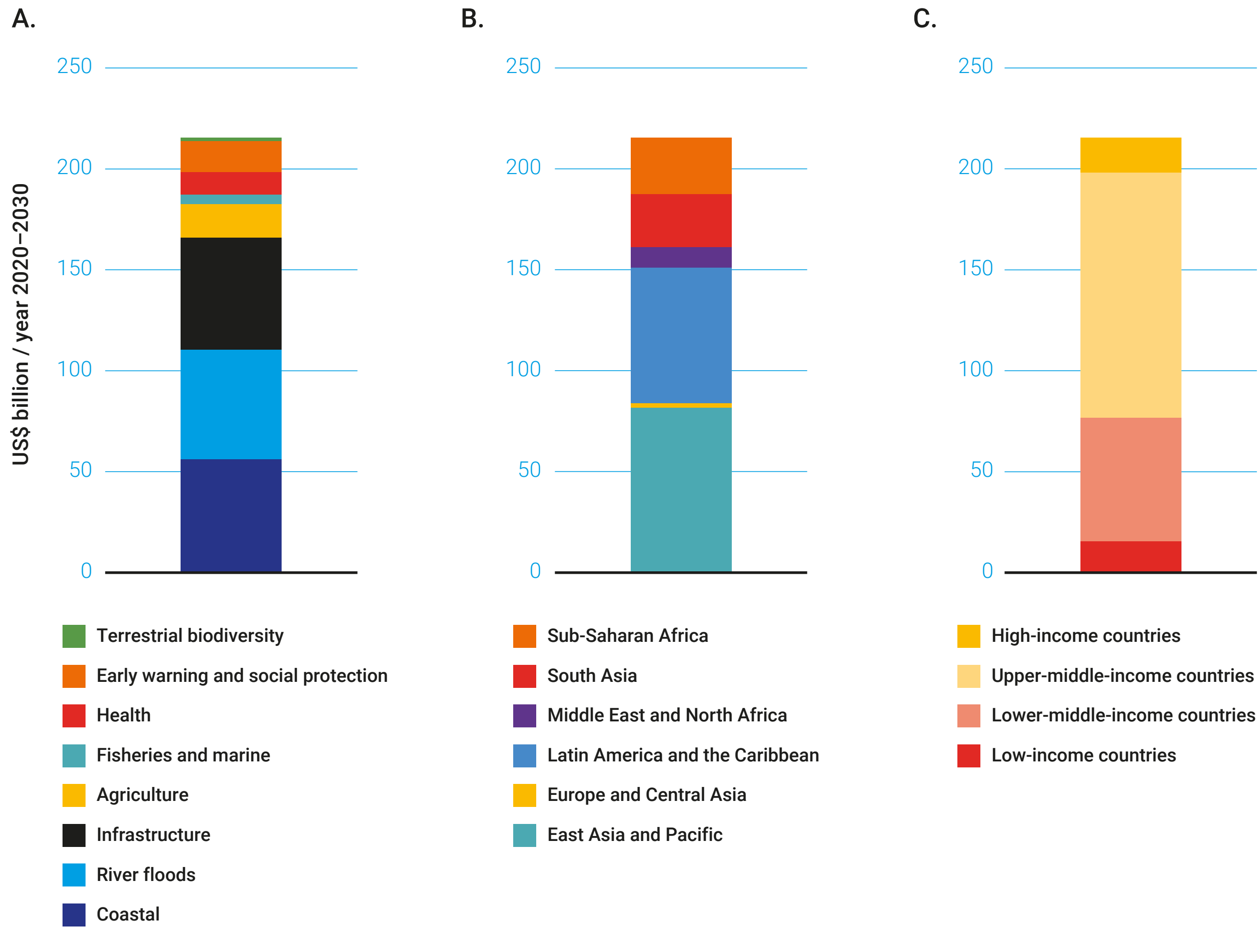
There is also growing literature around potential socially contingent effects and the potential role of climate change, directly or as a risk multiplier, for migration and for conflict. Migration can be voluntary or forced and can occur within a country or from one country to another, and be temporary, seasonal or permanent. Migration is a potential adaptation strategy and can arise in response to incremental risks, though the greater concern is when it is forced, or required because limits to adaptation are reached. There is little information on the potential costs of migration in the literature, and such costs are highly variable and context specific, though there are some studies of the potential costs of organized relocations (e.g. Hino, Field and Mach 2017). These socially contingent effects are an important omission, and further research into these are a priority.

Summary of sectoral analysis

The results of this updated analysis are presented in figure 2.7. This shows the aggregated costs of adaptation (undiscounted annual cost in the period up to 2030) for developing countries, by sector, region and income level group. The indicative total cost of adaptation (central estimate) is estimated at **US$215 billion per year for all developing countries**, though there is a large range around this value. This central estimate is equivalent to 0.56 per cent of GDP (2021) for all developing countries (or approximately US$33 per capita/per year).

The highest adaptation costs are for river flood protection, infrastructure, coastal protection and for the regions of East Asia and the Pacific as well as Latin America and the Caribbean. The highest absolute costs are for the upper- and lower-middle-income countries, but when expressed as a percentage of GDP, adaptation costs are much higher for low-income countries (3.5 per cent) than for lower-middle (0.7 per cent) or upper-middle (0.5 per cent).

Figure 2.7 Estimated costs of adaptation for developing countries by sector, region and income group for 2030 (indicative central value)



The modelled costs for the LDCs and SIDS have been considered separately. The indicative central values are estimated at US$4.7 billion per year for SIDS (0.7 per cent of their GDP), and US$25 billion per year (2 per cent of their GDP) for LDCs, totalling US$29 billion per year (noting that some SIDS are also LDCs). The costs of adaptation for LDCs and SIDS are 13 per cent of the modelled adaptation costs for all developing countries.

There are several issues to highlight with these global adaptation costs, which link to the issues raised in chapter 1. First, while the coverage is wider than earlier studies, it is still partial. For example, it does not include adaptation costs related to the built environment or labour productivity, and values for biodiversity and ecosystem services only cover protected areas. Second, these figures only include the costs of adaptation, and there are additional residual damages that remain after adaptation (which are especially relevant for loss and damage).

Second, there is a significant range around these central values. Sensitivity testing has been undertaken to explore the influence of these factors. Based on the information available, the range around the indicative central value for alternative RCPs and climate models is US$130–415 billion per year. However, a much wider range emerges if other factors are considered. As an example, the use of different objectives (e.g. for river floods) alters the adaptation costs by a factor of 2 or more (though this in turn affects the level of residual damage). Different functions or models for the same sector, and different assumptions on adaptation effectiveness and costs, also significantly affect the values.

These modelled **costs of adaptation are estimated to increase significantly by 2050** for most sectors and risks, especially for high-warming scenarios. For example, the annual costs of adaptation for coastal protection rise with increasing sea level rise by 2050, especially under the RCP6.0 and RCP8.5 scenarios. Similarly, for new infrastructure there are rising annual costs of adaptation resulting from rising risks, but also the growing stock of new infrastructure assets to protect. However, some adaptation cost estimates decrease with time. For example, the additional climate-induced cases of diarrhoeal disease are estimated to be lower in 2050 than 2030 (WHO 2014) as a result of reductions in baseline levels from socioeconomic change. Critically, the sector studies show that adaptation costs will be significantly lower in a world where the Paris Agreement goals are met, especially towards mid-century and beyond. This highlights the need for mitigation in reducing future impacts and reducing the future costs of adaptation.

These updated values can be compared with previous estimates. A similar sectoral modelling approach was used in the earlier EACC study (World Bank 2010; Narain, Margulis and Essam 2011). This estimated the costs of adaptation for developing countries at approximately US$70–100 billion per year for the period 2010–2050 for a 2°C scenario (by 2050) in 2005 prices, which is equivalent to US$125–171 billion per year in current prices (2021). The modelled costs in this update are therefore considerably higher (25–70 per cent higher than the EACC range, or an average of a 45 per cent increase), even though the same models have been used for sectoral analysis (as in coastal, river floods and agriculture). This reflects the more negative impacts of climate change reported in the literature (see IPCC 2022b), as well as updates to the level of adaptation costs. Further comparisons, including with previous AGRs and IPCC estimates, are included in chapter 5.

3. Adaptation finance needs of developing countries

Lead authors: Dipesh Chapagain (United Nations University Institute for Environment and Human Security), Blanche Butera (Paul Watkiss Associates), Sneha Rai (independent), Paul Watkiss (Paul Watkiss Associates)

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Key messages

- As at July 2023, 85 of the 155 developing countries (non-Annex I countries) had specified their adaptation finance needs in their nationally determined contributions (NDCs) or national adaptation plans (NAPs). Among low-income countries and lower-middle-income countries, 89 per cent and 68 per cent, respectively, had specified their adaptation finance needs, while only 42 per cent of upper-middle-income countries and 16 per cent of high-income countries had done so.

- The total cost of implementing adaptation priorities in these 85 country submissions is US$105 billion per year for 2021–2030. This is equivalent to 1.5 per cent of these countries' gross domestic product (GDP).

- In submissions from least developed countries (LDCs) and small island developing States (SIDS), 87 per cent of adaptation finance needs are conditional on international climate finance support, while 13 per cent are unconditional. For other developing countries, 83 per cent of adaptation finance needs are conditional and 17 per cent are unconditional.

- Water, agriculture and infrastructure are the priority sectors for adaptation finance needs across most countries and regions, though priorities vary on a country-by-country basis.

- Technical and financial capacity gaps in low-income countries mean that not all NDCs and NAPs have fully assessed the costs of adaptation (across all risks and sectors), potentially underestimating actual adaptation finance needs.

- Per capita adaptation finance needs, expressed in absolute dollars (US$), are generally higher in countries with higher income levels. In contrast, if adaptation finance needs are expressed as a percentage of GDP, they are higher in lower-income countries.

- The 85 costed NDCs and NAPs have been analysed to derive average adaptation finance needs per capita and as an equivalent percentage of GDP (by country income level). These values have then been used to derive a global value for all developing countries.

- Based on this analysis, the average adaptation finance needs for all developing countries for 2021–2030 are estimated at US$387 billion per year (with a range of US$101–975 billion per year). This is equivalent to 1 per cent of these countries' GDP (with a range of 0.25–2.50 per cent).

- The equivalent values for LDCs and SIDS are estimated at US$41 billion per year (with a range of US$16–83 billion per year), which is equivalent to 2 per cent of their GDP (with a range of 0.80–4 per cent).

Introduction

Adaptation is a key strategy for addressing the impacts of climate change. However, a lack of financial resources to meet countries' adaptation needs is a primary factor driving the slow progress on implementing adaptation. As highlighted in chapter 1 and chapter 2, there have been growing efforts to estimate sector-specific and economy-wide adaptation costs and finance needs at local, national and global scales (World Bank 2010; United Nations Environment Programme [UNEP] 2016; Markandya and González-Eguino 2019; Chapagain *et al.* 2020; Clima Capital Partners and Aviva Investors 2022; Climate Policy Initiative 2022; UNEP 2022), but these costs vary depending on the framing, methods and assumptions used. Chapter 2 set out the common modelling approaches to estimate adaptation costs. However, an alternative approach to estimate global adaptation costs is to assess the finance needs reported in countries' adaptation plans, such as NDCs and NAPs (Chapagain *et al.* 2020; New *et al.* 2022; UNEP 2022).

Numerous countries have assessed their adaptation priorities and adaptation finance needs, which they have conveyed through national reports submitted to the United Nations Framework Convention on Climate Change (UNFCCC), notably in NDCs, NAPs, adaptation communications and national communications. In accordance with article 4, paragraph 2 of the Paris Agreement, each country Party is required to prepare, communicate and maintain successive NDCs to achieve the goals of the agreement (United Nations 2015). Similarly, the Cancun Adaptation Framework established the NAP process to enable least developed countries (LDCs) and other developing countries to identify their medium- and long-term adaptation needs, and to develop and implement strategies and programmes to address those needs (UNFCCC 2010). The NDCs and NAPs therefore represent the two most important national reports that countries are using to communicate their adaptation needs. These national plans provide valuable insights and are an important source of evidence for estimating global adaptation finance needs and in turn the adaptation finance gap.

The first needs determination report of the Standing Committee on Finance used a very broad definition of finance needs as any expression in national reports that concerns the need to implement the adaptation and mitigation goals of the Convention and the Paris Agreement (UNFCCC 2021). In contrast, the Climate Policy Initiative (2022) adopted a highly specific definition for climate finance needs as the difference between total finance needs stated in NDCs and the amount of finance that countries can cover with their own domestic government resources. In the absence of a universally agreed-upon definition, the adaptation finance needs in this study refer to the financial resources that countries require from both international and domestic sources to implement their adaptation plans, as submitted to UNFCCC in the form of NDCs and NAPs.

The country-driven and bottom-up nature of these adaptation finance needs estimates, as submitted in NDCs and NAPs, make them an important source of evidence for estimating global adaptation costs, and they provide complementary information to the modelled costs in chapter 2. However, it is important to note that the information provided in these national reports is quite diverse. In particular, these national plans differ in terms of their adaptation ambition, socioeconomic circumstances, consideration of future climate scenarios, methods employed to identify and prioritize adaptation options, costing methodologies, sectoral coverage and implementation time frame. Moreover, their estimates are dynamic in nature and the adaptation planning is a continuous process. The adaptation finance needs reported must therefore be interpreted with consideration given to their inherent limitations.

This chapter aims to provide an up-to-date estimate of the total adaptation finance needs for developing countries (defined here as the non-Annex I countries under UNFCCC) and the sectoral and regional distribution of this estimate. The analysis conducted a comprehensive review and synthesis of the information on adaptation finance needs as conveyed by countries in their NDCs and NAPs. However, not all countries have submitted such needs. As such, data have been used from country submissions, with an analysis undertaken to normalize and then extrapolate the data to estimate the total adaptation finance needs for all developing countries for 2021–2030. These estimates are combined with the modelling estimates of adaptation costs (see chapter 2) and analysis of the adaptation finance flows (see chapter 4) to estimate the global adaptation finance gap (see chapter 5). Policymakers and negotiators can leverage this information to inform discussions and negotiations related to the new collective quantified goal on climate finance set to be agreed before 2025, and the global goal on adaptation agreed in the Paris Agreement.

The following sections in this chapter are organized into methodology, results and discussion sections. The methodology section sets out the approach used for data collection, data harmonization, identifying and removing double counting, inflation adjustment, data normalization and extrapolation. The results section presents key findings, including the status of information on adaptation finance needs in countries' adaptation plans, the reported costs of implementing these plans, the conditionality of the adaptation finance needs, the sectoral distribution of adaptation finance needs by region, normalized adaptation finance needs and the estimated regional and global adaptation finance needs of developing countries. The discussion section summarizes the findings along with previous similar studies. Policy implications of this analysis are presented in chapter 5.

Methodology

Data sources and collection

This review and synthesis are based on NDCs and NAPs submitted by developing countries to the UNFCCC Secretariat. The developing countries considered in this analysis are the 155 non-Annex I country Parties to the UNFCCC as at 31 July 2023 (UNFCCC 2023a). The submitted NDCs and NAPs were accessed from UNFCCC NDC Registry (UNFCCC 2023b) and NAP Central (UNFCCC 2023c), respectively. The data used in this review expand on the previous review conducted by Chapagain *et al.* (2020) and the United Nations Environment Programme (2022) with extended scope, and encompass the submissions available until 31 July 2023.

Data from NDCs and NAPs were systematically extracted and organized into a structured data-collection template created in Microsoft Excel. This data extraction was performed through a manual review. The extracted data include a range of aspects such as submission and country details, reported economy-wide and sector-specific adaptation finance needs, time duration, conditional, unconditional and conditionality-unspecified finance needs, as well as the finance needs estimation methodology.

Data cleaning and normalization

The adaptation finance needs reported in the countries' NDCs and NAPs varied in several aspects, making direct comparison and aggregation challenging. To address this, a series of steps were implemented to clean and normalize the adaptation finance needs data:

1. Normalization to average annual adaptation finance needs: The reported adaptation finance needs were normalized to average annual values. Several countries had already reported needs as annual average values. When the reported amount represented cumulative values for a specified investment time frame, the annual average amount for that period was estimated.

2. Inflation adjustment: To account for inflation and ensure comparability, finance needs reported in nominal or constant prices with different base years were converted to constant 2021 dollars, using the World Bank global GDP deflator (annual inflation rate as a percentage). The GDP deflator is the ratio of GDP in current local currency to GDP in constant local currency, and measures the rate of change in the price in the economy as a whole (World Bank 2023). The year 2021 was selected as the base year to present the financial needs in the most recent price terms, while maintaining consistency with the adaptation finance flow reported in constant 2021 price (see chapter 4). All the finance needs presented in this chapter are therefore in constant 2021 dollars unless otherwise stated.

3. Avoiding double counting: In instances where countries submitted multiple estimates in different reports, such as intended nationally determined contributions (INDCs), NDCs and NAPs, duplicated estimates were removed to prevent double counting. The most updated submissions were considered for countries with multiple NDC submissions. In cases of duplication between NDCs and NAPs, the most detailed or up-to-date submission was prioritized based on expert judgement. For sectoral analysis, only submissions that provided finance needs for at least three sectors were considered.

4. Normalization to per capita annual adaptation finance needs and annual adaptation finance needs as an equivalent percentage of GDP: To facilitate comparisons between countries and income groups, the data on the annual average adaptation finance needs were normalized to per capita annual adaptation finance needs in constant 2021 dollars, with annual adaptation finance needs normalized as an equivalent percentage of GDP. These normalized indicators control for population size and the size of the economy, which are major factors that influence total finance needs. Population and GDP data were obtained from the World Bank's World Development Indicators database.

5. Geographic region, income level and other country groupings: Geographic regions were based on the World Bank's regional classification and income groups were based on the World Bank's list of economies for 2021 (see table A.1 in Annex 3.A). The United Nations classification for LDCs and small island developing States (SIDS) were also used as two supplementary country groups in this analysis to represent the most vulnerable countries.

6. Outlier detection: To identify outliers in the normalized adaptation finance needs data, the Z-score test was applied. The analysis assumed that a Z-score exceeding 3 or falling below -3 indicated an outlier (Shiffler 1988). Applying a cut-off of +/-3 helped remove values that were in the top 0.135 per cent and bottom 0.135 per cent of the distribution, which corresponded to the most extreme 0.27 per cent of values.

Extrapolation to estimate developing countries' total adaptation finance needs

Using the countrywide normalized adaptation finance needs data, both in per capita absolute dollar value and as an equivalent percentage of GDP, the average (median) and interquartile (IQ) range of adaptation finance needs across three income groups were estimated. The income group includes low-income countries, lower-middle-income countries, and upper-middle-income countries and high-income countries. The upper-middle-income country and high-income country categories were combined into a single group due to the limited reporting of adaptation finance needs by non-Annex I high-income countries. Normalized adaptation finance needs were also obtained for LDCs and SIDS.

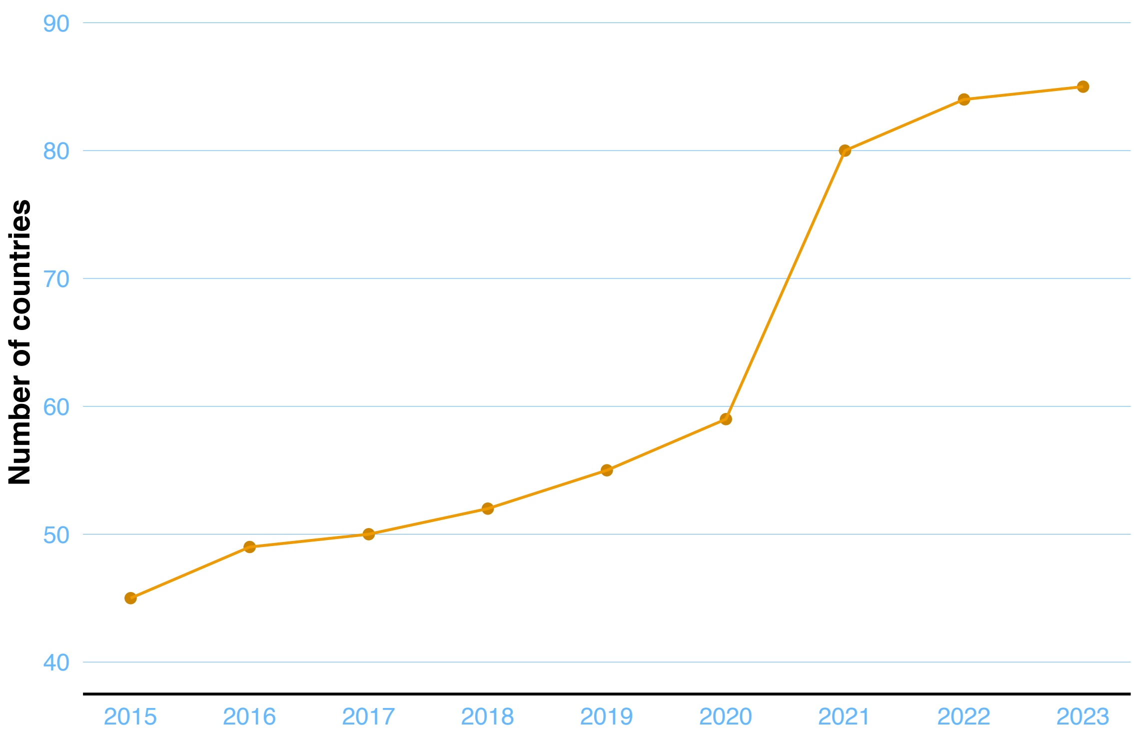
To estimate developing countries' total adaptation finance needs by region and globally, two extrapolation factors were employed to estimate values for all developing countries (including those that had made costed submissions). First, the median and IQ range of per capita adaptation finance needs based on country submissions by income group was used as an extrapolation factor. While per capita adaptation finance needs may not be the most comprehensive approach, it is a commonly used and straightforward method for global extrapolation. Second, income-level-specific adaptation finance needs as an equivalent percentage of GDP was used as an alternative extrapolation factor. This approach, which used needs as an equivalent percentage of GDP, allowed for an exploration of the uncertainty and sensitivity associated with using different extrapolation factors. However, the main results and interpretation have been based on the extrapolated values using the per capita adaptation finance needs.

Results

Adaptation finance needs information in countries' adaptation plans

The adaptation priorities identified within NDCs serve as a platform for countries to outline their intended actions to adapt to the impacts of climate change. As at 31 July 2023, of the 155 developing countries, all except Libya and Yemen had submitted their NDCs. With respect to NAPs, which similarly focus on identifying medium- and long-term adaptation needs, as at the same date, 46 developing countries had made submissions. The number of countries specifying their adaptation finance needs has been steadily increasing since 2015 when countries began submitting their NDCs and NAPs (see figure 3.1).

Figure 3.1 Total number of developing countries specifying their adaptation finance needs in NDCs or NAPs over time

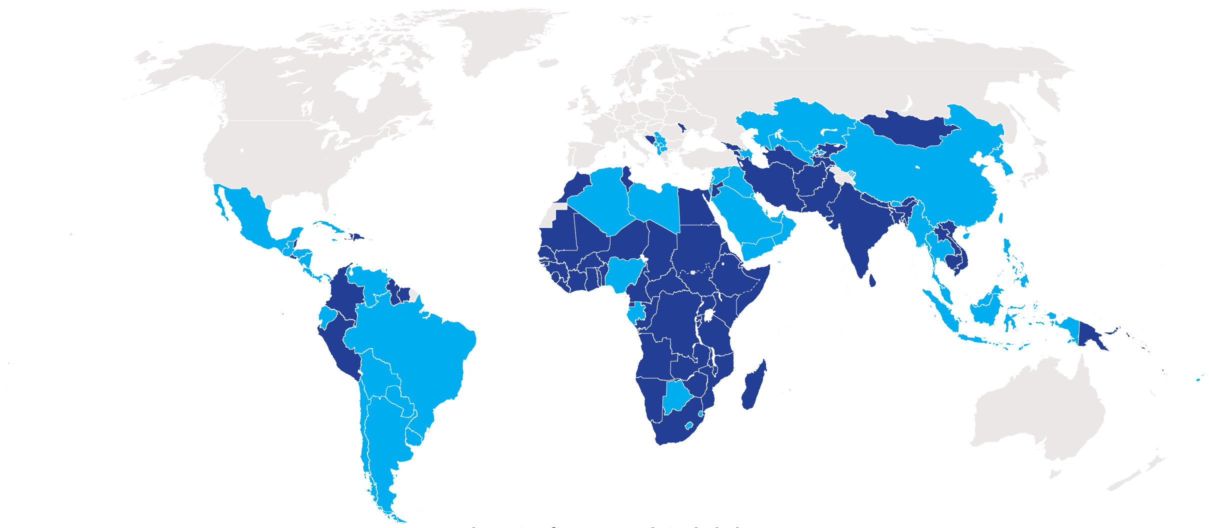


Among all the developing countries, 85 countries (55 per cent) have specified their adaptation finance needs for 2021–2030 in at least one of their NDC and NAP submissions (see figure 3.2 and table A.1 in Annex 3.A). At the regional level, 88 per cent of developing countries in sub-Saharan Africa (42 out of 48) and 75 per cent in South Asia (6 out of 8) have specified their adaptation finance needs in their submissions. However, the percentage drops to 41 per cent for countries in Europe and Central Asia (7 out of 17), 39 per cent in Latin America and the Caribbean (13 out of 33), 35 per cent in the Middle East and North Africa (7 out of 20) and 34 per cent in East Asia and the Pacific (10 out of 29).

It is noteworthy that the proportion of countries specifying their adaptation finance needs decreases as income levels rise. Among low-income countries, 89 per cent (25 out of

28) have specified their adaptation finance needs in their submissions, while 68 per cent (36 out of 53) of lower-middle-income countries have done so. In contrast, only 42 per cent (20 out of 48) of upper-middle-income countries and a mere 16 per cent (4 out of 25) of high-income countries have indicated their adaptation finance needs. This difference may suggest that lower-income countries have a greater need for international climate finance assistance and are more proactive in expressing their financial needs in their submissions.

Figure 3.2 World map of the status of adaptation finance needs information in developing countries' NDCs and NAPs



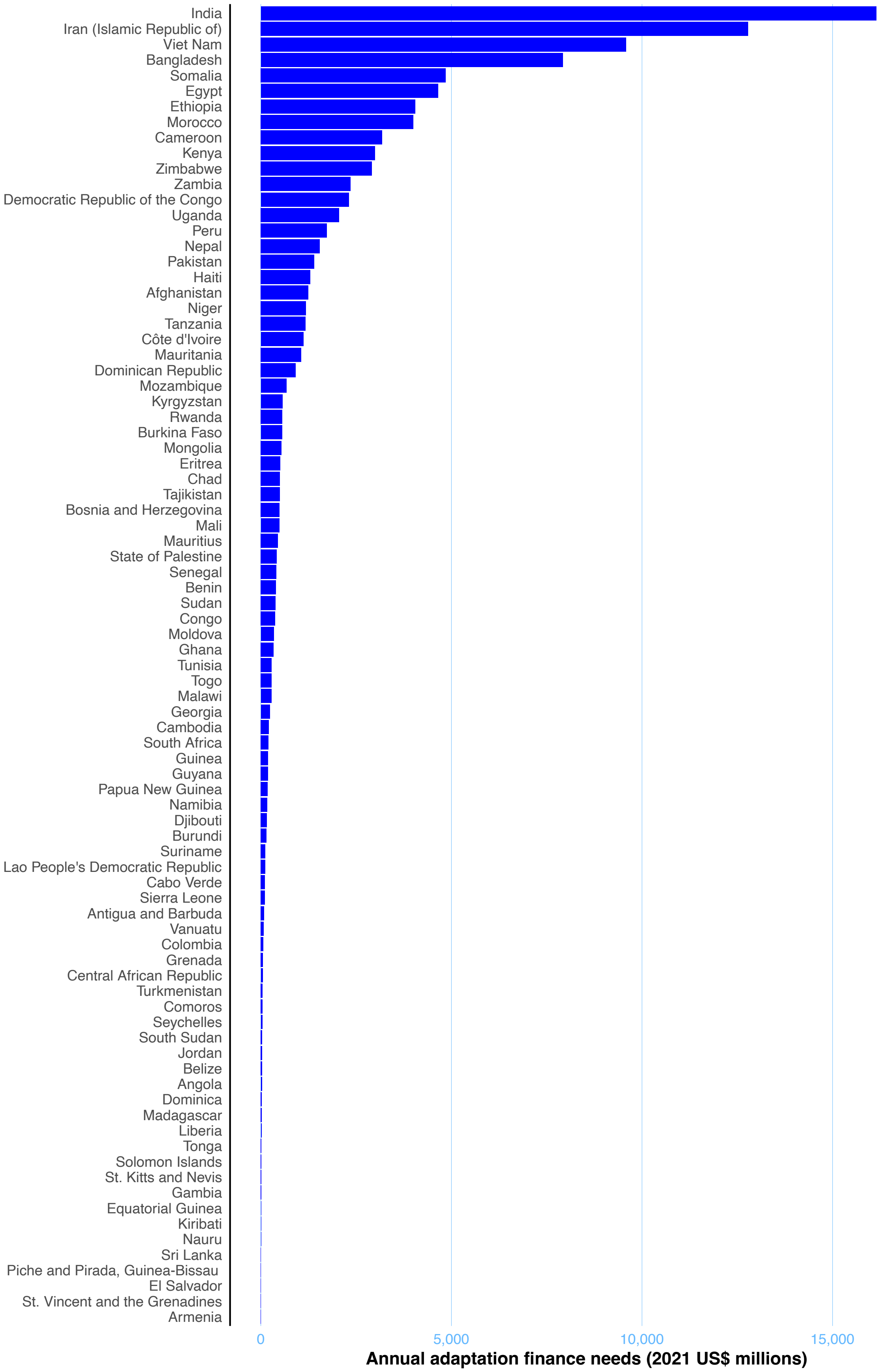
Note: N/A refers to Annex I countries.

Typically, in these adaptation plans, the country starts by identifying potential adaptation options in relevant sectors and estimates the associated implementation costs of these options. The application of appraisal techniques to identify adaptation options and cost them remains limited, even though the number of countries utilizing these techniques is increasing over time. Among the countries that have employed appraisal techniques, most rely on traditional methods such as a cost-benefit analysis or cost-effectiveness analysis and multi-criteria analysis. However, the adoption of robust economic appraisal techniques for adaptation planning, which account for uncertainty in the planning process, is still uncommon. The adaptation finance needs that countries have communicated in these submissions are therefore mostly based on sectoral and project-based estimates. Some countries also refer to previous studies that employ economic models and integrated assessment models to estimate their adaptation finance needs. In several cases, countries have not provided rationale for the methodology used to estimate their adaptation finance needs.

Costs of implementing developing countries' adaptation plans

The amount of adaptation finance needs estimated by countries varies widely due to factors such as the country's size, economy and methodology-related considerations. For example, India's NDC indicates annual adaptation finance needs of around US$16 billion, while Armenia's NAP identifies a much smaller amount of US$250,000 (see figure 3.3). The total cost of implementing adaptation priorities and plans for the 85 developing countries with submitted plans amounts to US$105 billion per year on average for 2021–2030. This amount is equivalent to 1.5 per cent of these countries' GDP.

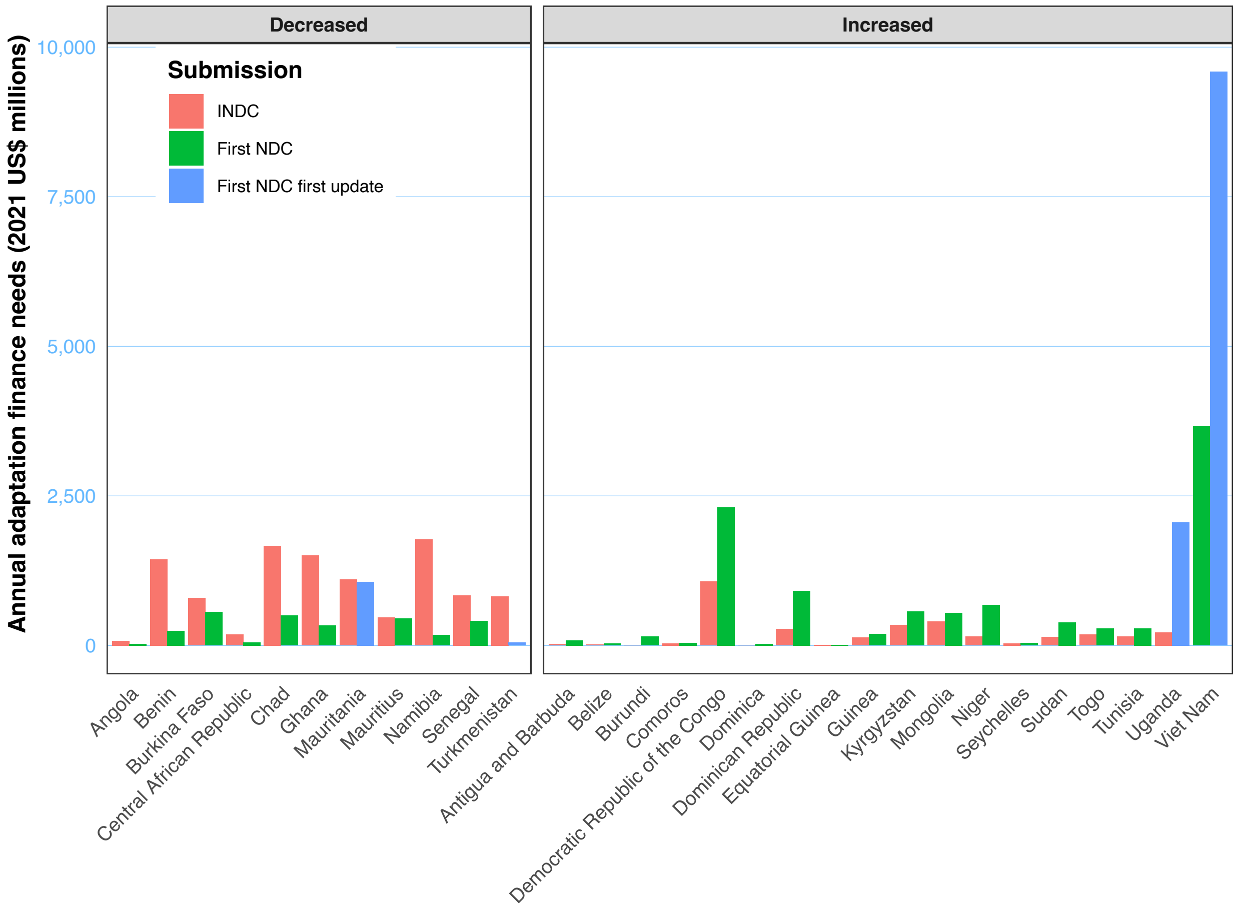
Figure 3.3 Adaptation finance needs of countries as reported in their NDCs or NAPs



Note: The amounts are normalized to an annual average for 2021–2030 and adjusted to constant 2021 dollars.

According to article 4, paragraph 9 of the Paris Agreement, each country has the flexibility to update its NDC at any time, with a requirement to do so at least once every five years to enhance its level of ambition. As a result, 131 developing countries have already revised their NDCs at least once, and 29 countries have adjusted their adaptation finance needs estimates (see figure 3.4), showing their ongoing efforts to refine these estimates. The updated finance needs exceed the initial estimates in nearly two thirds of the countries. This increase is mainly due to the expanded inclusion of sectors and subsectors in adaptation planning. For example, countries such as Burundi, the Democratic Republic of the Congo, Kyrgyzstan and Sudan have broadened their NDCs to encompass more adaptation sectors, leading to a rise in adaptation finance needs. However, in one third of the countries, finance needs decreased compared with their initial submissions, again mainly due to methodological changes. Around 140 developing countries have started the NAP formulation process and more countries will submit NAPs in the coming years (UNFCCC 2023d). The estimated finance needs in these national submissions are therefore highly dynamic and subject to change over time.

Figure 3.4 Comparison of adaptation finance needs in initial and updated NDC submissions of developing countries



Conditionality of the adaptation finance needs

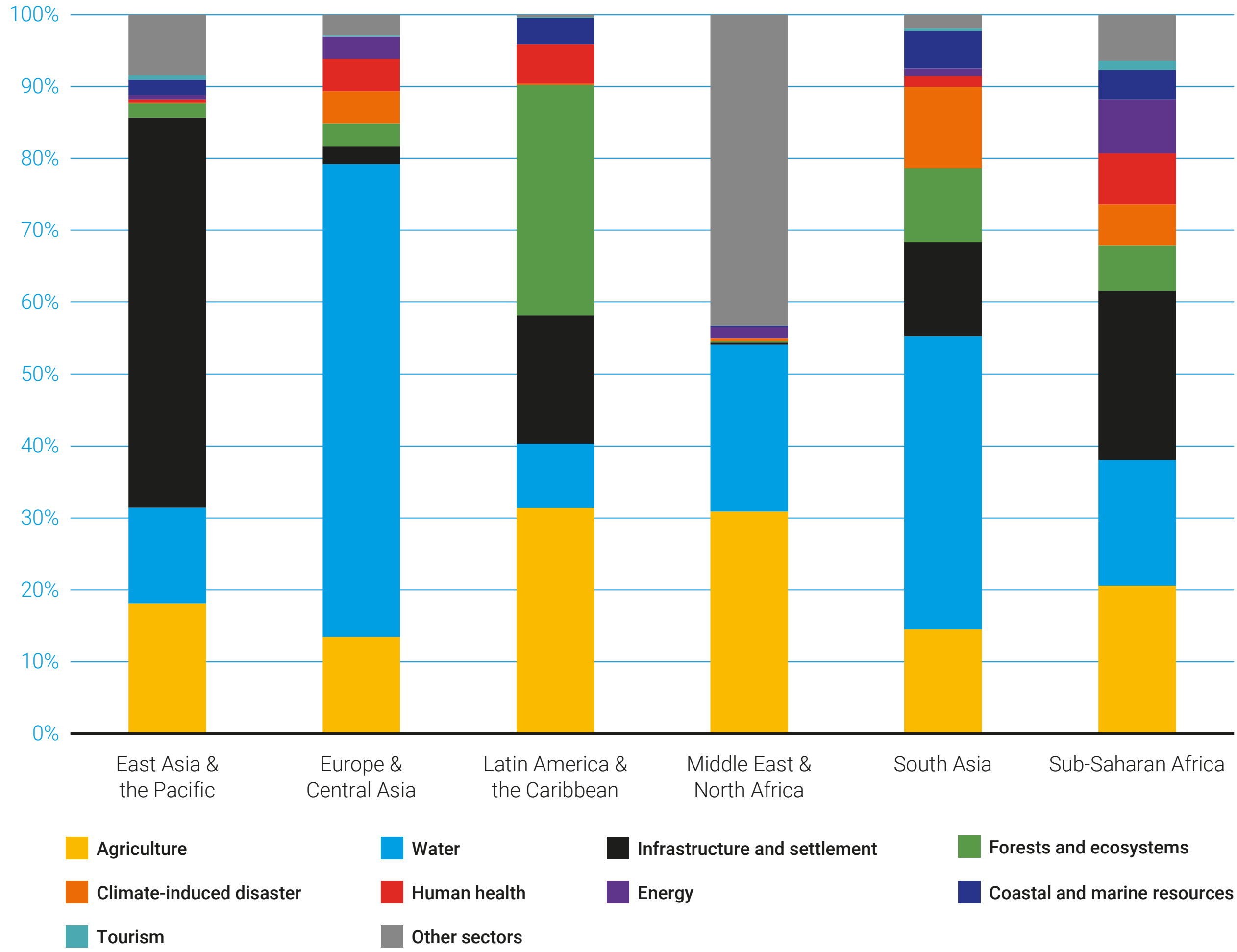
The adaptation finance needs set out in NDCs are meant to separate actions that are conditional and require international support for financing, and those that are unconditional and will be funded domestically through public and private sources. However, for the costed submissions, only 31 countries have indicated their conditional and unconditional adaptation finance needs. Among the countries specifying the conditionality of their finance needs, around 85 per cent of the adaptation finance needs, on average, are conditional. The remaining 15 per cent are unconditional. For LDCs and SIDS, the share of conditional adaptation finance needs is higher at 87 per cent, with only 13 per cent unconditional. In other developing countries, the shares are 83 per cent conditional and 17 per cent unconditional. This highlights that a larger proportion of adaptation finance needs in LDCs and SIDS are expected to require international climate finance assistance compared with other developing countries.

Sectoral distribution of adaptation finance needs

A total of 52 countries provided information on adaptation finance needs for various sectors, including at least three sectors in their reports (see table A.1 in Annex 3.A). Countries in sub-Saharan Africa and Asia were more likely to include sectoral breakdowns (56 per cent and 50 per cent of countries from these regions, respectively). In contrast, only 24 per cent of countries in Europe and Central Asia and Latin America and the Caribbean, 20 per cent of countries in the Middle East and North Africa and 17 per cent in East Asia and the Pacific included sectoral breakdowns.

These sectoral data have been analysed to assess the relative proportion of adaptation finance needs by sector, and how this varies by world region. The results show that the water, agriculture and infrastructure sectors have the highest adaptation finance needs in most of the regions. However, the sectoral preference for adaptation finance needs varies across world regions (see figure 3.5). Table A.2 in Annex 3.B) presents a complete list of adaptation finance needs by sector and region.

Figure 3.5 Sectoral distribution of adaptation finance needs by world region, presented as a percentage of total finance needs for the respective region



The patterns by region are summarized as follows:

- East Asia and the Pacific: The infrastructure and settlement sector has the highest finance needs, accounting for 54 per cent of the total. The agriculture and water sectors require 18 per cent and 13 per cent, respectively.
- Europe[1] and Central Asia: The water sector has the highest finance needs, accounting for 66 per cent of the total, followed by the agriculture sector at 13 per cent.
- Latin America and the Caribbean: The finance needs are distributed across multiple sectors, with the forests and ecosystems sector having the highest finance needs at 32 per cent, followed by the agriculture sector at 31 per cent and the infrastructure and settlement sector at 18 per cent.
- Middle East and North Africa: The agriculture sector requires 31 per cent of the total finance needs, with the water sector requiring 23 per cent. The largest share (43 per cent) of finance needs is required by

1 Non-Annex I countries, mainly from Eastern and Southern Europe.

sectors other than the nine sectors listed, such as capacity-building and governance.

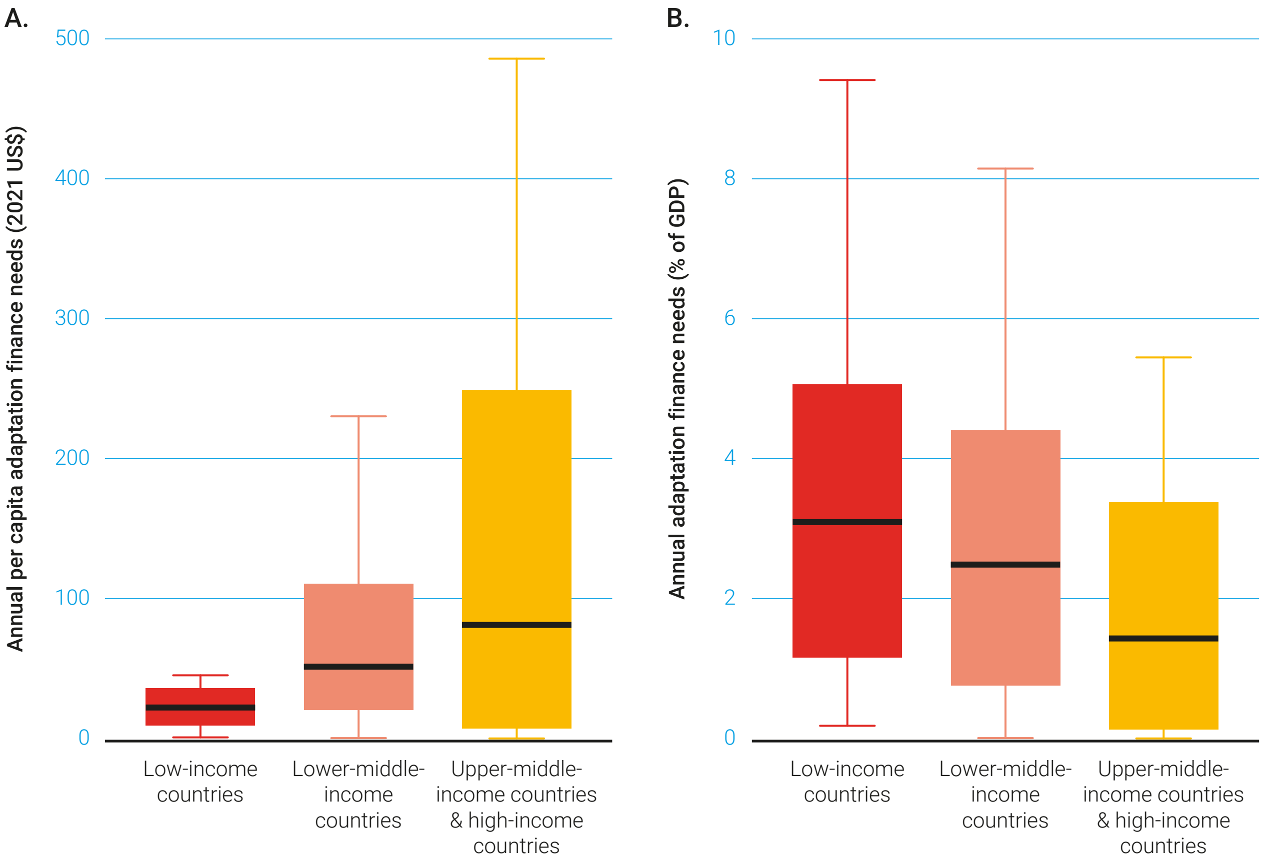
- South Asia: The highest finance needs are required by the water sector, accounting for 41 per cent of the total. The agriculture, infrastructure and settlement, climate-induced disaster and forests and ecosystems sectors cover 14 per cent, 13 per cent, 11 per cent and 10 per cent, respectively.
- Sub-Saharan Africa: The infrastructure and settlement sector requires 24 per cent of the total finance needs, followed by the agriculture and water sectors at 21 per cent and 17 per cent, respectively.

Normalized adaptation finance needs

To allow country-to-country comparisons, the reported adaptation finance needs were normalized using two different approaches, based on annual adaptation finance needs per capita and as an equivalent percentage of GDP.

The per capita results show that adaptation finance needs tend to increase with income level, with higher-income countries having higher average per capita needs in their submissions (see figure 3.6, panel A). In low-income countries, the average per capita adaptation finance needs from submissions are only US$22 with an IQ range of US$9–36. In lower-middle-income countries, the average per capita adaptation finance needs increases to US$51 with an IQ range of US$22–109. In upper-middle-income countries and high-income countries, the average per capita adaptation finance needs are US$81 with an IQ range of US$9–238. The per capita adaptation finance needs for submissions from LDCs reported an average of US$25 with an IQ range of US$13–46. The per capita adaptation finance needs from SIDS were higher, with an average of US$153 and an IQ range of US$65–258 (see figure 3.7, panel A).

Figure 3.6 Annual adaptation finance needs in per capita (panel A) and as a percentage of GDP (panel B) by income level, from submitted NDCs and NAPs.

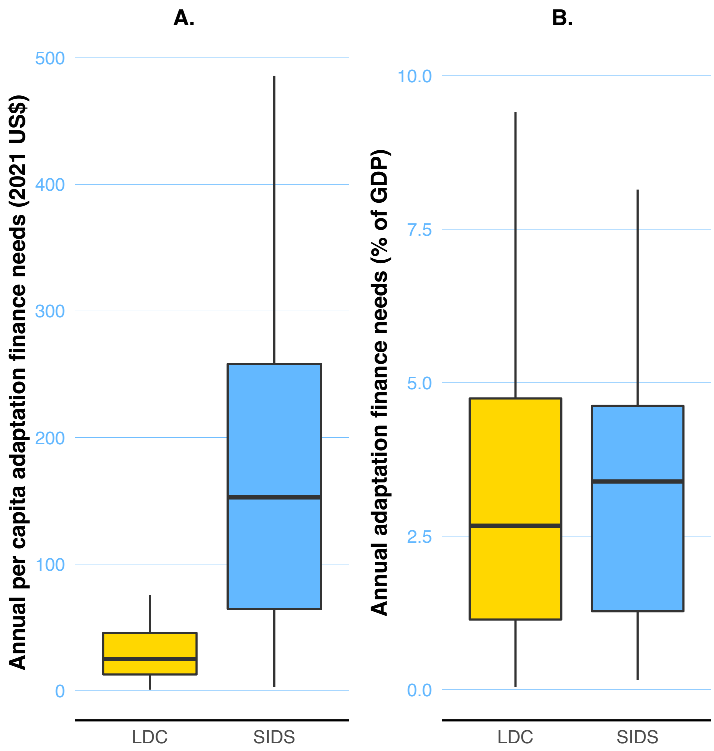


Notes: The figure shows the median, IQ range and full range.

In contrast, a different trend emerges when adaptation finance needs from country submissions are expressed as an equivalent percentage of GDP. In this case, adaptation finance needs increase as countries' income levels decrease, with lower-income countries having higher adaptation finance needs as an equivalent percentage of GDP (figure 3.6, panel B). The submissions from low-income countries show an average adaptation finance need that is equivalent to

3.09 per cent of the relevant country GDP, with an IQ range of 1.18–4.96 per cent. At the same time, the adaptation finance needs in submissions from lower-middle-income countries are equivalent to 2.5 per cent of GDP, with an IQ range of 0.77–4.41 per cent. For upper-middle-middle countries and high-income countries, the adaptation finance needs from submissions are equivalent to 1.43 per cent of GDP, with an IQ range of 0.14–3.20 per cent. For LDCs, the adaptation finance needs from submissions are equivalent to 2.67 per cent of GDP, with an IQ range of 1.14–4.74 per cent, while for SIDS, the adaptation finance needs are equivalent to 3.39 per cent of GDP, with an IQ range of 1.28–4.62 per cent (see figure 3.7, panel B).

Figure 3.7 Annual adaptation finance needs in per capita (panel A) and as a percentage of GDP (panel B) for LDCs and SIDS



Note: The figure shows the median, IQ range and full range.

The trends in per capita adaptation finance needs, categorized by income levels, provide some interesting observations. Wealthier countries, which typically have a higher value at risk (for example, assets and infrastructure) tend to report higher finance needs in their submissions in absolute dollar values. Their higher development level will have increased assets exposed to climate hazards, leading to potentially high economic losses, as observed in the substantial economic damage from wildfires and heat waves reported in North America, Australia and Europe (Pörtner *et al.* 2023). Furthermore, wealthier countries may have higher adaptive capacities and greater financial means to invest in adaptation measures. These countries may therefore assign more importance to adaptation, and accordingly have higher adaptation finance needs reported in their submissions. In the case of SIDS, the small population size of countries and their high exposure and vulnerability to tropical cyclones and sea level rise mean per capita adaptation needs are higher, due to their need to safeguard resources and critical infrastructure.

The lower adaptation finance needs in terms of absolute dollar values in low-income countries may be due to a number of factors. It is possible that adaptation in these countries is more cost-effective than in high-income countries, as there might be a higher adaptation deficit and thus more opportunities for low-regret and no-regret adaptation. Alternatively, this lower cost in absolute dollar value could be influenced by the existing low development baseline and limited infrastructure (and value at risk) in these low-income countries. Furthermore, it could be that the limited technical and financial capacity to conduct robust adaptation needs assessments in low-income countries might contribute to the underestimation of their actual adaptation finance needs.

The trends in adaptation finance needs when expressed as an equivalent percentage of GDP also provide some insights, especially as these are higher in low-income countries. This indicates that poorer countries require a larger investment in adaptation as a relative proportion of their economies (i.e. of GDP) compared with higher-income countries. Moreover, it is crucial to recognize that lower-income countries face a dual challenge – addressing their existing development gap and meeting their adaptation needs. This highlights the pressing need for increased international financial support to assist more vulnerable countries in building resilience and adapting to the impacts of climate change.

Global and regional adaptation finance needs

The two extrapolation factors have been used to estimate the potential finance needs for all developing countries.

The annual per capita adaptation finance needs (median and IQ range) by income group were first used (see figure 3.6, panel A) as an extrapolation factor to estimate the total regional and global adaptation finance needs of developing countries. Table 3.1 presents these results. The average annual adaptation finance needs in developing countries for 2021–2030 are estimated at US$387 billion, with a range of US$101–975 billion. The wide uncertainty range highlights the challenges in precisely determining the adaptation finance needs. This value is equivalent to 1 per cent of developing countries' GDP, with a range of 0.25–2.50 per cent. Using the same extrapolation approach, the estimated finance needs for all LDCs and SIDS is US$41 billion, with a range of US$16–83 billion. This is equivalent to 2 per cent of the GDP of LDCs and SIDS, with a range of 0.80–4 per cent.

In absolute dollar values, the East Asia and the Pacific region has the highest finance needs at US$158 billion, followed by South Asia at US$97 billion. These high costs can be attributed to the large populations and large economies in these regions, which include the countries of China, Indonesia and the Philippines in South-East Asia, and Bangladesh, India and Pakistan in South Asia. In contrast, when examining these estimated adaptation finance needs as an equivalent percentage of GDP, the values are highest in South Asia and sub-Saharan Africa, which are both estimated to require, on average, 2.4 per cent of their GDP to finance adaptation options. The Middle East and North Africa region and the East Asia and the Pacific region have lower adaptation finance needs when expressed as a percentage of GDP, at 0.7 per cent. These findings indicate the diverse financial requirements for adaptation across regions and the need for tailored approaches to address the specific challenges that different countries and regions face.

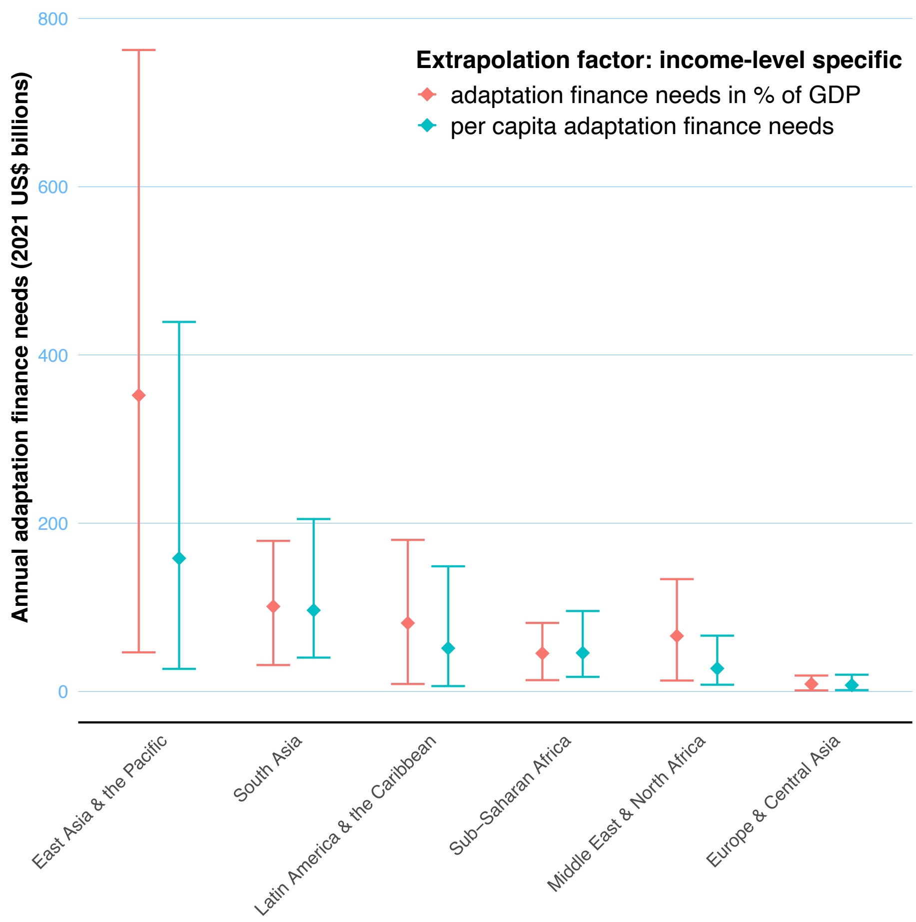
Table 3.1 Developing countries' adaptation finance needs by region for 2021–2030

Region	Annual adaptation finance needs in US$ billion (2021 value)		Annual adaptation finance needs in an equivalent % of GDP	
	Median	Min–Max	Median	Min–Max
East Asia & the Pacific	158	27–439	0.69	0.12–1.90
South Asia	97	40–205	2.38	0.99–5.05
Latin America & the Caribbean	51	6–149	0.92	0.12–2.66
Sub-Saharan Africa	46	17–96	2.37	0.90–4.95
Middle East & North Africa	27	8–66	0.74	0.22–1.78
Europe & Central Asia	8	2–20	1.35	0.29–3.56
Global	**387**	**101–975**	**1.00**	**0.25–2.50**

Note: Values are based on extrapolation of median and IQ range of annual per capita adaptation finance needs for each income class from figure 3.6 (panel A) to all developing countries (including those that have submitted finance needs).

The income-level-specific annual adaptation finance needs, normalized as a percentage of GDP (figure 3.6, panel A), have also been used as an alternate extrapolation factor. This provides additional insight into the uncertainty and sensitivity of the finance needs estimation. In this case, the total adaptation finance needs for developing countries, based on the income-level-specific percentage of GDP extrapolation factor, are estimated at US$655 million (median), with a range of US$115–1,356 million (see table A.3 in Annex 3.C). These estimates, particularly the median and upper-range values, are much higher compared with the per capita-based estimates (see figure 3.8). The largest difference between the two extrapolation approaches is seen in the East Asia and the Pacific and Middle East and North Africa regions. The large economies in these regions result in significantly higher finance needs when the income-level-specific percentage of GDP is used as an extrapolation factor. However, in other regions, the difference between approaches is not that significant.

Figure 3.8 Comparison of adaptation finance needs estimated using two extrapolation factors



Notes: The figure shows extrapolated values based on the median and IQ range for each income group from figure 3.6 to all developing countries (including those that have submitted finance needs).

Discussion

Currently, 85 developing countries, mostly the low- and lower-income countries, have communicated their domestic adaptation finance needs, though the number of countries is increasing all the time. These estimated finance needs provide valuable insights into the scale of developing countries' total adaptation finance needs. However, it is important to recognize that not all NDCs and NAPs, as well as the identified adaptation needs in submitted plans, have been fully costed. Many countries have highlighted methodological challenges and technical and financial capacity gaps in identifying adaptation needs and quantifying these needs (UNFCCC 2021; Clima Capital Partners and Aviva Investors 2022). Furthermore, adaptation will require long-term interventions along iterative risk management pathways, which are difficult to estimate in monetary values (UNFCCC 2021). This includes more transformational adaptation. It is therefore likely that the actual adaptation finance needs may exceed the submitted figures due to these limitations. Nevertheless, due to the lack of rigorous assessments and countries' interest in attracting additional international finance, adaptation finance needs in some of these submissions may be overestimates.

The analysis here has used normalized adaptation finance needs based on submitted country NDCs and NAPs, extrapolated to all developing countries. The results indicate that adaptation finance needs for developing countries is $387 billion per year, with a range of US$101–957 billion per year for 2021–2030. However, it is important to consider the limitations of these estimates when interpreting them. The global estimate has been determined based on the normalization and extrapolation of costs submitted in NDCs and NAPs, an approach that is sensitive to the extrapolation factor used. That said, the estimation is based on the most up-to-date information available for adaptation finance needs derived from country-owned processes.

This estimate is higher than the median adaptation cost estimates for developing counties reported in the Intergovernmental Panel on Climate Change Working Group II Sixth Assessment Report (IPCC WGII AR6). The reported median estimate (and range) in IPCC WGII AR6 from earlier studies is US$127billion per year (with a range of US$15–411 per year) for 2030, rising to US$295 billion per year (with a range of US$47–1,088 billion per year) for 2050 (New *et al.* 2022). Similarly, this estimated amount significantly exceeds the US$25–250 billion (in 2005 prices) per year estimated by Chapagain *et al.* (2020) using a similar approach. However, the updated estimate here benefits from a richer input data set and more advanced extrapolation factors. Furthermore, a similar analysis by the Standing Committee on Finance in its first determination of the needs of developing country Parties suggests that the total costs of implementing adaptation needs in NDCs of developing countries (for those with costed adaptation needs) range from US$764 billion to US$835 billion in total. The costs of implementing NAP needs in the same report is estimated at US$135 billion (UNFCCC 2021). However, a direct comparison of these estimates with the updated values should take into account the underlying differences in data and methodology. A more recent NDC-based estimation conducted by Clima Capital Partners and Aviva Investors (2022) indicates that the cumulative adaptation finance needs of developing countries for 2020–2030 are within the range of US$1.95–6.79 trillion in total, which is equivalent to an average of US$195–679 billion per year. Although the two estimates are generated from different extrapolation methods and assumptions, and this study incorporates more recent submissions, the range is comparable. Overall, the updated estimate strongly indicates that developing countries' adaptation finance needs have increased significantly from the previous estimates.

This new estimate, along with other evidence lines on modelled costs and adaptation finance flows, is used as part of the updated adaptation finance gap analysis in chapter 5.

4. Adaptation finance

Lead authors: Georgia Savvidou (Stockholm Environment Institute and Chalmers University of Technology), Nella Canales (Stockholm Environment Institute), Nabil Haque (Stockholm Environment Institute), Pieter Pauw (Eindhoven University of Technology), Kennedy Mbeva (University of Oxford), Luis Zamarioli (independent)

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Key messages

- For the five years following the Paris Agreement's entry into force (2017–2021), finance for adaptation from international public sources to developing countries remained at or below US$25 billion per year, or approximately US$3 per person per year. In 2021, there was a 15 per cent decrease from 2020 levels, down to US$21 billion.

- In the same five-year period, the disbursement ratio for adaptation finance (at 66 per cent) was lower than for development finance overall (at 98 per cent): this indicates specific barriers to adaptation that hinder the implementation of projects in developing countries.

  - These barriers include low grant-to-loan ratios, failure to consider local issues when planning and designing projects, limited technical capacity among decision makers, and misalignment between the duration of the approval and disbursement process and the shorter-term mandates of national and local governments.

- In the 2017–2021 period, less than 17 per cent of commitments were dedicated to projects with a specific focus on local communities. While this is an increase from previous levels, these low levels exist despite increasing understanding of the importance of local communities' agency and involvement in adaptation projects.

- In the same period, the share of grants as a proportion of the total finance for adaptation for least developed countries (LDCs) (at 52 per cent) was substantially higher than that of non-LDCs (26 per cent). Small island developing States (SIDS) have an even higher share of grants in their total commitments (67 per cent).

  - This demonstrates that financial institutions are placing a higher emphasis on providing grant-based funding to LDCs and SIDS. This reflects concerns that traditional debt instruments (loans) are a less equitable option for adaptation finance in the most vulnerable countries, due to current debt vulnerabilities and limited fiscal capacity.

- Approximately a quarter of the finance simultaneously addressing both adaptation and mitigation (cross-cutting finance) was committed for general environment protection, indicating the potentially synergetic role of nature-based solutions for both adaptation and mitigation.

- Domestic expenditure and private finance are identified as vitally important sources of adaptation finance, but quantitative estimates continue to be unavailable. However, neither domestic expenditures nor private finance flows are likely to bridge the adaptation finance gap alone, especially in low-income countries (including the LDCs and SIDS), and there are important equity issues in using domestic budgets to address the finance gap in these countries.

- Analyses of adaptation finance flows are highly dependent on the tracking and reporting of data for finance to adaptation. As such, the enhancement of data quality and granularity is generally, but especially with regards to financial disbursements and for local-level financing, important for understanding whether the international community is achieving the adaptation finance goals previously agreed upon.

Introduction

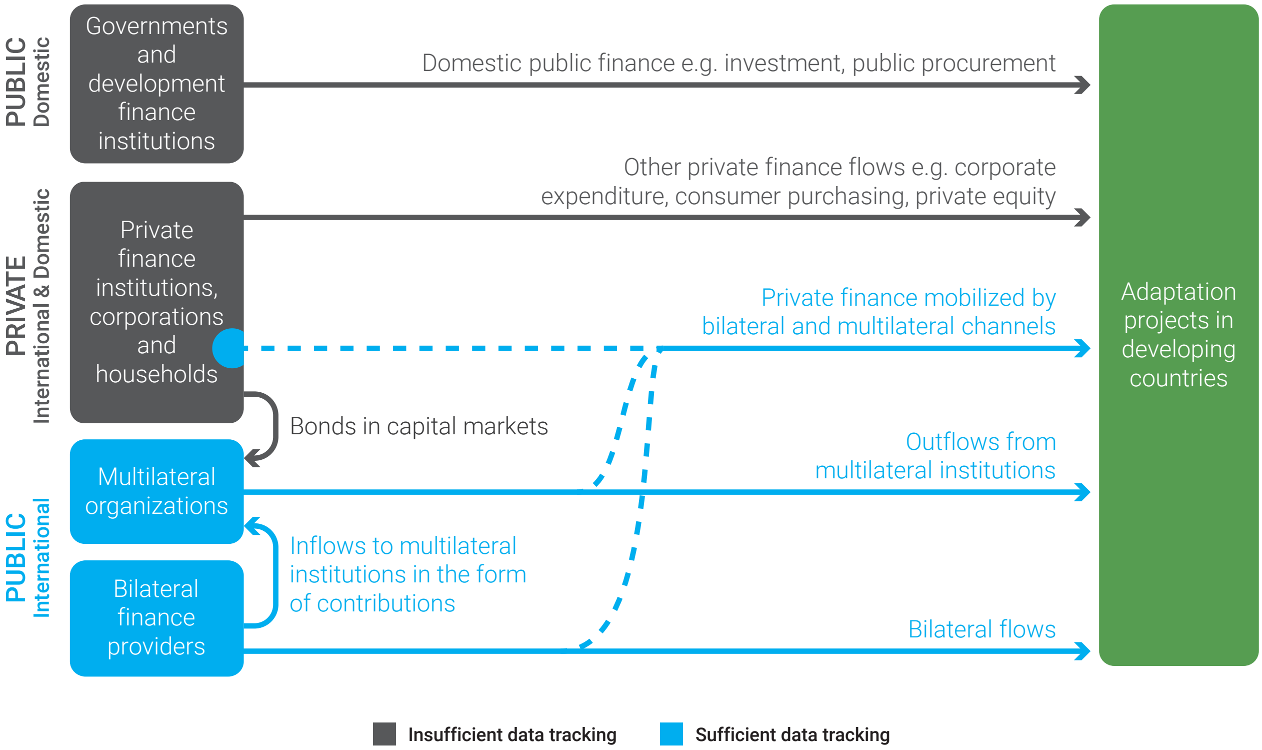
A revised assessment of current adaptation financial flows to developing countries has been undertaken, as these flows will allow implementation of the adaptation costs/financing needs outlined in previous chapters. This analysis focuses on the finance flows from developed to developing countries, as compared to existing reports which focus on global financial flows, including for developed and developing countries (Buchner *et al.* 2021; United Nations Framework Convention on Climate Change [UNFCCC] Standing Committee on Finance 2022).

These finance flows are particularly important in the context of the UNFCCC negotiations. In November 2021, at the twenty-sixth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 26) in Glasgow, a decision was taken to urge developed countries to at least double their collective provision of finance for adaptation to developing countries from 2019 levels by 2025 (decision CMA.3). The data included in this chapter provide an overview of adaptation finance between 2017 and 2021, and thus the progress towards this target. Furthermore, in 2015, at the twenty-first session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21) in Paris, it was decided to establish a new collective quantified goal (NCQG) for climate finance before the year 2025. This new target, which will be set by end of 2024, has a floor of US$100 billion per year, and must account for the needs and priorities of developing nations. Formal deliberations among Parties and non-Party stakeholders for the NCQG began at COP 26 in Glasgow and are ongoing. As well as the overall volume of finance, the NCQG could seek to advance more effectively targeted adaptation actions, scale adaptation finance and continue to seek much-needed grant finance for adaptation, potentially through an adaptation sub-target (Pauw *et al.* 2022b).

There is no formal agreement among countries on the sources of finance (and their distribution between regions or countries, and public and private sources) to deliver the previous goal of mobilizing US$100 billion of climate finance per year by 2020, nor the doubling of adaptation finance. A recent study (Colenbrander, Pettinotti and Cao 2022) determining fair shares of the US$100 billion goal based on gross national income, cumulative territorial CO_2 emissions and population concludes that only seven developed countries provided and mobilized their fair share in 2020 and pledged the full amount up to 2025, noting that the United States of America is overwhelmingly responsible for the largest climate finance gap of the US$100 billion goal.

Adaptation projects in developing countries can be financed by both public and private sources. This includes public and private international finance flows as well as domestic expenditures and domestic private flows (figure 4.1). However, data on these various flows are not equally robust. Existing data sources allow for detailed analysis of international public finance flows to adaptation. Data also exist for private finance mobilized by public bilateral and multilateral channels. However, the data quality of other private flows, as well as domestic expenditures (public and private) is not sufficient to allow robust analysis (see figure 4.1).

Figure 4.1 Finance types for adaptation projects in developing countries



Note: The figure provides an overview of the main actors and most relevant flows of climate finance for developing countries. The dashed line from private finance institutions, corporations and households signifies that, technically, private finance mobilized does not materialize until the public interventions from bilateral and multilateral channels occur. The dashed lines from bilateral and multilateral channels signify the public interventions to mobilize private finance, as opposed to actual finance flows to developing countries.

Source: Authors, based on OECD (2022a).

There are long-standing barriers to accessing adaptation finance. Access remains a challenge for vulnerable developing countries in particular, not least due to inadequate programming capacity within many countries (UNFCCC Adaptation Committee 2021; De Marez *et al.* 2022).

Adaptation finance also must consider the potential risk of maladaptation, an issue that is arising in the literature (Atteridge and Remling 2018; Schipper 2020; Eriksen *et al.* 2021). While there are many aspects to this, it may include methods for assessing adaptation outcomes (including potential maladaptive ones) (Reckien *et al.* 2023), consideration of underlying dynamics, especially in fragile and conflict affected contexts (Cao *et al.* 2021; Reda and Wong 2021; Meijer *et al.* 2023), and consideration of local vulnerabilities and securing local ownership and participation (Soanes *et al.* 2021).

Methodological approach

For this report, a comprehensive analysis of the self-reported public international adaptation finance flows from bilateral and multilateral finance providers to developing countries was conducted. This includes finance committed and/or disbursed for adaptation purposes from Annex II to non-Annex I Parties.

Such an analysis is constrained by data availability and limitations (Roberts and Weikmans 2022; Canales *et al.* 2023), including around definitions, methodological differences among finance providers, accounting issues, confidentiality restrictions and a lack of universally accepted definitions (for an overview, see Annex 4.A). Several studies highlight that self-reporting by climate finance providers and lack of independent quality control can result in low data reliability and, occasionally, substantial overestimations of finance flows (Weikmans *et al.* 2017; United Nations Environment Programme [UNEP] 2021; Toetzke, Stünzi and Egli 2022). This reduces the accountability and transparency of climate finance, which is fundamental for building trust in climate negotiations (Pauw *et al.* 2022b). Table 4.1 presents the main methodological decisions used in this analysis. Annex 4.B further elaborates on these.

Table 4.1 Main methodological decisions for the international public adaptation finance flows analysis

Technical factor	Methodological decision
Data source	Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee
Finance type	International public finance flows
Period covered	2017–2021
Geographic classification	Annex II Parties to non-Annex I Parties
Sources of finance	• Bilateral flows • Multilateral outflows (from multilateral development banks [MDBs], climate funds and other multilateral institutions) attributed to developed countries
Financial instruments	• Grants and loans (concessional and non-concessional) • Other (equity and shares in collective investment vehicles, mezzanine finance instrument)
Point of measurement	Commitments and disbursements
Methodological decisions	• Activities marked as 'significant' and 'principal' under Rio marker methodology were discounted based on coefficients to estimate climate specific amounts. • For multilateral finance providers outflows, coefficients to identify amounts attributable to developed countries were applied. • Export credits, coal-related projects and administrative costs of finance providers were excluded.

Total international public climate finance for developing countries

The updated analysis identifies that between 2017 and 2021 (the five years following the year of the Paris Agreement's entry into force and the latest five years for which comparable data are available for bilateral and multilateral sources), total international public climate-specific finance commitments (including mitigation and adaptation) towards developing countries from bilateral and multilateral finance providers were US$65 billion per year or below (at US$65 billion, 2020 was the year with the highest amount) (figure 4.2, panel A).

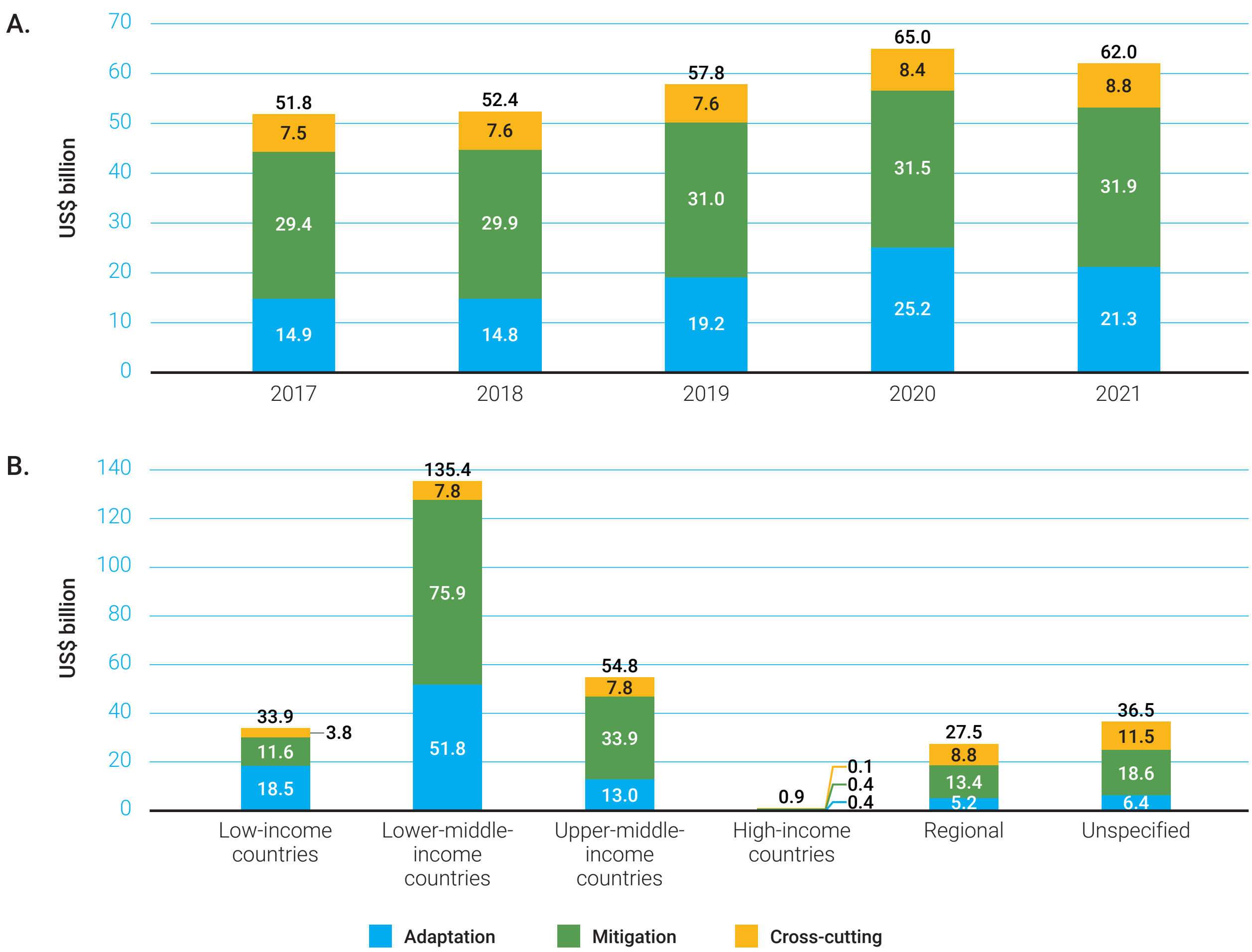
The trend of increasing finance between 2017 and 2020 was followed by a decrease in commitments between 2020 and 2021 (figure 4.2, panel A). This decrease was driven by the lower financial commitments for adaptation, which dropped by 15 per cent (figure 4.2, panel A). Often, year-on-year variations in climate finance can be influenced by large individual projects (such as infrastructure) and by changes in methodologies used by financial providers in climate finance reporting. However, our analysis shows that the 2021 decline is not attributed to a single or a handful of sectors or finance providers. The decline across multiple sectors and finance providers may be associated with the impact of COVID-19. On the other hand, both mitigation and cross-cutting commitments experienced slight increases on the order of 1.4 per cent and 5 per cent respectively, from 2020 to 2021.

Total international public **adaptation-specific** finance towards developing countries remained at or below US$25 billion per year between 2017 and 2021 (figure 4.2, panel A). In 2019, the baseline year for the doubling of adaptation finance by 2025, our estimates point to total financial commitments of US$19.2 billion, implying annual flows of US$38.4 billion would be required by the year 2025 at the latest to achieve the doubling. In 2020, finance increased by 31 per cent (from 2019), reaching US$25.2 billion. However, in 2021, adaptation-specific finance declined to $21.3 billion, a 15 per cent reduction from 2020 levels. This also implies that to reach a doubling by 2025, a 16 per cent annual compound growth rate is now required between 2021 and 2025.

In line with article 9, paragraph 4, of the Paris Agreement, climate finance should be balanced between adaptation and mitigation. Total international public climate-specific finance for the five-year period 2017–2021 to developing countries totalled US$289 billion. Of this, around US$95 billion (33 per cent) went towards supporting adaptation activities (figure 4.2). In addition, US$40 billion (14 per cent) was earmarked for initiatives that addressed both adaptation and mitigation, also known as cross-cutting initiatives. Regional allocations, representing finance for regional cooperation, received a substantial amount (approximately 10 per cent of total commitments in the period 2017–2021) (figure 4.2, panel B).

In terms of climate-specific finance per countries' income group, low-income and lower-middle-income country groups received higher commitments for adaptation than for mitigation, unlike upper-middle-income and high-income country groups (figure 4.2, panel B). The highest amount of climate- and adaptation-specific finance is concentrated in lower-middle-income countries, which is also the group with the highest number of countries (53 countries) in our analysis. The share of adaptation in total climate-specific finance is the highest in low-income countries (at 55 per cent), followed by lower-middle- and upper-middle-income countries (with 38 per cent and 24 per cent, respectively). LDCs and SIDS also receive higher commitments for adaptation (51 per cent and 52 per cent) than for mitigation (39 per cent and 30 per cent).

Figure 4.2 Climate-specific finance commitments from developed to developing countries per year (panel A) and per income group (panel B) for the period 2017–2021 (US$ billions, constant prices)



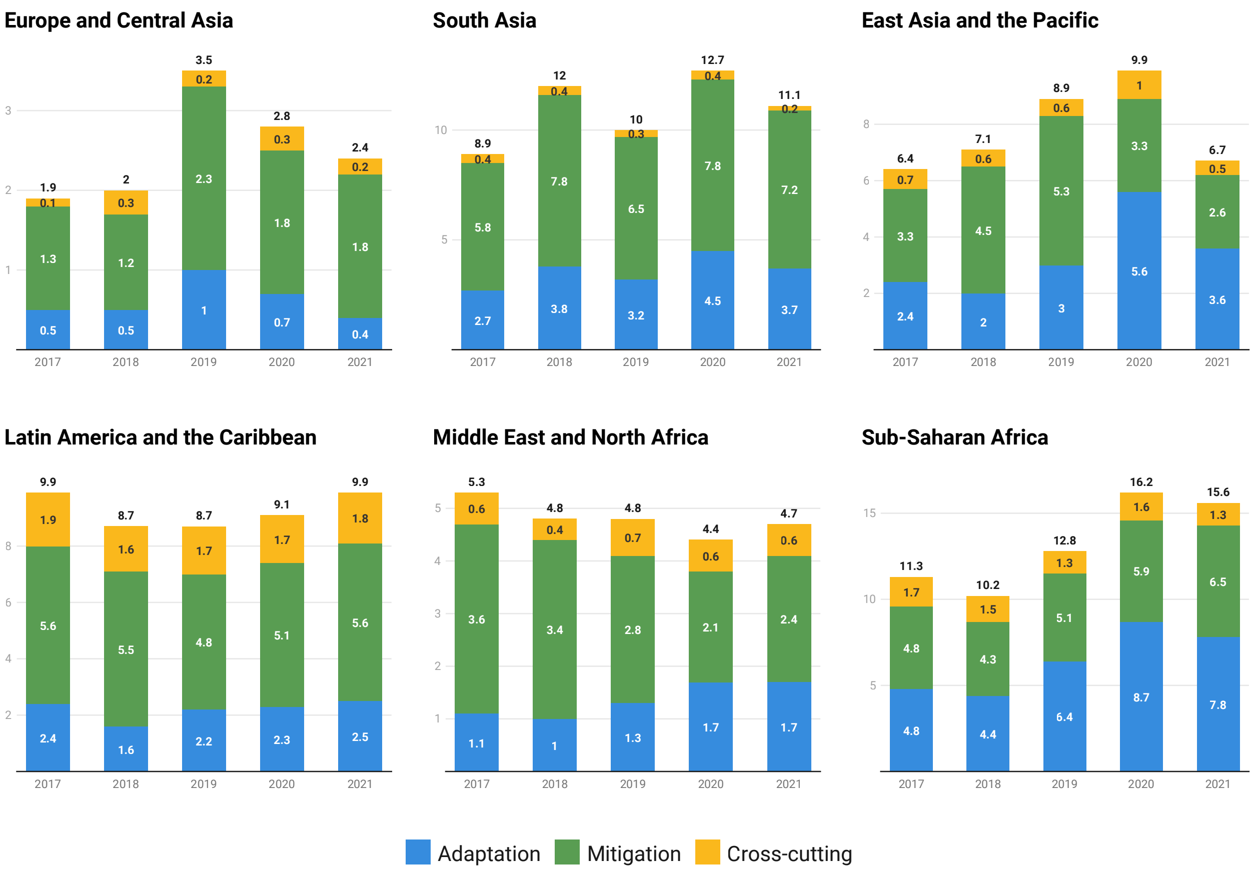
Note: Small errors in some totals are due to rounding of numbers. Amounts are presented at face value. Regional allocations include those to Far East Asia, Oceania, Melanesia, the Federated States of Micronesia, South Asia, America, the Caribbean, Central America, Central America and the Caribbean, South America, Western Africa, South of the Sahara, Eastern Africa, Southern Africa, Middle Africa, Asia, and Africa. Unspecified allocations are those without any specific recipient country or region information.

In terms of the balance between adaptation and mitigation for the period 2017–2021 per region (figure 4.3), sub-Saharan Africa is the only region that was allocated higher finance amounts for adaptation (49 per cent) compared to mitigation (40 per cent), with an additional 11 per cent for cross-cutting activities. Regarding the amounts per year, adaptation was allocated higher amounts consistently from 2018 onwards. East Asia and the Pacific received 43 per cent of the total climate-specific finance between 2017 and 2021 for adaptation, 49 per cent of that for mitigation and 9 per cent of that for activities targeting both simultaneously. Adaptation-specific finance in this region was higher than mitigation in both 2020 and 2021, constituting a shift from previous years. All other regions were allocated less than 35 per cent of their total climate-specific finance for adaptation (33 per cent for South Asia, 28 per cent for the Middle East and North Africa, 25 per cent for Europe and Central Asia and 24 per cent for Latin America and the Caribbean). In these regions, adaptation-specific finance remained substantially lower than mitigation throughout the analysis period.

Between 2019 (the baseline year for the goal on doubling adaptation finance) and 2020, all regions saw an increase in their adaptation-specific finance except for Europe and Central Asia, which experienced a 30 per cent reduction (figure 4.3). East Asia and the Pacific had the highest increase, equivalent to 85 per cent, followed by South Asia with 40 per cent, sub-Saharan Africa with 37 per cent, the Middle East and North Africa with 35 per cent and, finally, Latin America and the Caribbean with only a 1 per cent increase.

Between 2020 and 2021, adaptation-specific finance in sub-Saharan Africa, South Asia and East Asia and the Pacific decreased substantially (by 10 per cent, 19 per cent and 37 per cent, respectively). Together, these three regions account for the majority (76 per cent) of adaptation finance in developing countries; sub-Saharan Africa with $32.1 billion (37 per cent), South Asia with $17.8 billion (20 per cent), and East Asia and the Pacific with $16.7 billion (19 per cent). Together, Latin America and the Pacific, the Middle East and North Africa and Europe and Central Asia account for the remaining 24 per cent (equivalent to US$20.9 billion in total). Adaptation-specific finance has been relatively stable in these regions during the past five years.

Figure 4.3 International public climate-specific finance commitments from developed to developing countries by region and per year for the period 2017–2021 (US$ billions, constant prices)



Note: Amounts are presented at face value. Regional allocations that could not be integrated in a region (Africa, Asia, South and Central Asia and unspecified allocations) were not included.

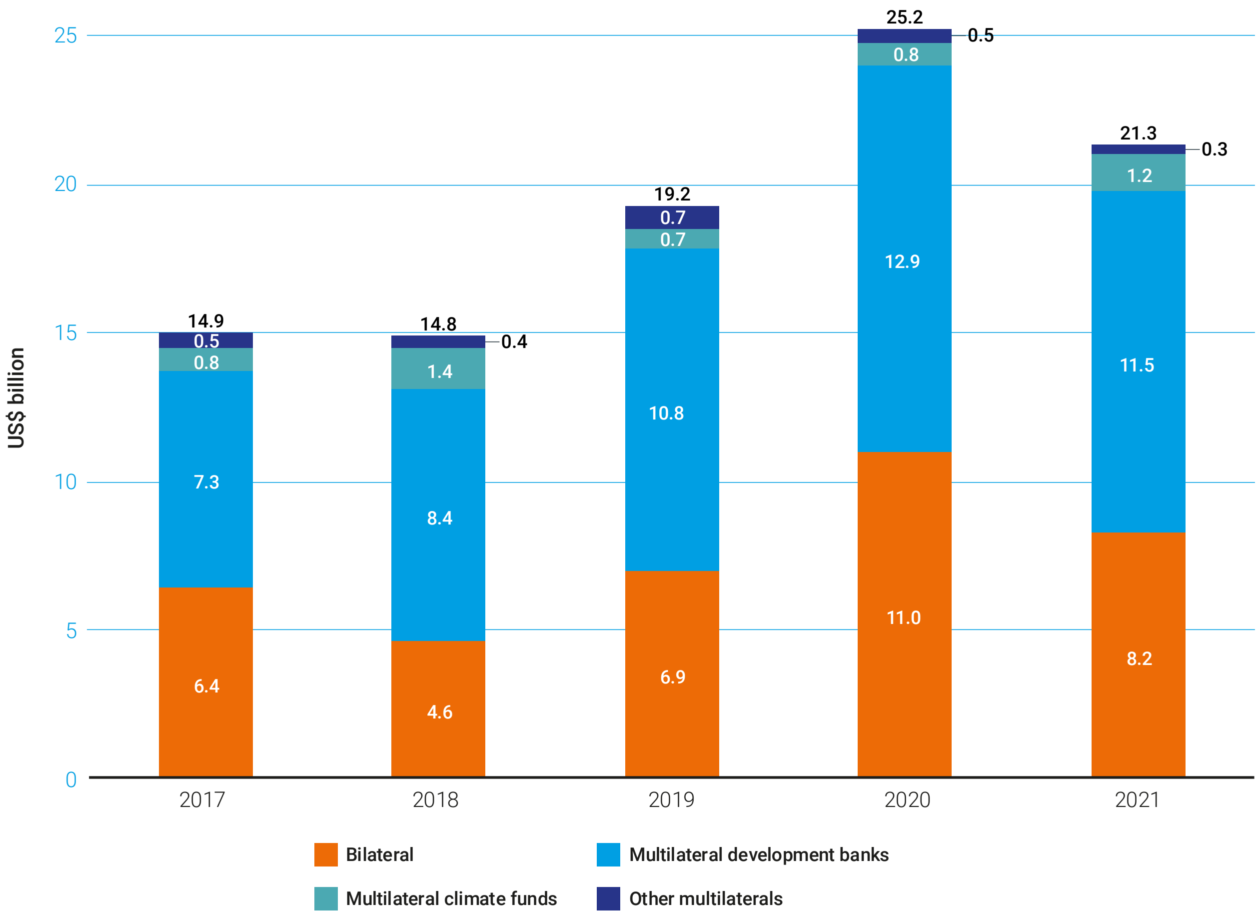
The distribution between adaptation and mitigation within the regions varies with countries' income levels. Overall, there is a trend for higher adaptation shares in lower-income countries. For example, in East Asia and the Pacific, about half of climate finance in lower-middle-income countries was allocated to adaptation, compared to 25 per cent in upper-middle-income countries. In South Asia, 50 per cent of climate-specific finance in low-income countries was committed for adaptation, compared to 32 per cent for lower-middle-income countries. In Latin America and the Caribbean, lower-middle-income countries had the highest share (51 per cent) for adaptation, while adaptation in upper-middle-income countries reached only 26 per cent.

Finally, in terms of the largest country recipients of adaptation-specific finance in each region between 2017 and 2021, in East Asia and the Pacific, these are the Philippines (US$3.8 billion), Indonesia (US$3.5 billion) and China (US$2.2 billion). In Europe and Central Asia, Uzbekistan is the largest adaptation finance recipient, with US$ 1.2 billion throughout the studied period, followed by Kazakhstan (US$0.6 billion) and Georgia (US$0.5 billion). The largest recipients in South Asia were India (US$7.5 billion), Bangladesh (US$4.3 billion) and Pakistan (US$2.3 billion). In Latin America and the Caribbean, the largest adaptation finance recipients were Argentina (US$1.1 billion), Brazil (US$1 billion) and Mexico (US$1 billion). In the Middle East and North Africa, Morocco (US$2.1 billion), Tunisia (US$1 billion) and Jordan (US$0.9 billion) were the largest adaptation finance recipients. In sub-Saharan Africa, the largest shares of adaptation finance went to Ethiopia (US$ 2.9 billion), a low-income country, followed by Nigeria (US$2.6 billion) and Kenya (US$2.6 billion), two lower-middle-income countries.

Adaptation finance commitments per finance provider

Regarding adaptation-specific finance, which includes finance across financial instruments (mainly loans and grants), per finance provider type, multilateral development banks (MDBs) are the largest provider type throughout the period (figure 4.4). Their financial commitments follow a continuous increase from 2017 to 2020 (a 15 per cent, 28 per cent and 20 per cent increase between 2017–2018, 2018–2019 and 2019–2020, respectively). However, this was followed by an 11 per cent decrease in 2021 (figure 4.4). For bilateral providers, the second largest finance provider type, there was a steeper increase between 2018 and 2020 (approximately 51 per cent from 2018 to 2019 and 58 per cent from 2019 to 2020), which was also followed by a decrease of 25 per cent in 2021. Although the volume of financial commitments by multilateral climate funds (such as the Green Climate Fund, the Adaptation Fund, the Global Environment Facility and Climate Investment Funds) are low compared to MDB and bilateral finance volumes, they play a significant role. Multilateral climate funds comprise the only finance provider type that increased its commitments between 2020 and 2021 (figure 4.4).

Figure 4.4 Adaptation-specific finance commitments to developing countries per finance provider type over time (US$ billions, constant prices)

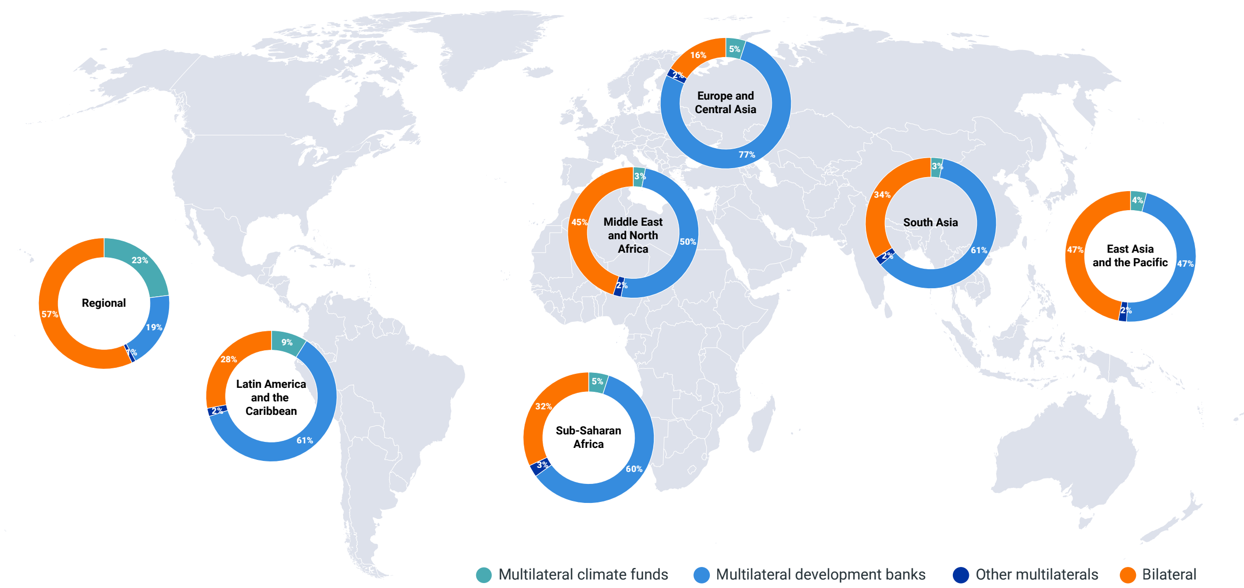


Note: Small errors in some totals are due to rounding of numbers. The amounts include financial commitments for adaptation and exclude financial commitments for initiatives that target both adaptation and mitigation simultaneously (cross-cutting). Amounts are presented at face value. For more on the data and methodology, see Annex 4.B.

MDBs provide 53 per cent of total adaptation finance throughout all regions and years of our analysis. In terms of their share in regions, the smallest share is 47 per cent in East Asia and the Pacific, while the largest is 77 per cent in

Europe and Central Asia (figure 4.5). Bilateral funders remain an important source of adaptation finance, particularly in East Asia and the Pacific, where they have the same share as MDBs (47 per cent); and in the Middle East and North Africa, where they provided 45 per cent. However, bilateral funders' contributions to adaptation were dwarfed by MDBs in sub-Saharan Africa (32 per cent and 60 per cent, respectively) and in South Asia (34 per cent and 61 per cent, respectively). The share of multilateral climate funds is less than 10 per cent in all regions, with the highest share in Latin America and the Caribbean (9 per cent) and the lowest in South Asia (2 per cent). However, in terms of regional spending,[1] bilateral providers and multilateral climate funds have higher shares than MDBs; multilateral climate funds allocate almost a quarter of all finance (23 per cent) and bilateral providers have the highest share (57 per cent). A breakdown of finance per financial instrument is provided in the following section.

Figure 4.5 Adaptation-specific finance commitments to developing countries per finance provider type by region for the period 2017–2021 (US$ billions, constant prices)



Note: The amounts include financial commitments for adaptation and exclude financial commitments for initiatives that target both adaptation and mitigation simultaneously (cross-cutting finance). Amounts are presented at face value. For more on the data and methodology, see Annex 4.B.

Adaptation finance commitments per finance provider, financial instrument and recipient country

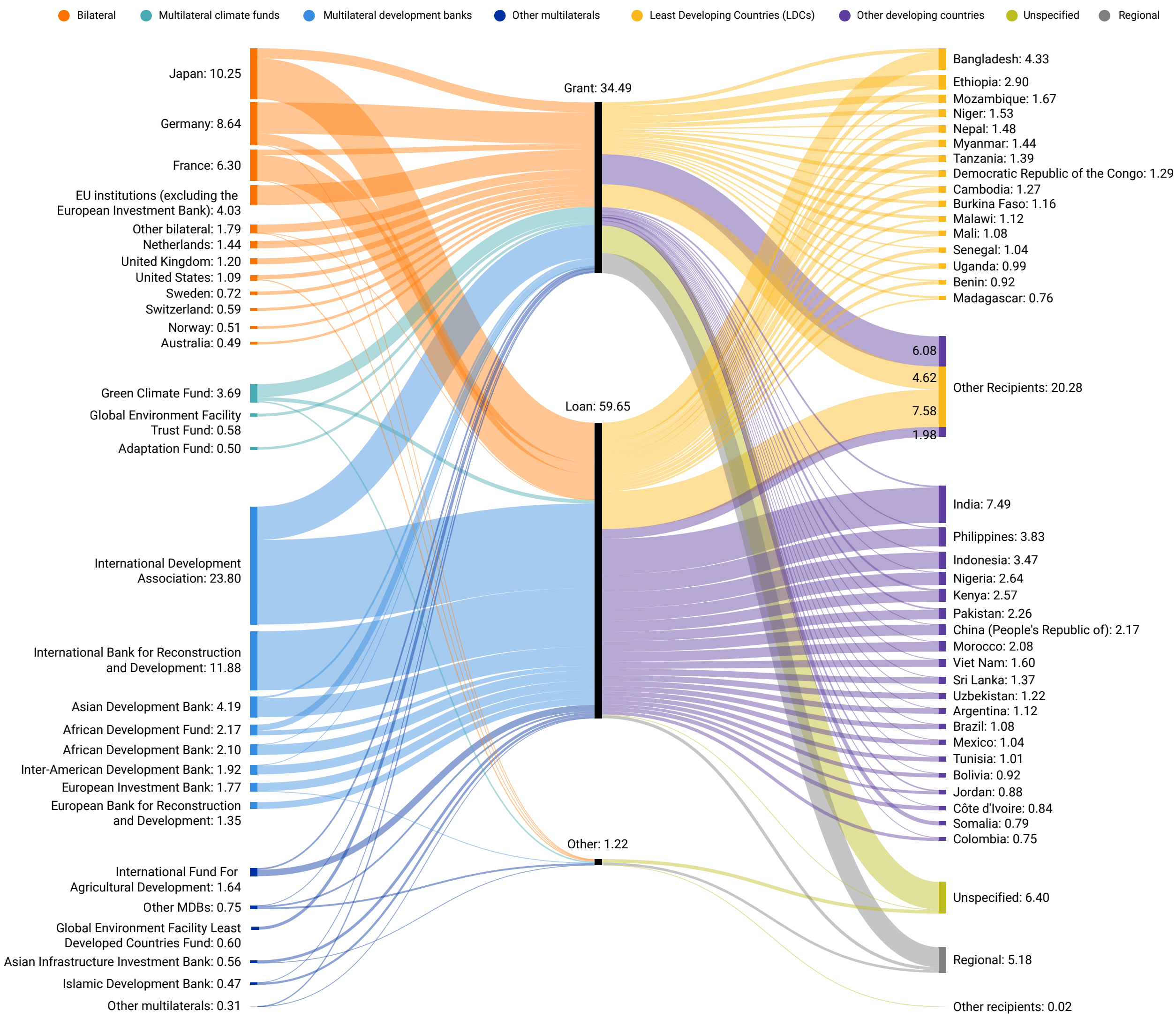
While it is critical for developed countries to fulfil their commitment to double adaptation finance from 2019 levels by 2025, it is also important to investigate the structure of this financing and its suitability for the intended purpose, and whether it is deemed fair by recipient countries that have contributed least to climate change but are most impacted by it, especially the most vulnerable countries such as the LDCs. For example, debt instruments (loans) are not necessarily a negative option if they are employed to fund a project with a high likelihood of yielding returns, and/or if the borrower has the capacity and institutions to ensure the debt is sustainable and used productively (Mustapha 2022). However, considering the prevalent debt vulnerabilities and limited fiscal capacity in many developing countries, and the fact that adaptation often does not offer a direct return on investment for the investor, it is improbable that delivering most climate finance via traditional debt instruments would be equitable (ibid.).

In terms of the shares of financial instruments, 63 per cent of all adaptation-specific finance between 2017 and 2021 was provided as debt instruments (loans) and 36 per cent as grants (figure 4.6). Of the total adaptation finance offered as debt instruments, 70 per cent was from MDBs, 26 per cent was from bilateral providers, 1 per cent was from multilateral climate funds (primarily the Green Climate Fund) and the remaining 2 per cent was from other multilateral funds. Grant-based finance, on the other hand, came predominantly from bilateral sources (61 per cent), followed by MDBs (25 per cent), multilateral climate funds (13 per cent) and other multilateral funds (1 per cent).

1 Regional spending represents finance not allocated to a specific country, but rather finance for regional cooperation projects.

Focusing on the share of grants and loans per finance provider type, the majority of MDB adaptation finance (67 per cent) consisted of loans, while their share of grants was 29 per cent. In contrast, most finance from multilateral climate funds is delivered as grant funding. For bilateral providers, 57 per cent of total adaptation finance was provided as grants and 42 per cent as loans. On the recipient side, at an aggregate level, more adaptation finance is committed to those regions with a larger number of LDCs – primarily Africa. The share of grants for LDCs (52 per cent) is substantially higher than that of non-LDCs (26 per cent) indicating that financial providers prioritize grant-based financing for LDCs. SIDS have an even higher share of grants in their total commitments (67 per cent) (figure 4.6).

Figure 4.6 Total adaptation-specific finance commitments by finance providers, financial instruments and recipient countries, 2017–2021 (US$ billions, constant prices)



Note: The amounts include financial commitments for adaptation and exclude financial commitments for initiatives that target both adaptation and mitigation simultaneously (cross-cutting finance). Amounts are presented at face value. For more on the data and methodology, see Annex 4.B.

Between 2017 and 2021, four Asian countries (India, Bangladesh, the Philippines and Indonesia) were the largest recipients of adaptation finance, together accounting for about 20 per cent of the total adaptation finance. All of them were primarily allocated loans. In terms of grant-based funding, the four highest recipients (Ethiopia, Mozambique, Niger and the Democratic Republic of the Congo) are in sub-Saharan Africa and are low-income countries. Nigeria, Kenya and Tanzania, all lower-middle-income sub-Saharan African countries, receive higher volumes of loans than grants.

As for the financial providers, the World Bank's International Development Association is by far the largest, with about a quarter of total adaptation finance. It is followed by the International Bank for Reconstruction and Development, with about 12 per cent of the total adaptation finance. The third, fourth and fifth highest finance providers are bilateral providers, Japan (11 per cent), Germany (9 per cent) and France (7 per cent).

The bulk of adaptation finance provided by Japan and France comes in the form of loans, whereas for Germany, the majority is grant-based adaptation finance. Countries that exclusively provide adaptation finance in the form of grants include Sweden, the Netherlands, the United Kingdom, Switzerland, Norway and Australia.

Finance flows per capita

We find that, with the exception of Djibouti and various SIDS, no country was allocated more than US$25 per person per year for adaptation. From the 132 recipient countries included in our analysis, only 38 were allocated more than US$15 per person per year and 47 countries were allocated less than US$5 per person per year.

In terms of income levels, the average finance per person per year was US$6 for low-income countries, US$23 for lower-middle-income countries, US$79 for upper-middle-income countries and US$119 for high-income countries. These values are compared to adaptation finance needs in chapter 5.

Adaptation finance to the local level

There is growing evidence that not all adaptation finance is strategically targeted towards countries and population groups with the greatest vulnerability and needs, especially at the subnational level (Browne *et al.* 2022; Savvidou *et al.* 2021). There is growing recognition that local organizations, people and communities need to lead or to be meaningfully involved in adaptation projects. At the frontline of climate change impacts, they are often the most engaged and innovative in developing transformative adaptation solutions (Global Center on Adaptation 2020; Castro and Sen, 2022). However, they often face a shortage of resources and lack the ownership to effectively implement these solutions (Global Center on Adaptation 2020). In a recent analysis of 374 global adaptation projects, only 22 projects exhibited substantial attributes that enable locally led adaptation (LLA) (Tye and Suarez 2021). The LDC Group aims to channel 70 per cent of climate finance to the local level by 2030 and is driving momentum behind a shift towards more LLA. To guide the promotion of LLA, eight LLA principles were developed.[2]

Knowledge of the flows and quality of adaptation finance to the local level remains limited. Previous analysis of international climate funds' financial commitments for climate change mitigation and adaptation to developing countries found that less than 10 per cent was directed at the local level (Soanes *et al.* 2017). An updated analysis has been undertaken to investigate bilateral and multilateral finance providers' reporting (to OECD) following the methodology of Soanes *et al.* (2017) and applying it for adaptation in particular. Currently, finance providers neither track nor report on how much of their financial commitments are intended to reach local actors, making this quantification of finance to the local level challenging. Therefore, the analysis uses key search words[3] in the project description of the OECD database, and is contingent on the comprehensiveness of the detail provided in each entry. Based on the analysis, out of the total adaptation finance of about US$95 billion allocated between 2017 and 2021, less than 17 per cent (US$16.5 billion) was allocated to climate change adaptation projects with a specific focus on local communities, though this is an increase on the (10 per cent) reported in the earlier Soanes *et al.* (2017) study.

A comprehensive assessment of local-level finance would necessitate reviewing project documents and analysing the implementation of projects, which is beyond the scope of this study. Soanes *et al.* (2021) offer a detailed examination with a specific focus on LDCs. Overall, reporting of climate finance at the local level needs to be improved, and finance allocations need to be increased. The global goal on adaptation could present important opportunities to better define LLA efforts, ensuring that social inequalities among local actors and between local and non-local actors are addressed, and ultimately improving the tracking of LLA activities for assessing adaptation progress.

Adaptation finance disbursements

The analysis above is based on commitment data. A further important issue is the disbursement of this committed finance. This is more difficult to track from bilateral and multilateral providers but is critical, because while commitments showcase ambition, projects can have an impact only when they are disbursed and implemented (Sustainable Energy for All 2020; Savvidou *et al.* 2021; Jain and Bardhan 2023). Assessing the ratio of disbursements to commitments over a specific time frame provides insights into whether approved projects are being implemented as intended, or if they are facing challenges during implementation. While there is always a lag between

2 See https://gca.org/programs/locally-led-adaptation/.

3 The keywords used for tracking finance flows to the local level are: civic, Indigenous, smallholders, community, local, SMEs, cooperative, municipal, subnational, decentralised, province, town, home, rural, village, household, slums. See Annex 4.B for more on the methodology, including the shorter version of words included for maximizing the search results.

commitment and disbursements,[4] the disbursement ratio is considered an important indicator for the implementation status and absorptive capacity of recipient institutions.

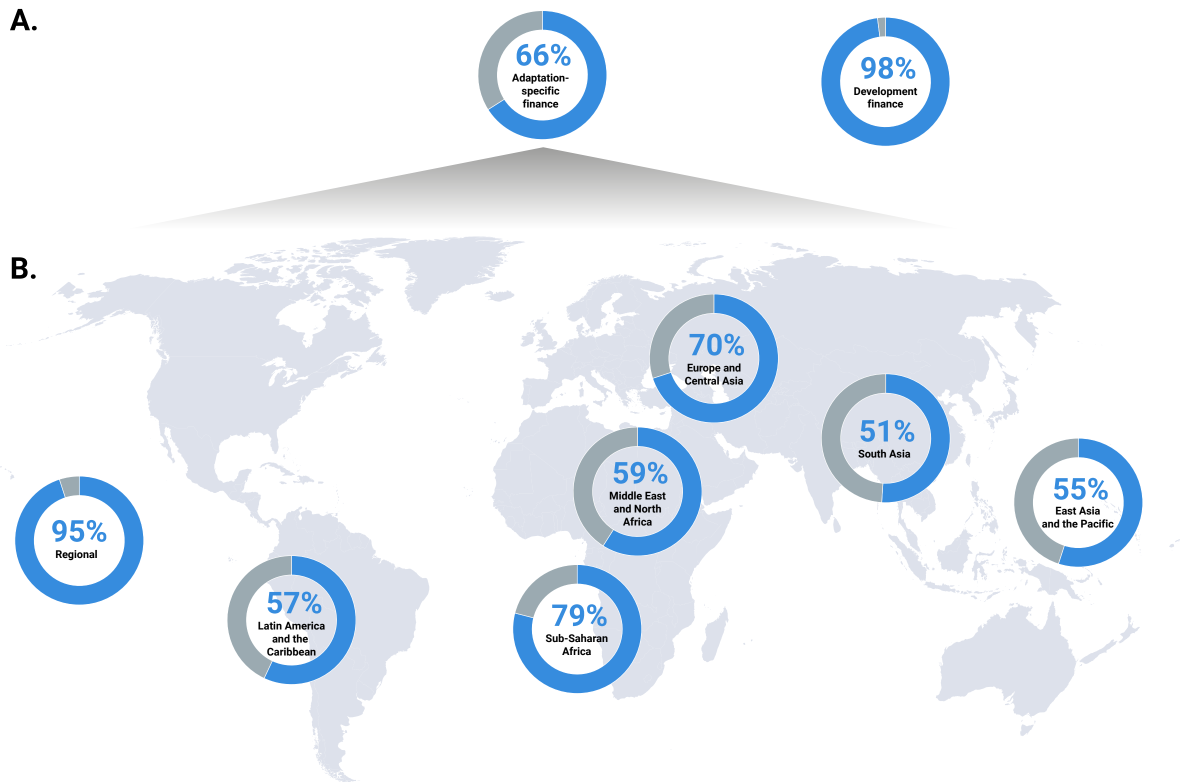
An analysis has been made of commitment versus disbursement information for adaptation finance. Disbursement information has been reported regularly by bilateral finance providers since 2007 (OECD undated). However, most MDBs and some multilateral organizations report only on commitments. This analysis therefore focuses only on disbursements by bilateral providers. The analysis has found that disbursements from bilateral providers to developing countries for adaptation are lower than the amounts committed during the period under analysis. In particular, 66 per cent of the committed amounts during the period were disbursed. The estimated disbursement ratio for adaptation finance globally (66 per cent) is much lower than the disbursement ratio for all development finance (98 per cent) (figure 4.7, panel A), which indicates challenges in disbursing adaptation-specific projects.

Looking at adaptation-specific disbursement ratios per region (figure 4.7, panel B), with 51 per cent of all commitments being disbursed, South Asia is the region with the lowest disbursement ratio during 2017 to 2021. This is followed by East Asia and the Pacific, and Latin America and the Caribbean, with 55 per cent and 57 per cent, respectively. Sub-Saharan Africa, the region with the largest number of LDCs, seems to have the highest disbursement ratio during the same period. Regional allocations, which represent finance not allocated to a specific country but for regional cooperation for adaptation, have by far the highest disbursement ratio. At the country level, 14 countries have a disbursement ratio of less than 30 per cent (Angola, Jamaica, the Marshall Islands, Saint Lucia, Guinea, Azerbaijan, Côte d'Ivoire, Comoros, Lesotho, Iraq, Gambia, China, Sri Lanka and Dominica).

Savvidou *et al.* (2021) analysed disbursement ratios for adaptation finance in Africa between 2014 and 2018 and investigated whether the low disbursement ratio is a general characteristic of particular sectors where adaptation-related finance is concentrated. They found the low disbursement ratio to be unrelated to the sectors. The proportion of loans (39 per cent of total bilateral finance) may explain to some extent the low disbursement ratio, given that grant-based finance has been documented to have higher disbursement rates compared to loan-based finance (Gaoussou 2011; Nkamleu *et al.* 2011). This may explain the higher disbursement ratio in sub-Saharan Africa compared to the other regions, since sub-Saharan Africa has the highest share of grants among the different regions. According to Meattle *et al.* (2022), barriers to disbursements include the failure to incorporate operational realities of domestic markets in project planning and design, limited technical capacity and awareness concerning climate policies among policymakers, skewed perceptions of local mandates with implications for managing local due diligence and procurement processes and limited maturity of local financial institutions have been documented. Furthermore, according to Sustainable Energy for All (2020), efficient disbursement relies heavily on project-specific elements such as well thought-out project design, which takes into account the limited availability of local financial services and ensures effective coordination among key stakeholders. Other barriers to implementation include the misalignment between the duration of the approval and disbursement process and the shorter-term mandates of local governments (Global Center on Adaptation 2020), low grant-to-loan ratios, co-financing requirements and rigid rules of climate funds (Omari-Motsumi, Barnett and Schalatek 2019; UNFCCC Adaptation Committee 2021; De Marez *et al.* 2022).

4 This means that some disbursements in the studied period might correspond to commitments made in previous years (leading to overestimation of disbursements). At the same time, disbursements from some commitments in the studied period may occur in the years after the studied period (leading to underestimation of disbursements).

Figure 4.7 Disbursement ratios for bilateral development finance and bilateral adaptation-specific finance to developing countries (panel A) and bilateral adaptation-specific finance per region (panel B), 2017–2021



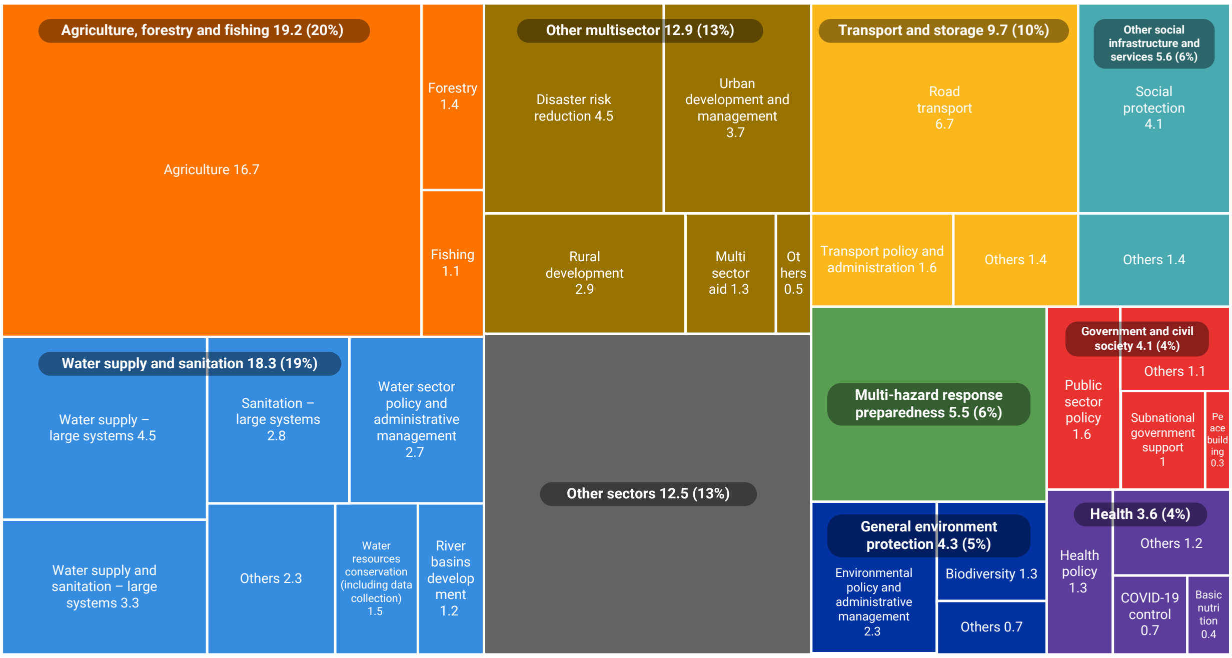
Note: The adaptation-specific amounts include financial disbursements over commitments in developing countries excluding 'unspecified' flows, and financial commitments for initiatives that combined adaptation and mitigation simultaneously (cross-cutting initiatives). Data on total bilateral development finance are sourced from Aid Atlas (Atteridge *et al.* 2019). Amounts are presented at face value. For more on the data and methodology, see Annex 4.B.

Adaptation finance per sector

Globally, adaptation finance has been targeted mainly at two major sectors – 'agriculture, forestry and fishing' (around 20 per cent of total adaptation finance); and 'water supply and sanitation' (around 19 per cent of total adaptation finance) (figure 4.8). To a large extent, finance being targeted to these two sectors aligns with their climate sensitivity as well as the adaptation priorities identified by developing countries in their adaptation communications (see chapter 3 and UNFCCC [2022]).

However, financing of adaptation in key development sectors, such as 'health' or 'education' has been very low (4 per cent for 'health' and 2 per cent for 'education'). Similarly, finance for the 'general environment protection' sector received only 4.5 per cent of the total adaptation-specific finance. This includes 'biodiversity', which only received about 1 per cent and is important given the vulnerability of biodiversity and the ecosystem services this delivers, as well as the related goals to guide global action through 2030 to halt and reverse nature loss (see the goals and targets of the UN Biodiversity Conference at the fifteenth session of the Conference of the Parties]).

Figure 4.8 Total international public finance to developing countries that targets adaptation, by sector (US$ billions, commitments, constant prices), 2017–2021



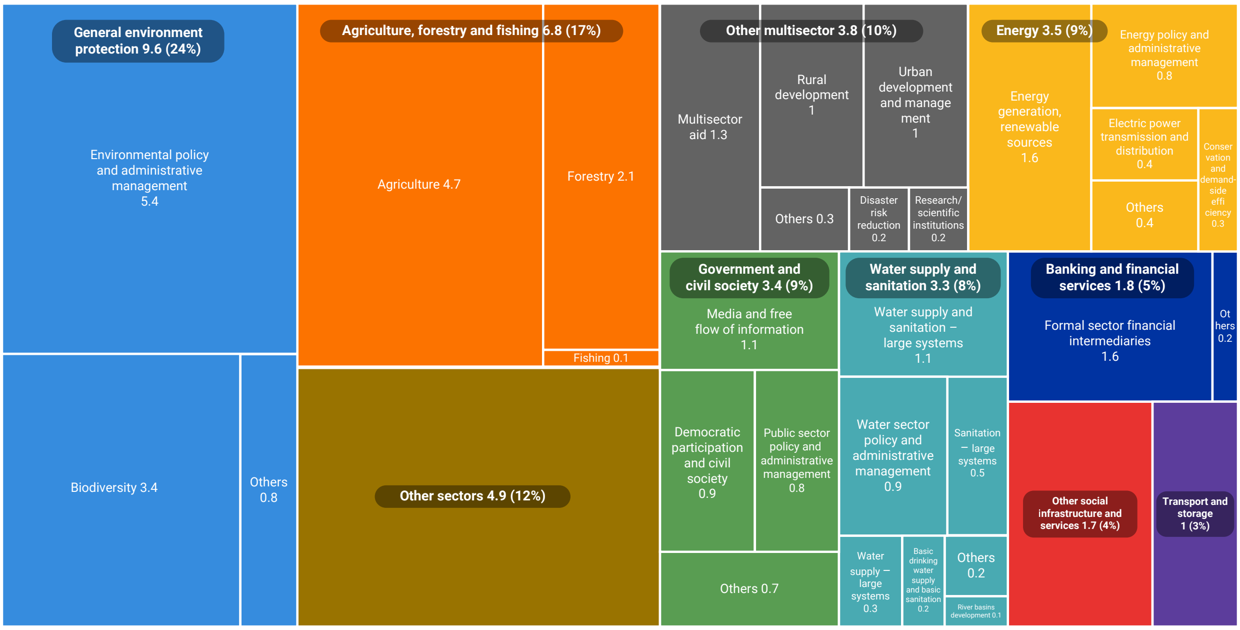
Note: The amounts include financial commitments for adaptation and exclude financial commitments for initiatives that target both adaptation and mitigation simultaneously (cross-cutting initiatives). Amounts are presented at face value. For more on the data and methodology, see Annex 4.B.

The relatively concentrated sectoral focus observed in committed finance may be indicative of the specific thematic expertise and/or normative views on climate adaptation held by the national and international institutions primarily responsible for programming adaptation finance. It may also reflect the priorities of developing countries, as these sectors also feature strongly in nationally determined contribution and national adaptation plan submissions (chapter 3). However, between 2021 and 2022, the MDBs carried out a review of the joint MDB methodology for tracking adaptation finance aimed to better characterize adaptation activities for the purpose of tracking adaptation finance, and to provide guidance on the application of the joint methodology in a broader range of financing instruments (European Investment Bank 2022). In this review, they state that "Adaptation is no longer viewed purely as an add-on to development investments, but rather as an imperative for putting development on the path to resilience. As a result, adaptation support has expanded from traditional infrastructure sectors to a wider range of sectors, such as education, health, social protection, financial services, and research and innovation for adaptation solutions". While these changes are expected to be reflected in the data from MDBs from 2023 onwards, the share of the 'health' sector in total adaptation-specific finance continuously already increased from 1 per cent in 2017 to 6 per cent in 2021. The sectors 'government and civil society and 'other social infrastructure and services' also saw substantial increases particularly in the last two years of the period studies, 2020 and 2021. These developments may reflect a shift in finance providers' perspectives of adaptation away from traditional adaptation sectors.

Cross-cutting finance

While the above sections focused on finance addressing adaptation only, cross-cutting finance covering both adaptation and mitigation simultaneously plays an important role for climate change, especially given the potential synergies between adaptation and mitigation. During 2017–2021, US$39.9 billion was provided globally as cross-cutting climate finance, equivalent to about 42 per cent of total adaptation finance. Unlike dedicated adaptation finance that has a higher proportion of loans than grants (figure 4.6), cross-cutting finance has higher share of grants (64 per cent) than loans (29 per cent). The bulk of this finance targets adaptation marked as 'significant' (69 per cent, US$25.5 billion), while about 31 per cent (US$11.4 billion) targets adaptation as a 'principal' objective.

Figure 4.9 Total international public climate finance tagged as cross-cutting by sector (US$ billions, commitments, constant prices), 2017–2021



Note: The amounts include financial commitments for activities that combine adaptation and mitigation simultaneously (cross-cutting finance). Amounts are presented at face value. For more on the data and methodology, see Annex 4.B.

Looking at the sectoral distribution of the cross-cutting finance, the top three sectors are ‘general environment protection’ (24 per cent, US$9.6 billion), ‘agriculture, forestry and fishing’ (17 per cent, US$6.9 billion) and ‘other multisector’ (10 per cent, US$3.8 billion). Together, these sectors were allocated more than half of the total cross-cutting finance. This was followed by ‘energy’ with US$3.5 billion (approximately 4 per cent).

Although there are some similarities in the sector profile of cross-cutting finance (figure 4.9) compared to dedicated adaptation funding (figure 4.8), the flows to ‘general environment protection’ in cross-cutting finance clearly stands out and its high share might explain the low share (for the same sector) in the adaptation-dedicated finance. The ‘general environment protection’ sector includes six sub-sectors: ‘environmental policy and administrative management’, ‘biodiversity’, ‘biosphere protection’, ‘environmental research’, ‘site preservation’ and ‘environmental education/training’. Activities under these include ecosystem-based adaptation and nature-based solutions.[5]

The strong potential synergies between adaptation and mitigation action are demonstrated by the cross-cutting finance and its main sectors. The Intergovernmental Panel on Climate Change (2023) noted the strong synergistic link between adaptation, mitigation and wider sustainable development goals in an analysis of near-term synergies and trade-offs that showed considerably greater opportunities for synergies among energy, land use and urban infrastructure than for potential trade-offs. The synergies between adaptation and mitigation actions can also have significant impacts. For example, the process of land restoration could offer multiple benefits that align with both mitigation and adaptation efforts. These potential benefits include improved ecosystem services, positive economic returns and co-benefits related to poverty reduction and livelihood improvement.

Assessment of domestic expenditures on adaptation

Domestic expenditure continues to be an under-examined but potentially vitally important, and often sustainable, source of finance for adaptation. In many developing

5 For example, one of the largest environmental policy and administrative management transactions during the period of analysis by the Green Climate Fund had the objective to “support innovative GCF tropical forest states and provinces to meet the commitments of the Rio Branco Declaration by developing/updating jurisdictional strategies and investment plans for REDD+ and low emissions development and catalysing transformative financing opportunities”. Under the sub-sector Biodiversity, one of the largest commitments in the sector had the aim to ”restore and enhance ecosystem services by development of mangroves and coastal shelterbelts, restoration of grasslands, wetlands and forests, management of human wildlife conflict and institutional strengthening, thereby contributing to addressing various socio-economic issues in the state of Gujarat”.

countries, domestic budgets are likely to be the largest source of funds for adaptation (Allan *et al.* 2019; United Nations Development Programme [UNDP] forthcoming). Compared to international adaptation finance and private finance, domestic expenditure offers several advantages that make it particularly well-suited to financing adaptation:

- Domestic budgets are well-suited to mainstream development and adaptation. To date, most adaptation occurs through climate-proofing routine investments rather than stand-alone targeted investments solely for adaptation purposes (Pauw 2015; UNDP forthcoming). Failing to integrate adaptation spending into development spending may undermine the achievement of development objectives when faced with climate impacts (Allen *et al.* 2019). Governments can also mainstream international adaptation financing across key ministries, such as those dealing with agriculture and water. However, this makes it difficult to identify adaptation expenditure and weights within the general budget and to quantify it vis-à-vis a potential adaptation finance gap (UNDP forthcoming).

- Many adaptation investments would be undersupplied when left to the market, for example, because they generate public goods (Pauw 2022a). There is therefore a clear role for governments to finance their provision, or to incentivize private provision (Allen *et al.* 2019).

- Domestic budgets also allow governments to address their domestic policy priorities on adaptation, which can vary including across countries with similar contexts (Kirchhofer and Fozzard 2021).

- From a government's perspective, the budget is more predictable compared to international adaptation finance. Depending on the availability of funds, it is also better suited for financing long-term adaptation investments, or those that involve recurring expenditures (which international sources tend to avoid for sustainability reasons) (Allen *et al.* 2019).

- Government budgets might be more effective than official development assistance in delivering adaptation benefits, principally because they can leverage existing institutional structures, thereby improving impact and value for money (Africa Adaptation Initiative 2018).

- When tracking of climate-related expenditure is undertaken over longer periods, it can help identify whether countries are shifting public financial flows towards climate-resilient development pathways, thereby implementing article 2.1(c) of the Paris Agreement (see chapter 7).

Domestic expenditure on adaptation can be measured through, for instance, climate change budget tagging and regular tracking. Tagging is the process of defining and applying a tag, while tracking is the process of using the tag to quantify and monitor climate-relevant activities and expenditure (Choi *et al.* 2023). It builds on prior experience in tagging and tracking of other whole-government policy objectives, such as poverty, gender and the Sustainable Development Goals (Kirchhofer and Fozzard 2021). Tracking can be conducted and reviewed occasionally, as a standard process in the budget execution, accounting and reporting stages of the annual budget cycle (Choi *et al.* 2023). At present, there are no internationally agreed-upon tagging methodologies to identify climate related expenditures in public sector budgets. However, there are some recognized approaches, such as the OECD Rio markers methodology, the European Union climate action taxonomy and the Climate Public Expenditures and Institutional Review approach developed by UNDP (Pizarro *et al.* 2021). UNDP uses the latter to support at least 10 African countries track their expenditure on adaptation (UNDP forthcoming). Some countries have developed their own criteria, drawing from diverse sources, and also using domestic frameworks, such as the Government Standard Chart of Accounts manual (UNDP 2019, p. 59).

Estimates of domestic expenditure on adaptation

The amount of information on domestic expenditure on adaptation has increased in recent years. A recent review found that twenty-four national studies had assessed domestic climate expenditures, 14 of which report on adaptation-only expenditure (UNFCCC Adaptation Committee 2022). However, it is 'strongly' recommended not to make direct cross-country comparisons between values from different countries because of the methodological differences between studies (ibid.). Method inconsistency makes direct comparison difficult and reported government budgets spent on adaptation range from 0.2 per cent to over 5 per cent. These are equivalent to a large range of total gross domestic product (from 0.1 per cent to 3 per cent). Another study shows that African countries on average spent 0.95 per cent of their government budget on adaptation in 2019 (with two countries, Botswana and the Seychelles, spending over 4 per cent) (UNDP forthcoming). According to UNDP (forthcoming), this makes government expenditure on adaptation in Africa 10 times larger than international support for adaptation (which they calculate to be 0.09 per cent of the gross domestic product) and also larger than the indicative 0.22 per cent from private adaptation.

It is not yet possible to assess whether developing countries are increasing domestic expenditure to meet increasing climate change impacts and financing needs for adaptation (Adaptation Committee 2022). It will be important to investigate this once a significant number of countries update their earlier tagging and tracking assessments.

The main reported benefits of climate budget tagging and tracking are awareness raising and improvements in transparency and accountability (Kirchhofer and Fozzard 2021). Tagging and tracking analyses provide relevant insights on adaptation costs, current domestic allocations to adaptation and adaptation finance gaps within countries. However, related expenditure estimates cannot be directly used in the finance gap estimates of the UNEP Adaptation Gap reports. Current data are unreliable and non-comparable due to the diversity of methods and approaches and the inherent subjective analysis and judgement on adaptation-relevance of expenditure (Choi *et al.* 2023; Adaptation Committee 2022). Furthermore, budget tagging is often not systematically applied to subnational government expenditures and mobilized private finance (Choi *et al.* 2023), and 'negative expenditure' such as harmful initiatives that may increase vulnerability are typically excluded (ibid.). Finally, across different regions, there was limited evidence of formal quality assurance and verification mechanisms (ibid.). This has implications for knowledge on the effectiveness of adaptation-related expenditure, which often remains limited.

Another note must be added when considering whether and to what extent domestic expenditure can help close the adaptation finance gap. While, in principle, closing the gap is positive, there are important ethical issues around domestic expenditure and it being a substitute for international funding (Adaptation Committee 2022). This is especially the case in relation to particularly vulnerable countries that have contributed little to global historical greenhouse gas emissions and are highly vulnerable, such as LDCs (Grasso 2010). The potential for domestic expenditure on adaptation also must be seen in the context of other challenges facing developing countries, such as high indebtedness and limited fiscal space (Kozul-Wright 2022).

The challenges faced in aggregating domestic expenditure on adaptation are also reflected in the broader efforts to develop a global goal on adaptation. Some of these challenges include the lack of systematic tracking frameworks and methodological tools (Berrang-Ford *et al.* 2019), inconsistent metrics (Craft and Fisher 2018) and limited legitimacy of existing global governance initiatives (Persson 2019). The global stocktake process under the Paris Agreement and the global goal on adaptation could present important opportunities to advance efforts and initiatives to measure and track domestic adaptation efforts.

Assessment of private finance flows related to adaptation

The private sector's interest in investing in adaptation is limited by barriers and constraints such as information failures, market failures (including positive externalities that reduce the return on investment but could have public benefits), financial challenges, policy and governance barriers and behavioral and cultural barriers (Bisaro and Hinkel 2018; Tall *et al.* 2021; Adaptation Committee 2022; Frontier Economics and Paul Watkiss Associates 2022; Lu 2022; Pauw *et al.* 2022a). Nevertheless, there is fragmented evidence of private sector adaptation interventions worldwide and across sectors (e.g. water, food and agriculture; transport and infrastructure; and tourism) (Pauw *et al.* 2015). However, reporting of private sector interventions and engagement in adaptation in the academic literature continues to be low, particularly when it comes to small business adaptation and developing countries (Berrang-Ford *et al.* 2021; Harries 2021; Carè and Weber 2023). While companies are increasingly reporting on climate-related issues, the comparability, consistency, comprehensiveness and coherence across different data sets, as well as the limited information on adaptation actions taken, inhibit meaningful aggregation (Dale *et al.* 2021). Information on mobilized private finance for adaptation is also largely absent from Party submissions to the UNFCCC (Dale *et al.* 2021). Such finance continues to be limited and far below mitigation. For the period 2016–2020, OECD (2022b) reports around US$1.9 billion/year on average. Philanthropy provided an additional US$0.09 billion/year in this period (Atteridge *et al.* 2019). Therefore, while evidence hints at increasing private sector engagement in adaptation, the related investments – and contribution to closing the adaptation finance gap – remains unclear.

Private sector financing for adaptation includes 'internal' adaptation investments by large companies and corporations. For example, an analysis of voluntary public disclosures on physical climate change risks by 1,959 companies (representing 69 per cent of global market capitalization) demonstrated that 68 per cent reports on implementation of adaptation actions (Goldstein *et al.* 2019). Despite these high numbers, reporting on the costs of both physical climate change impacts and the strategies required to manage them are sporadic and inconsistent (ibid.). It is therefore not clear how much these large companies invest in adaptation and to what extent this helps close the adaptation finance gap. While small businesses are less likely to plan and finance measures to reduce their vulnerability than larger businesses (Daddi and Iraldo 2016; Harries 2021), empirical evidence demonstrates that small and medium-sized enterprises (SMEs) also innovate and invest in the response to climate change impacts. In Europe, for example, tourism companies are adopting technologies for making artificial snow; diversifying mountain tourism activities; and developing environmental guidelines for tourist activities to protect the industry against glacier thinning and decline in snowfall (Rasul *et al.* 2020). In Kenya, the private sector is strengthening the resilience of agriculture value chains, typically in multi-stakeholder partnerships (Gannon *et al.* 2021). In Thailand, private sector actors in the tourism sector are adapting too, albeit often unconsciously (Hess 2020). However, adaptation is often done unconsciously (ibid) and related investments are often unknown.

Apart from such 'internal' adaptation investments, the private sector contribution to adaptation is also driven by financial institutions' provision of finance for activities that contribute to adaptation, and through companies' provision of adaptation goods and services (Stout 2022). Examples of the former include loans for sustainable agriculture and property retrofits. However, data on such private finance for adaptation are still largely missing due to challenges associated with context dependency, confidentiality restrictions, uncertain causality and a lack of agreed-upon impact metrics (Buchner *et al.* 2021). For example, financing for SMEs is expanding, especially in the context of climate-vulnerable economies, e.g. Aisa (Papadavid 2021) and Africa (African Development Bank 2019), but details on the relevance of this finance for adaptation are not available, since reporting is mainly on aggregate financing. At the same time, financial institutions – including public and commercial banks, insurance companies and bond-rating agencies – understand the shifting landscapes of market risk and are engaged in an 'intelligence arms race' to measure climate impacts on investments and steer them to new speculative sites and cities (Shi and Moser 2021).

Public sector actors also continue to make efforts to stimulate or mobilize more private sector investments in adaptation, including through blending public and private finance. For example, through 'monetizing resilience benefits' (International Fund for Agricultural Development); the G20's Global Partnership for Financial Inclusion that supports SMEs to respond to climate change and incorporate climate risks into their operations (Csaky 2017); the Global Environment Facility-funded Adaptation SME Accelerator Project led by Lightsmith and supported by the Global Environment Facility, Conservation International and the Inter-American Development Bank (Botero *et al.* 2022), and the Africa SME Programme of the African Development Bank in Africa (African Development Bank 2019).

Finally, it is important to indicate the potential of non-finance related private sector initiatives, as they could have substantial impacts on reducing vulnerability over time. Private sector actors are taking climate risks into account in their non-financial business operations. Standard-setting organizations overseeing, for instance, engineering, design, insurance and lending practices are moving towards incorporating climate science into their benchmarks, requirements and guidelines (Shi and Moser 2021). In the absence of federal leadership on risk disclosure in the United States, for example, private consulting firms (and some non-governmental organizations) are growing in-house technical expertise to map forward-looking flood risks. This not only directly helps inform individual homeowner purchasing decisions; indirectly, it also integrates climate risks into the real estate market (Shi and Moser 2021). Such private sector initiatives do not necessarily bring along private investments that help to reduce the adaptation finance gap, and in the short-term they have a negative effect on, for example, homeowners that cannot insure their property. In the longer term, however, they will reduce overall vulnerability.

Even if it can be assumed that the private sector will invest more in adaptation over time and as the climate change crisis deepens, private sector finance for adaptation is not a panacea. Private-sector investment will gravitate towards opportunities where revenues are highest and risks are lowest, where private interests often outweigh public interests. This means it is unlikely that private adaptation finance targets the most vulnerable in LDCs or non-market sectors (Pauw 2015; UNEP 2021). Furthermore, knowledge on the effectiveness of private investments in adaptation is low. Effectiveness could be constrained through, for example, adaptation being carried out unconsciously (e.g. Pauw 2015; Hess, 2020) or with a narrow view of climate change risks (e.g. underestimating supply chain and broader societal impacts (see Goldstein *et al.* 2019), and/or because adaptation only shifts vulnerability to others (Pauw 2021). Finally, it is important to realize that significant amounts of private finance do not take climate change into account whatsoever (UNEP 2022), potentially leading to increased vulnerability in the long term. For example, property developers can make short-term financial gains from developing on vulnerable coasts, creating long-term risks for others (Siders 2019). Two important developments are therefore that investors are starting to ask companies to disclose climate change risks (Dale *et al.* 2021) and that governments are starting to develop policies for sustainable financial systems (UNEP 2021). For example, the Task Force on Climate-related Financial Disclosures includes reporting on the physical impacts on climate change (Task Force on Climate-related Financial Disclosures 2017).

5. The adaptation finance gap

Lead authors: Paul Watkiss (Paul Watkiss Associates), Dipesh Chapagain (United Nations University Institute for Environment and Human Security), Georgia Savvidou (Stockholm Environment Institute and Chalmers University of Technology)

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Key messages

- The updated costs of adaptation for developing countries are estimated to be in a plausible central range of US$215 billion to US$387 billion per year this decade.
- This estimate is based on two evidence lines:
  - The modelled costs of adaptation in developing countries are estimated at US$215 billion per year this decade and are projected to rise significantly by 2050.
  - The adaptation finance needed to implement domestic adaptation priorities – based on extrapolation of costed nationally determined contributions (NDCs) and national adaptation plans (NAPs) to all developing countries – is estimated at US$387 billion per year for 2021 to 2030.
- Public multilateral and bilateral adaptation finance flows to developing countries declined by 15 per cent to around US$21 billion in 2021.
- As a result of the growing adaptation finance needs and drop in current flows, the current adaptation finance gap is now estimated to be between US$194 and US$366 billion per year.
- The adaptation finance needs of developing countries are estimated to be 10–18 times as much as international public finance flows. This is over 50 per cent larger than the previous estimated adaptation finance gap range.
- A widening adaptation finance gap indicates a deepening climate crisis and will lead to increased loss and damage.
- The increase in the adaptation finance gap comes despite the Glasgow Climate Pact, adopted at the twenty-sixth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 26), which urges developed country Parties to at least double their collective provision of climate finance for adaptation from 2019 levels by 2025, which would be to around US$40 billion per year. However, even if this goal were met, it would not fill the adaptation gap, and would only reduce the current gap by between 5 and 10 per cent.
- Least developed countries (LDCs) and small island developing States (SIDS) alone are likely to require US$29 billion to US$41 billion per year (based on modelled costs and finance needs). These can be compared to the finance flows averaging US$7 billion per year that LDCs and SIDS received over the 2017–2021 period, indicating an annual finance gap for LDCs and SIDS of US$22 billion to US$34 billion per year.

Introduction

The previous chapters set out the updated estimates of the cost of adaptation (with the modelled analysis in chapter 2 and adaptation finance needs in chapter 3), as well as the current adaptation finance flows (chapter 4). This chapter combines these findings to provide an updated adaptation finance gap estimate for developing countries.

The updated costs of adaptation

The updated modelling analysis (chapter 2) estimates that the plausible costs of adaptation could be US$215 billion per year this decade, with a range of US$130 billion to US$415 billion per year. These costs are projected to rise over future decades towards 2050. The updated analysis of the needs communicated in NDCs and NAPs, with extrapolation to all developing countries (chapter 3), estimates adaptation finance needs at US$387 billion per year for 2021 to 2030, with a range of US$101 to US$975 billion per year.

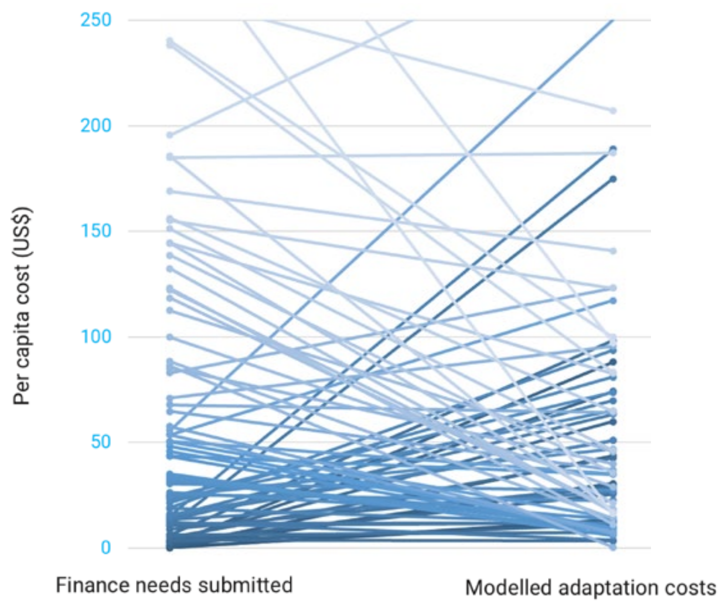
These two evidence lines provide the basis for the updated central estimate of adaptation costs / finance needs, which is a plausible central range for the costs of adaptation / finance needs of **US$215 billion per year to US$387 billion per year for developing countries this decade**. This is equivalent to between 0.6 per cent and 1.0 per cent of gross domestic product (GDP for all developing countries, 2021).

It is stressed that a central range is reported for this updated analysis, rather than a single central value, because of the framing and methodological issues set out in chapter 1. For example, many of the modelling studies set adaptation objectives that are based around economic efficiency, and thus will allow higher levels of residual damage than may be considered acceptable by developing countries (who will bear these residual damages). Conversely, the finance needs submitted by developing countries may assume more ambitious levels of adaptation, with lower residual damages and thus adaptation higher costs. Similarly, the two sets of values may have different framing perspectives on what counts as adaptation, and they use different methodological approaches to derive adaptation costs. For example, the modelling studies assess the costs of adaptation primarily to address the additional climate change related risks. By comparison, developing country submissions may also include adaptation to help address the adaptation deficit, i.e. to reduce impacts from climate variability and extremes.

These framing issues may explain why the adaptation finance needs derived from submitted NDCs/NAPs for all developing countries (the value of US$387 billion per year; see chapter 3) leads to a higher value than from the modelled costs of adaptation (the value of US$215 billion per year; see chapter 2), i.e. overall estimated finance needs are 1.8 times as high as modelled costs. However, it is stressed that this is not always the case at the individual country level. A direct comparison between the 85 submitted adaptation finance needs in costed NDCs and NAPs and the modelled costs for the same countries finds that in many cases, submitted costs are lower than modelled costs, as shown in figure 5.1 (shown as costs per capita to facilitate comparison). Figure 5.1 also shows the high variability in the per costs per country, for both submitted needs and modelled costs. This highlights that some countries have much higher vulnerability and are likely to have much higher needs.

There are also differences in the split by sector, region and income group between the two data sets. These are explored below in the comparison against finance flows.

Figure 5.1 Comparison of reported financial needs in NDCs/NAPs (left) for the 85 countries that have submitted costed plans versus modelled costs of adaptation (right) for the same countries (per capita costs in US$)



The updated (2023) estimate of the adaptation finance gap

The new 2030 values for adaptation costs/financing needs, and the central range of US$215 billion per year to US$387 billion per year for developing countries this decade, can be compared with the updated estimates of global public finance flows to adaptation (chapter 4).

For the five years following the Paris Agreement's entry into force (2017–2021), finance for adaptation from international public sources to developing countries remained at or below US$25 billion per year, or approximately US3$ per person per year. In 2021, there was a 15 per cent decrease from 2020 levels, down to **US$21 billion in 2021.**

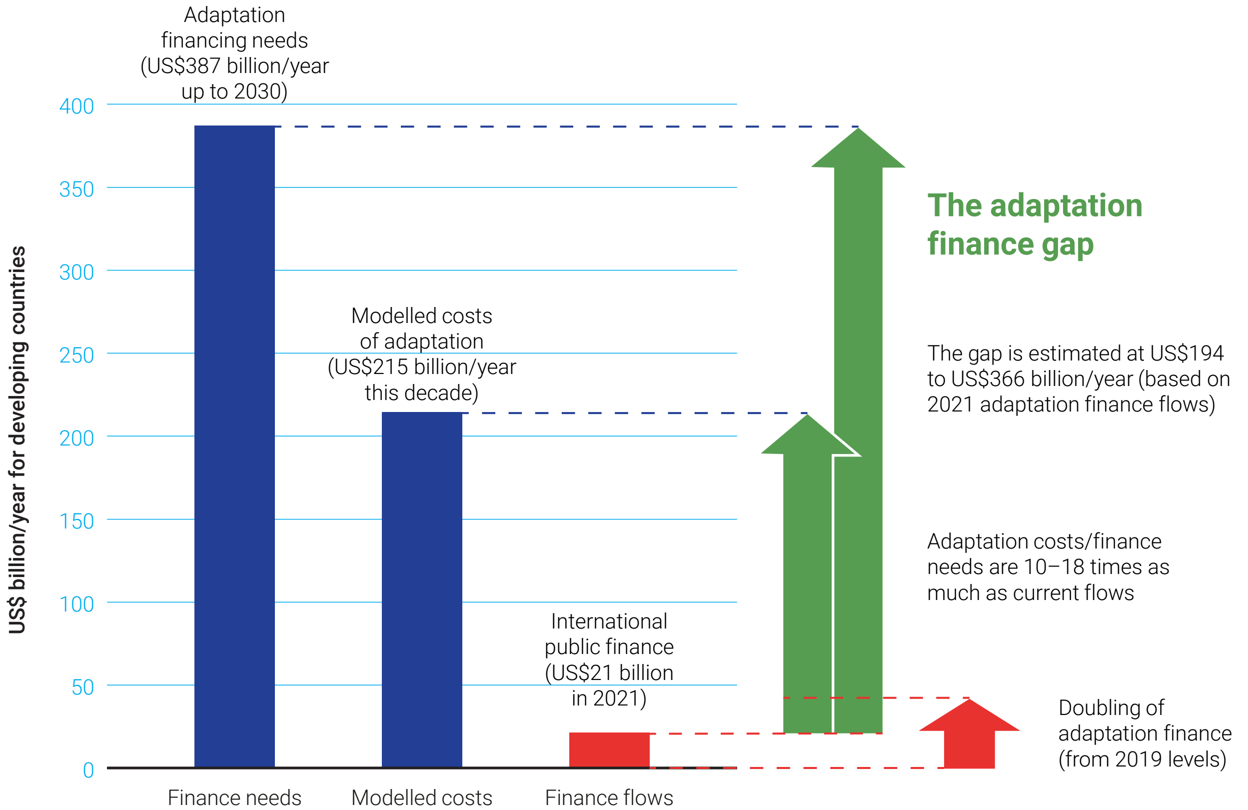
The resulting adaptation finance gap is shown in table 5.1 and figure 5.2. The adaptation finance needs/modelled costs are at least an order of magnitude greater than current adaptation finance flows.

Based on these updates, the adaptation finance gap – the difference between needs/costs and flows – is very large, **estimated at US$194 billion per year to US$366 billion per year** (for modelled costs and extrapolated submissions, respectively). The modelled costs/finance needs are therefore 10 to 18 times as much as current international public finance flows though this gap will be narrowed by current domestic finance (including unconditional commitments in NDCs) and private-sector adaptation flows, which are not included, as there are not sufficient data to track.

Table 5.1 Summary of the adaptation finance gap in developing countries, based on available evidence

Modelled cost of adaptation	Adaptation finance needs	Adaptation finance flows	Adaptation finance gap
US$215 billion/year this decade (central estimate), with a range of US$130 billion to US$415 billion/year	US$387 billion/year (median), with a range of US$101 billion to US$975 billion/year (up to 2030)	US$21.3 billion (2021)	The adaptation finance gap is estimated at US$194 billion to US$366 billion per year. The costs/needs are 10–18 times as much as flows.
Central range of US$215 billion to US$387 billion/year for developing countries this decade			

Figure 5.2 Adaptation financing needs, modelled adaptation costs and international public adaptation finance flows (left) and the adaptation finance gap (right)



The adaptation finance gap has increased by more than 50 per cent since the previous Adaptation Gap Report (AGR) assessments (UNEP 2016a; UNEP 2022). This increase is due to several reasons. As highlighted earlier, there are higher modelled costs of adaptation (chapter 2), which reflect the more negative impacts of climate change reported in the literature (see IPCC 2022). There are also more comprehensive studies in submitted NDCs/NAPs, which include more detailed estimates and greater coverage (chapter 3), and thus higher reported adaptation finance needs. These trends can be compared to the level of public international adaptation finance flows, which increased from 2017 to 2020, but declined in 2021 (chapter 4).

Developed countries failed to meet their international climate finance commitment made in 2010 to mobilize US$100 billion per year by 2020 to developing countries, and developed countries were able to mobilize only US$83.3 billion in 2020, with the share of adaptation finance at 34 per cent of the total finance (Organisation for Economic Co-operation and Development 2022).

The Glasgow Climate Pact (United Nations Framework Convention on Climate Change [UNFCCC] 2021) urged developed country Parties to at least double their collective provision of climate finance for adaptation to developing country Parties from 2019 levels by 2025 (decision 1/CMA.3, para 18). Based on the analysis in chapter 4, this new adaptation finance target would be US$38.4 billion per year by 2025. Developed countries would require a 16 per cent annual compound growth from 2021 to 2025 to meet the Glasgow goal. However, even achieving this goal would not fill the adaptation gap and would only reduce the gap by between 5 per cent and 10 per cent.

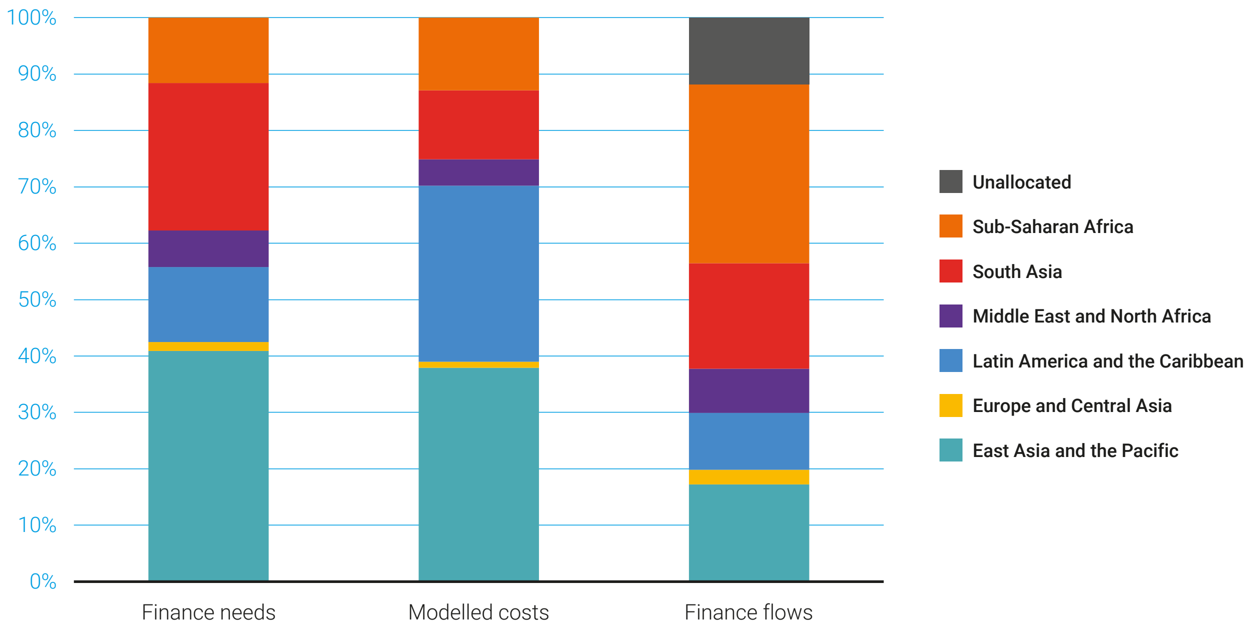
The LDCs and SIDS alone require US$29 billion to US$41 billion per year, based on modelled costs and finance needs. This can be compared with the finance flows to these countries, which over the 2017–2021 period averaged US$7 billion per year, indicating an annual finance gap of US$22 billion to US$34 billion per year for LDCs and SIDS.

These updated estimates are relevant for the Paris Agreement (decision 1/CP.21, para. 54), where Parties agreed to set a new collective quantified goal for climate finance from a floor of US$100 billion per year, taking into account the needs and priorities of developing countries, prior to 2025 (UNFCCC 2016). Formal deliberations among countries for the new collective quantified goal on climate finance began at COP 26 in Glasgow and it is on the agenda for COP 28 and COP 29.

The comparison of the modelled costs, finance needs and finance flows reveals additional insights.

The first comparison is shown by region in figure 5.3. The highest adaptation finance needs (extrapolated from NDCs and NAPs) are for East Asia and the Pacific, and for South Asia, while the highest modelled costs are for East Asia and the Pacific, and for Latin America and the Caribbean. In contrast, the highest financial flows, in percentage terms, are to sub-Saharan Africa (though these actual flows are far below estimated adaptation finance needs or costs).

Figure 5.3 Comparison of adaptation finance needs (extrapolated), modelled costs of adaptation, and international public adaptation finance flows for developing countries by region



Note: Finance flows are the average for the period 2017–2021.

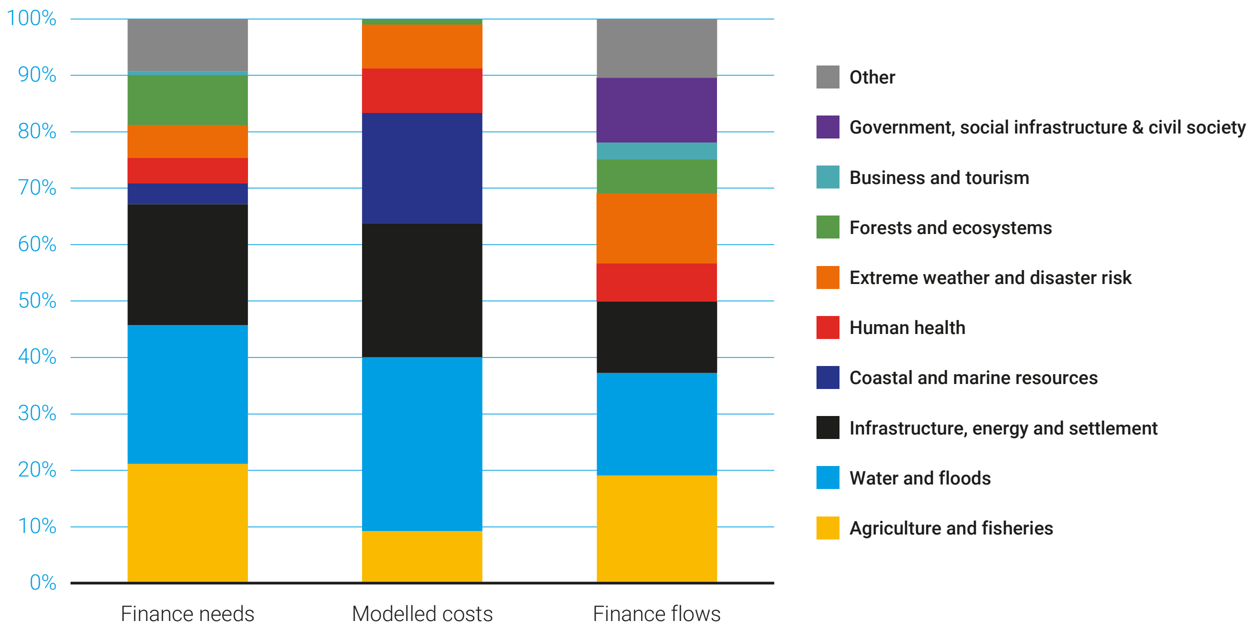
A further comparison is made by sector in figure 5.4, though some caveats are needed, because the data are not reported or collated on a like-for-like basis. For example, several categories that appear in the finance flows are not yet modelled (business, government, capacity-building). Further, there is not always a direct equivalence in sector categorization e.g. many cross-cutting disaster risk reduction measures are reported differently across the three evidence lines. There are also a relatively small number of costed NDCs and NAPs that include a sectoral breakdown (only 52 countries) and the average of these countries may not be representative of the global value. Nonetheless, some trends do emerge.

The highest financial needs (from extrapolated NDCs and NAPs) are for the water (25 per cent), infrastructure and energy (21 per cent) and agriculture (21 per cent) sectors. These are also three of the largest areas of adaptation finance flows (agriculture 19 per cent, water 19 per cent and infrastructure 13 per cent), though it is stressed that the level of flows (in US$ billions) is over an order of magnitude lower than financing needs (see figure 5.2).

Compared to the modelled costs, the values for water and infrastructure are also high (river floods and water at 25 per cent and infrastructure at 25 per cent), but the values for agriculture (including fisheries) are much lower (10 per cent). This indicates that developing countries may be giving more weight to the agriculture sector in their adaptation plans, but may also reflect that the modelling studies have lower adaptation costs because they assume that some of the climate-induced productivity falls will be offset by increased trade and imports (noting that this option of increasing imports may not be considered equitable by developing countries, especially given its potential impact on food security). The modelled costs also have large values for coastal protection (26 per cent). This is much higher than reported needs or financial flows. This may reflect the approach to coastal modelling, but also that less consideration has been given to this risk in NDCs and NAPs. There are also significant modelled costs for human health, which are higher than the proportion in finance needs or finance flows.

While the finance flows have a large share (50 per cent) in agriculture, water and infrastructure (see above), a much greater share of flows go to other areas. This includes significant flows to extreme weather and disaster risk reduction (12 per cent), government, social infrastructure and civil society (11 per cent) and forests and ecosystems (6 per cent). Some of these are challenging for the modelling cost analysis, where they are underestimated or omitted (see chapter 2), and this highlights the need to move beyond the current modelling coverage.

Figure 5.4 Comparison of adaptation finance needs (extrapolated), modelled costs of adaptation, and international public adaptation finance flows for developing countries

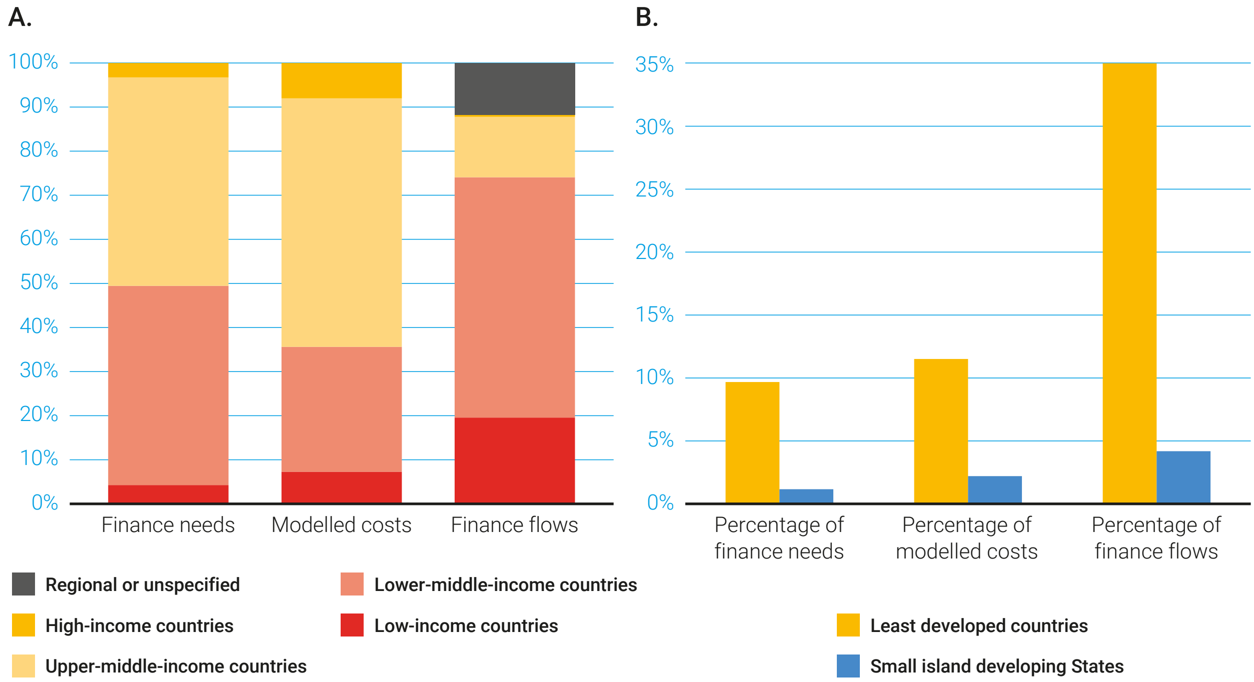


Note: Finance flows are the average for the period 2017–2021. There is not strict equivalence on definitions and categorization across the three values.

It is also interesting to investigate the adaptation finance gap by sector, though this is often difficult because of the aforementioned factors. Nonetheless, there do appear to be some cases where flows are low compared with needs/costs. For example, the estimated modelled costs of adaptation for fisheries is 20 times greater than current finance flows – much higher than the average across all sectors.

The final comparison is based on income level, including a focus on LDCs and SIDS as the most vulnerable countries (noting that some LDCs are also SIDS). The comparison between finance needs, modelled costs and finance flows is shown in figure 5.5 (panel A). This shows that a higher relative proportion of finance is flowing to low- and lower-middle-income countries, and also to LDCs and to SIDS (figure 5.5, panel B), as compared with the finance needs and modelled cost estimates. This provides some indication that while the total finance flows are insufficient to meet finance needs or modelled costs, the relative share of total finance is higher (in relative terms), and that finance allocated is somewhat prioritized to these more vulnerable countries. Nonetheless, the annual adaptation finance gap for LDCs and SIDS alone is still very large, at US$22 billion to US$34 billion per year.

Figure 5.5 Comparison of adaptation finance needs (extrapolated), modelled costs of adaptation, and international public adaptation finance flows for developing countries by country income level (panel A). LDCs' and SIDS' share of adaptation finance needs (extrapolated), modelled costs of adaptation, and international public adaptation finance flows (panel B).

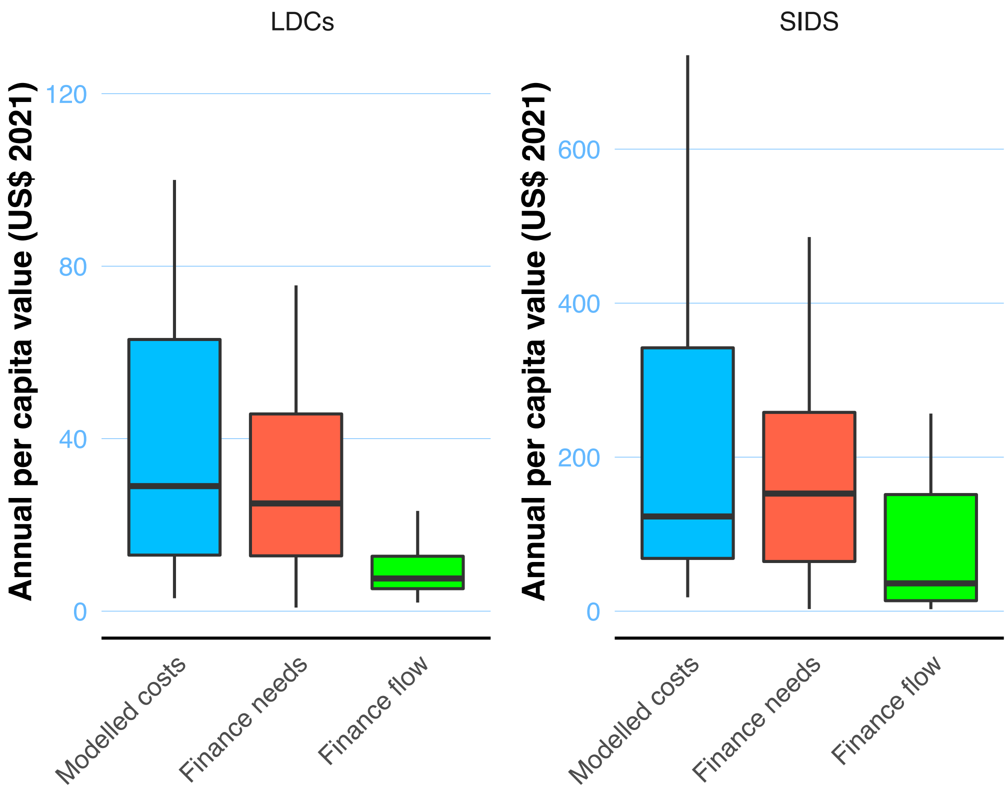


Note: Finance flows are the average for the period 2017–2021.

It is also possible to look at these data in per capita terms. The modelled costs estimate that for all developing countries, the average per capita cost of adaptation is US$33 per person per year. For the finance needs (normalized values), the value is estimated at US$59 per person per year. This compares with the average value for finance flows (2017–2021) of US$3 per person per year.

In addition, it is possible to look at costs, needs and flows in per capita terms for the most vulnerable countries. The distribution of the per capita values for individual LDCs and SIDS are shown in figure 5.6. This is based on the modelled costs, individual country submissions for finance needs (values from country NDCs and NAPs) and finance flows. This provides several insights. It shows that the estimated costs and submitted finance needs are much higher than the actual finance flows to these countries. It also shows that even among these LDCs and SIDS, there is a wide range of modelled costs/finance needs, reflecting different levels of vulnerability.

Figure 5.6 Distribution of annual per capita values for modelled costs of adaptation, adaptation finance needs (based on submitted NDCs and NAPs) and adaptation finance flows (international public) for LDCs and SIDS



Note: Different y-axis scale

The Adaptation Finance Gap Update 2023 values can also be compared to the previous AGR values as well as other values in the literature (see also Chapagain *et al.* 2020 and in the Intergovernmental Panel on Climate Change Working Group II *Sixth Assessment Report* (IPCC WGII AR6) (New *et al.* 2022). The AGR 2016 estimated the costs of adaptation were in a likely range of US$140 billion to US$300 billion per annum in 2030, rising to US$280 billion to US$500 billion per annum in 2050. In current prices (2021), these are equivalent to approximately US$170 billion to US$360 billion per annum in 2030, rising to US$340 billion to US$600 billion per annum in 2050. The updated AGR 2023 values for 2030 (US$315 billion to US$387 billion per annum in 2030) are therefore a significant increase. In addition, the AGR 2023 values are higher than those in most earlier studies (reported in the review in New *et al.* 2022). This indeed indicates that the adaptation finance gap has increased. A widening gap indicates a deepening climate crisis and will lead to increased loss and damage.

The benefits of adaptation and reducing the adaptation gap

It is stressed that closing the adaptation gap – by increasing adaptation finance flows – will deliver large benefits by reducing climate impacts (and residual damage). Even incremental steps in closing the finance gap are likely to lead to large benefits.

As an example, based on the coastal sector analysis (in chapter 2, and the Dynamic Interactive Vulnerability Assessment (DIVA) model results, an additional US$1 billion of adaptation investment is estimated to generate a US$14 billion benefit, from the reduction in the economic costs of coastal flooding. As a further example, as reported in the original World Bank Study (Hallegatte, Rentschler and Rozenberg 2019a), investing in more resilient infrastructure in low- and middle-income countries has low additional costs and is very cost-effective, with the benefits four times higher than the costs. This makes it not only robust and profitable, but also urgent.

These benefits are not just economic or financial. In the case of agriculture, the analysis of the benefits of agriculture sector adaptation by the International Food Policy Research Institute (IFPRI) (Sulser *et al.* 2021), reported in chapter 2 and adjusted to US$2021 prices, indicate that US$16 billion per year additional investment in adaptation (on average, between 2015 and 2050) would prevent approximately 78 million people from chronic hunger due to climate change.

6. Gender equality and social inclusion

Lead authors: Katharine Vincent (Kulima Integrated Development Solutions), Blanche Butera (Paul Watkiss Associates), Georgia Savvidou (Stockholm Environment Institute and Chalmers University of Technology)

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Key messages

- For the first time, a quantitative analysis has been made of gender equality and social inclusion (GESI) as part of the Adaptation Finance Gap Update. This has used a gender continuum including four categories: GESI-blind, GESI-specific, GESI-integrative and GESI-responsive. This has been applied to assess progress on gender and social inclusion in the submitted nationally determined contributions (NDCs) and national adaptation plans (NAPs) (adaptation finance needs) and in gender principle-tagged international public adaptation finance flows.

- An analysis of costed NDCs and NAPs finds that 20 per cent of these include dedicated finance needs for gender interventions, rising to 33 per cent of costed NDCs and NAPs with a sectoral cost breakdown. However, the proportion of total adaptation finance needs allocated to GESI is generally low, at an average of 2.4 per cent of total adaptation finance needs (with a range from 0.01 per cent to 12.0 per cent).

- The level of ambition of GESI-integration in costed NDCs and NAP submissions is variable. Only one country's plans are categorized as gender-responsive, the rest being gender-specific or gender-integrative. Other aspects of social inclusion (e.g. Indigeneity, ethnicity, disability, age and migration status) receive much less attention and finance needs allocations.

- Of the total international public finance for adaptation, approximately 2 per cent has been tagged as having gender equality as a principal objective, based on self-reporting by finance providers.

- Of this gender principle-tagged public adaptation finance, only 2 per cent of projects are categorized as gender-responsive, with 5 per cent assessed as gender-specific and 19 per cent as gender-integrative. This indicates that gender is only weakly included in adaptation finance. Moreover, based on the project descriptions, 31 per cent have been categorized as gender-blind. This finding also raises concerns over the validity of self-reporting and tagging within the Organisation for Economic Co-operation and Development (OECD) Development Assistant Committee (DAC) database.

- Given that GESI ambition levels and associated finance is weak in both documents and finance flows, there is a need for more capacity-building support on how to design and implement GESI-responsive activities (in alignment with international commitments), as well as strengthened guidance on monitoring and reporting.

Introduction

There is global recognition that climate change can exacerbate inequality in multiple dimensions of social identity, including gender (Prakash *et al.* 2022). The need to address this has been recognized through international commitments, such as the Gender Action Plan to the United Nations Framework Convention on Climate Change (UNFCCC), which includes the use of gender-responsive finance as a core tool for implementation (UNFCCC 2017).

There is also increasing evidence that funded adaptation programmes that consider gender dynamics are more effective and efficient (Roy *et al.* 2022; United Nations Development Programme 2018; Grabowski and Essick 2020; Soanes *et al.* 2021).

Consequently, this year's Adaptation Gap Report has included a more detailed assessment of GESI,[1] which is set out in this chapter.

The GESI continuum

Responses to gender and social inequalities can be classified according to the approach and level of ambition that they take. There are various iterations of a 'gender continuum' that have been applied to categorize plans and projects. This year, the Adaptation Finance Gap Update has used a modified version of such a gender continuum to investigate the extent to which GESI is included in the lines of evidence presented throughout the Adaptation Gap Report.

The modified gender continuum includes four categories: GESI-blind, GESI-specific, GESI-integrative and GESI-responsive (figure 6.1).

GESI-blind interventions are characterized by the failure to recognize current inequalities and to account for gender and socially differentiated vulnerabilities. As a result, these activities reinforce existing inequalities. GESI-blind interventions are inconsistent with global commitments such as the UNFCCC Gender Action Plan and commitments to gender-responsive adaptation in the Paris Agreement.

GESI-specific and GESI-integrative are represented as similar levels of ambition, albeit carried out through different approaches.

GESI-specific interventions acknowledge gender and social inequality and target the needs of disadvantaged groups to contribute to equality. For example, they may target women's empowerment, or that of the elderly, youth, Indigenous groups or migrants.

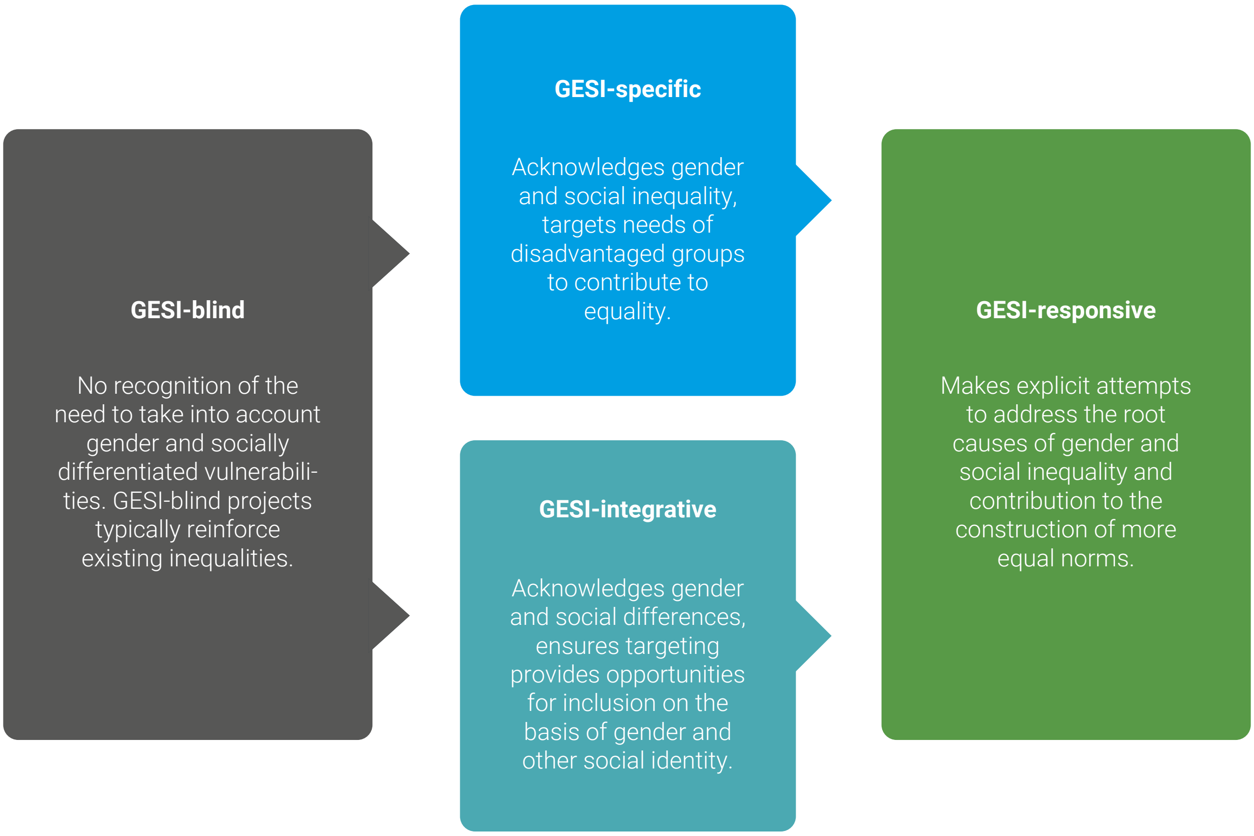
GESI-integrative interventions acknowledge gender and social differences and ensure that targeting provides opportunities for inclusion based on gender and other facets of social identity. They typically have targets for participation by different groups and may differentiate activities according to different needs.

GESI-specific and GESI-integrative approaches attempt to redress current inequalities but do nothing to address the root causes of those inequalities.

GESI-responsive interventions make more explicit attempts to address the root causes of gender and social inequality and contribute the construction of more equal social norms.

1 The work undertaken for this chapter was funded by the ECONOGENESIS project funded under the Climate Adaptation and Resilience (CLARE) programme, a partnership between the UK Foreign, Commonwealth and Development Office (FCDO) and the International Development Research Centre (IDRC), Canada. The views expressed herein do not necessarily represent those of the UK government, IDRC or its Board of Governors.

Figure 6.1 The modified GESI continuum used in the Adaptation Finance Gap Update 2023



This continuum has been applied to the three evidence lines in the Adaptation Finance Gap Update, the modelled costs of adaptation (chapter 2), the adaptation finance needs from submitted NDCs and NAPs (chapter 3) and the adaptation finance flows (chapter 4).

Modelled cost of adaptation

A review of the literature on the modelled costs of adaptation (see chapter 2) found no studies that comprehensively assessed the gender and social inclusion dimensions of the economic costs of climate change, or the costs of adaptation, at the aggregated level. This is hence a priority for future research.[2] There have, however, been some studies on the distributional impacts of climate change, as well as analyses of how climate change may move people into poverty (Hallegatte *et al.* 2016).

Adaptation finance needs

The analysis of adaptation finance needs (see chapter 3) was based on countries' domestic adaptation plans, as communicated in their NDCs and NAPs. The analysis was based on the developing countries (the 155 non-Annex I country Parties. The submitted NDCs and NAPs were accessed from the UNFCCC NDC Registry and NAP Central, respectively (UNFCCC 2023a; UNFCCC 2023b). The analysis identified that 85 developing countries submitted costed adaptation priorities[3] and 52 of them included a sectoral breakdown.

These costed NDCs and NAPs were also assessed to identify their alignment with the GESI continuum (shown in figure 6.1). The analysis focused on examining (1) the extent to which gender equality and social inclusion were considered during the development process of adaptation policy and plans, (2) the nature of the specific GESI commitment/actions that were proposed and (3) and the resources that were allocated for these GESI commitments.

2 This research includes the ECONOGENESIS project, which is assessing the GESI dimensions of the economics of climate change.

3 The 85 countries include some that have submitted costings for both NAPs and NDCs, thus there are a total of 97 documents that have costings. Of these, 58 NDCs/NAPs have a sector breakdown of costs and 52 countries have submitted NDCs/NAPs with sector breakdowns.

The review found that only 20 per cent of the costed NDCs and NAPs had dedicated finance needs allocated to GESI interventions. However, this rises to 33 per cent of the 52 countries that include a sectoral breakdown of costs, noting that only documents with a sectoral breakdown would be expected to report separate GESI budget lines. This is a total of 17 countries (noting that Cameroon and Benin's NDCs and NAPs both include costed GESI activities).

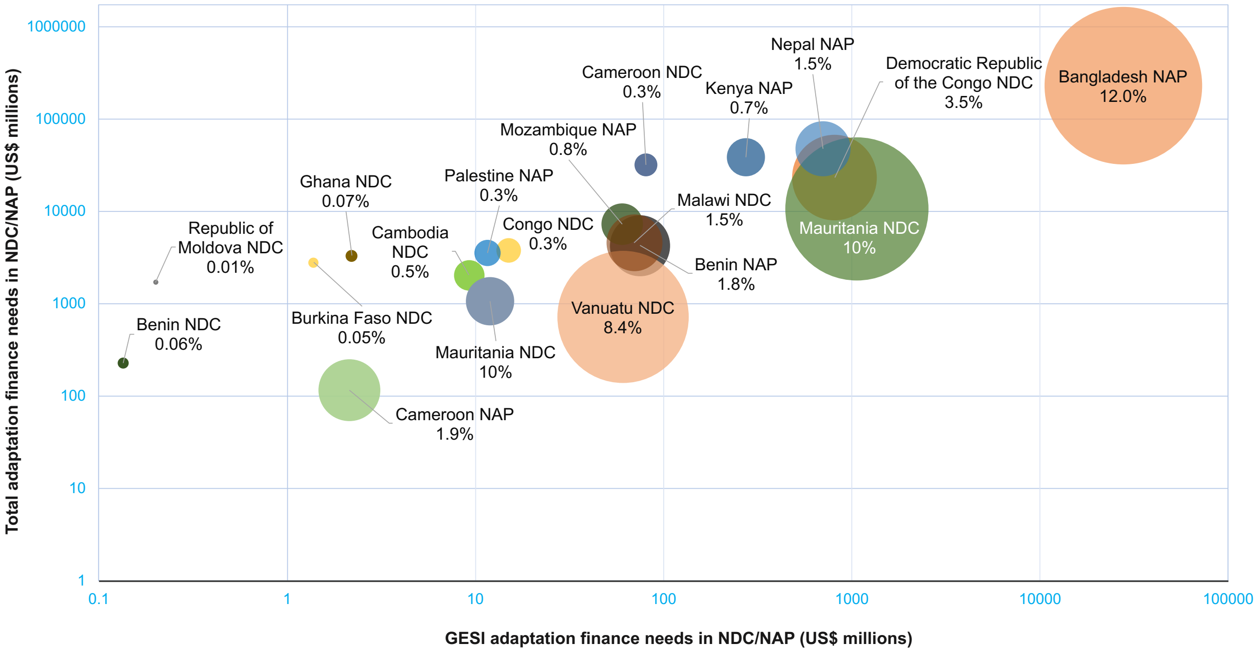
The analysis here has assessed the budget allocated to GESI interventions as compared to the total adaptation finance needs in these documents. This identified a wide range in the proportion of finance that was allocated to GESI activities and commitments, from 0.01 per cent to 12.0 per cent of total adaptation finance needs, though the average amount was low (see table 6.1 and figure 6.2).

The analysis also mapped the GESI interventions in these NAPs and NDCs to the adapted GESI continuum (shown in figure 6.1). Most interventions were classified as GESI-specific and GESI-integrative, with only Vanuatu's NDC categorized as GESI-responsive. It was found that most commitments were made to gender equality interventions rather than other aspects of social inclusion such as indigeneity, age, migrant status or disability.

Table 6.1 GESI adaptation finance needs in NDCs and NAPs

Country	Total adaptation finance needs (US$ million)	GESI-related finance needs (US$ million)	% GESI share of finance needs	GESI rating
Bangladesh[NAP]	230,012	27,632.83	12.01%	Integrative
Benin[NAP]	4,240	75.00	1.77%	Integrative
Benin[NDC]	230	0.13	0.06%	Integrative
Burkina Faso[NDC]	2,789	1.38	0.05%	Integrative
Cambodia[NDC]	2,040	9.27	0.45%	Integrative
Cameroon[NAP]	115.02	2.13	1.85%	Integrative
Cameroon[NDC]	31,856	80.80	0.25%	Specific
Congo[NDC]	3,795	15.00	0.29%	Specific
Democratic Republic of the Congo[NDC]	23,080	810.00	3.51%	Specific
Ghana[NDC]	3,300	2.20	0.07%	Specific
Kenya[NAP]	38,704	274.65	0.71%	Specific
Malawi[NDC]	4,547	70	1.54%	Integrative
Mauritania[NDC]	10,626	1,062.60	10%	Integrative
Mozambique[NAP]	7,237	60.36	0.83%	Integrative
Republic of Moldova[NDC]	1,707.46	0.2	0.01%	Integrative
Nepal[NAP]	47,440	700.00	1.48%	Specific
Palestine[NAP]	3,544	11.6	0.33%	Specific
Sierra Leone[NDC]	1,064	12	1.13%	Integrative
Vanuatu[NDC]	721	60.86	8.44%	Responsive
Average			**2.36%**	

Figure 6.2 Share of GESI activities as share of total adaptation finance needs in NDC/NAP



It is noted that some countries have also made efforts to mainstream gender or include gender budget statements as part of medium-term expenditure planning and budget cycles. This suggests that some countries may be further advanced than they appear from a review of their costed NDCs or NAPs. This is because mainstreaming or integration incorporates gender budget lines within other activities, rather than reporting them separately (unless these expenditures are tagged). However, there may be some risk of integrated budget allocations being merged or lost to other priorities. Therefore, dedicated and ringfenced budgets may be a stronger indication of commitment to implementation of GESI interventions, at least in the short term.

International public adaptation finance flows

The analysis of adaptation finance flows (see chapter 4) assessed the international public finance flows to developing countries using the OECD DAC database. The entries to the OECD DAC database can be screened and then tagged using a variety of markers. Under the Rio markers, for instance, entries can be tagged with a 'principal' or 'significant' objective for adaptation and/or mitigation (as assessed in chapter 4).

In 2016, a gender equality marker was added to the database, which allows tagging based on gender equality as a principal or significant objective. This has allowed an extended analysis to look at the gender equality and social inclusion aspects of finance flows, again using the GESI continuum (see figure 6.1). It is noted that as there is no explicit tag for social inclusion in the database, a gender-only continuum was used for the analysis here (gender-blind, gender-specific, gender-integrative and gender-responsive). In addition, not all finance transactions are screened against the gender equality marker, which means there may be relevant finance flows not captured in the data set used for this analysis.

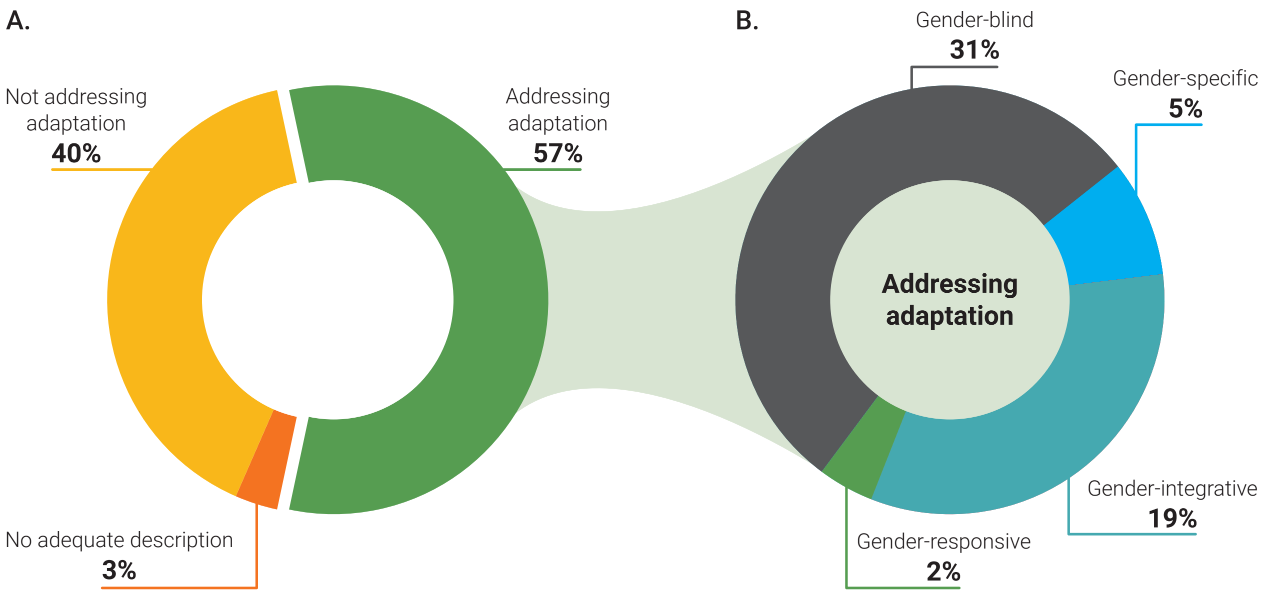
The analysis has focused on international public finance for adaptation in the period 2017–2021 (US$95 billion) (see chapter 4) that was marked with a principal objective (only) for the marker gender equality in the same period (approximately US$2 billion, equivalent to 2 per cent of the total adaptation finance).

This subset (adaptation principal or significant and gender principal) was assessed using the gender continuum outlined above. Notably, a review was conducted of titles and project descriptions as self-reported by finance providers in the OECD DAC database. However, prior to this analysis, some filtering of the data was undertaken. A small proportion (3 per cent) of the entries were removed as they did not contain any project description and therefore did not include sufficient information for analysis against the gender continuum. Furthermore, the analysis of entries found that a substantial proportion (40 per cent) were not obviously adaptation activities, in that they did not have a well-defined or specific climate rationale, so these were also excluded (figure 6.3). This finding is aligned with the growing evidence of possible over-reporting (see chapter 4) as well as findings from previous Adaptation Gap Reports (UNEP 2021).

The remaining 57 per cent of the gender principal entries addressing adaptation, were analysed against the gender continuum. Of this, 2 per cent were assessed as being gender-responsive, 19 per cent as gender-integrative and

5 per cent as gender-specific. A further 31 per cent were categorized as gender-blind, meaning that the title and description show no evidence of how they take account of gender. The results are shown in figure 6.3. It is noted that gender-blind activities are inconsistent with global commitments, including the UNFCCC Gender Action Plan and commitments to gender-responsive adaptation in the Paris Agreement.

Figure 6.3 International public adaptation-specific finance marked with a principal objective for gender equality marker (panel A) along the gender continuum (panel B).



Although social inclusion was not officially included in this assessment, as there is no explicit social inclusion marker in the OECD database, it is unlikely (in practice) that social inclusion would be addressed separately from gender. Of the finance tagged as gender-specific, integrative or responsive (US$450 million), a relatively small proportion (16 per cent) addressed the intersections of gender with other dimensions of social inclusion: age (8.3 per cent), race (0.3 per cent) and a combination of social identities (7.4 per cent).

Discussion

There are international commitments to addressing gender inequality (in particular) and social exclusion and evidence that funded adaptation programmes that consider gender dynamics are more effective and efficient. However, the analysis has found that the extent to which GESI are actively addressed and financed is inadequate, in both NDCs and NAPs and in international public adaptation finance flows. This mirrors earlier analysis that, despite increasing consideration of gender and social inclusion by multilateral climate funds, few were reporting gender-disaggregated results and there was an absence of good gender budgeting practices (Schalatek 2019).

An analysis of costed NDCs and NAPs finds that 20 per cent of these include dedicated finance needs for gender aspects, though this rises to 33 per cent of the costed plans with a sectoral breakdown. However, the proportion of total adaptation finance needs allocated to GESI is generally low, at an average of 2.4 per cent of total adaptation finance needs, (with a range from 0.01 per cent to 12.per cent). Furthermore, only one country's documents are considered gender-responsive, with the rest gender-specific or gender-integrative. Other aspects of social inclusion (e.g. Indigeneity, ethnicity, disability, age and migration status) receive much less attention and finance needs allocations.

An analysis of international public adaptation finance flows has also been undertaken, looking at adaptation finance that is also tagged as having the principal objective for gender equality, and assessing this using the gender continuum. A small proportion, approximately 2 per cent is assessed as being gender-responsive, with a further quarter categorized as gender-specific (6 per cent) or gender-integrative (19 per cent). Notably, nearly a third of entries tagged with the gender principal marker appear be gender-blind, at least based on their project descriptions and titles.

A comprehensive assessment of adaptation finance for gender would necessitate reviewing the entirety of project documents beyond their project description from the OECD DAC entries, which has been beyond the scope of this report. Still, the current analysis raises some concerns over the validity of self-reporting and tagging within the OECD DAC database. The analysis has found significant inclusion errors, both for adaptation (with 40 per cent of the entries tagged as adaptation principal or significant not seeming to have a climate rationale) and for gender (with nearly a third of the entries tagged as gender principal appearing to be gender-blind based on project descriptions). These inclusion errors run the risk of skewing results and over-reporting finance flows for adaptation, as well as adaptation that takes gender aspects into account.

Finally, recent assessments of progress in implementing the gender mandates of multilateral climate funds highlight the need for more capacity-building support on how to design and implement GESI-responsive activities (in alignment with international commitments), as well as strengthened guidance on monitoring and reporting. The analysis underlines the ongoing relevance of this finding, which and highlights the need for better verification/quality control of self-reporting in the database and/or capacity-building to improve understanding of what can legitimately be reported as adaptation or gender.

7. Bridging the gap

Lead authors: Pieter Pauw (Eindhoven University of Technology), Kennedy Mbeva (University of Oxford), Luis Zamarioli (independent)

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Key messages

- Bridging the adaptation finance gap requires more ambitious mitigation and effective adaptation.
- In addition to international public adaptation finance, private adaptation finance and domestic expenditure, several approaches can help bridge the adaptation finance gap. These include remittances, increased finance for small and medium-sized enterprises (SMEs) and reform of the international financial system.
- The implementation of the Paris Agreement's article 2.1(c) (making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development) offers developing countries the potential to help close the adaptation gap. However, it also brings the risk that vulnerable developing countries become less attractive to invest in if article 2.1(c) is solely driven by financial materiality.

Introduction

Before looking into how more finance could help close the adaptation finance gap, it is important to look for ways to limit or reduce the need for finance in three ways.

First, ambitious mitigation will mean that fewer hard and soft adaptation limits are hit and is therefore essential to limit costs of future adaptation and of measures to address loss and damage. Any further delay in anticipatory global action on mitigation and adaptation "will miss a brief and rapidly closing window of opportunity to secure a liveable and sustainable future for all" (IPCC 2022, p. 33).

Second, more focus should be on how to adapt effectively to climate change (UNEP 2022). Timing of adaptation is one key aspect of this. Anticipatory adaptation leads to more economic growth than either inaction or remedial action (Catalano, Forni and Pezzolla 2020). However, due to high costs of early adaptation and budgetary constraints, countries are often inactive, adapt reactively and/or rely on international support. Developing countries facing soft adaptation limits and receiving inadequate international support may therefore remain too inactive or only adapt reactively. This could cause overall costs to rise and turn soft adaptation limits into hard adaptation limits (Pauw 2021).

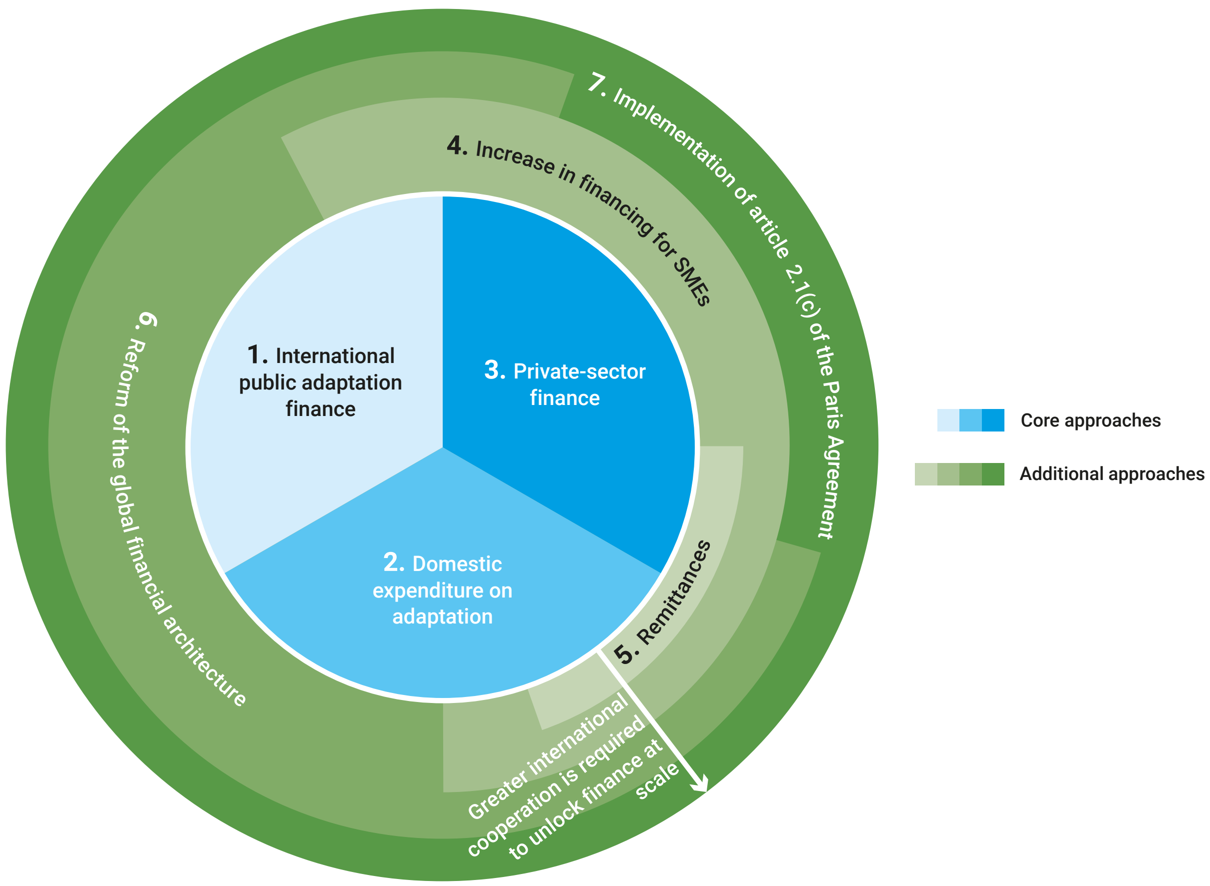
Third, as the number of institutions and initiatives on adaptation financing and the number of actors involved are increasing, enhancing institutional and technical capacity is also key to bridging the adaptation finance gap.

At the same time, the size of the adaptation finance gap clearly indicates that financing for adaptation needs to increase rapidly.

Bridging the gap

This report identifies seven ways to bridge the adaptation financing gap (see figure 7.1). The core continues to be dominated by international adaptation finance, domestic expenditure on adaptation and private-sector finance for adaptation, even if relative contributions of these three sources to closing the adaptation finance gap remain uncertain (see chapter 4). Around this core, four additional potential approaches to bridge the finance gap are identified. The further away from the core, the more international cooperation is required to unlock finance at scale. The outer ring is the implementation of article 2.1(c) of the Paris Agreement on shifting finance flows towards low-carbon and climate-resilient development pathways, which encompasses all financial flows in all countries (Zamarioli *et al.* 2021). It is important to note that these seven approaches offer different opportunities and constraints across countries. Chapter 4 of this report demonstrates, for example, that least developed countries (LDCs) rely heavily on international support, in particular grants. Bridging the adaptation finance gap requires attention to both quantitative aspects and qualitative aspects, such as access to finance (Khan *et al.* 2020).

Figure 7.1 Seven complementary approaches to bridge the adaptation finance gap



Dominant sources of finance for adaptation

Increase international adaptation finance. The Glasgow Climate Pact, adopted at the twenty-sixth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, urges developed country Parties to at least double their collective provision of climate finance for adaptation from 2019 levels by 2025 (UNFCCC 2021). Considering the important role of public and grant-based finance in the context of adaptation, this is an essential but insufficient step to closing the adaptation finance gap, although achieving the target will require reversal of the decrease in commitments in 2021 and consistent ambition (see chapter 4). In addition, Parties are negotiating a new collective quantified goal for the post-2025 period. This could safeguard an increase in adaptation finance. First, the goal could increase significantly as compared to the US$ 100 billion goal. While the Technical Expert Dialogue is still discussing the elements required to make informed discussions on the quantum of the goal (UNFCCC 2023), a correction for inflation would already increase the target from US$100 billion per year to US$139 billion per year (Pauw *et al.* 2022a). Second, the new collective quantified goal should 'take into account' "the needs and priorities of developing countries" (UNFCCC 2015, Decision 1/CP.21, paragraph 53), which could be translated into a larger share of the finance going towards adaptation or a sub-goal on adaptation (Pauw *et al.* 2022a). Any increase in international adaptation finance will be instrumental in helping close the adaptation finance gap. However, it is unlikely that any such increase in international adaptation finance will close the gap by itself.

Effective domestic expenditure: increase and improve budget tagging and tracking. Currently, budget tagging and tracking cannot be used to estimate the extent to which domestic expenditure helps close the adaptation finance gap. In fact, methodological differences among individual countries' assessments preclude cross-country comparison (UNFCCC 2022). However, tagging and tracking increases awareness among policymakers in different ministries of the options for integrating adaptation into budget planning, such as for long-term adaptation investments, or in recurring expenditures, and to reduce potential negative expenditure (Choi *et al.* 2023). Increased and improved tagging and tracking can therefore help spend government funds more consciously and integrate climate risks more effectively. This helps make the most of domestic financing and potentially increase domestic expenditure on adaptation, especially when a country also has systems in place to assess how effective those expenditures are. When coupled with other initiatives such as the recommendations by the Task Force on Climate-Related Financial Disclosures (Task Force on Climate-Related Financial Disclosures 2017), which target the broader financial system, tagging and tracking could also help countries implement article 2.1(c) of the Paris Agreement to make all finance flows consistent with climate-resilient development pathways.

Harmonization of tagging and tracking systems can bring greater coherence to the current diversity of initiatives and enable more direct learning between countries. While it is not clear whether this would also mobilize increased expenditure on adaptation, in any case it would allow for a comparison between countries for better understanding of how domestic expenditure can help close the global adaptation finance gap and work towards the Global Goal on Adaptation (see Canales *et al.* 2023). Currently, methodologies are diverse and were not envisioned as an attempt to meet the criteria of a methodology based on a statistical standard associated principally with standardization (Pizarro *et al.* 2021). For these purposes, implementation of general guidelines should be anchored within budget and public investment planning cycles, and integrated into financial management information systems to enable effective classification and analysis of expenditure investment planning cycles (Choi *et al.* 2023).

Mobilize private investments. From an economic point of view, it should not be the public sector's role to cover the full costs of adaptation, which would also typically exceed governments' fiscal space (Pauw *et al.* 2022b). Rather, the public sector should set the right conditions to catalyse private investments in adaptation, while keeping in mind the overall welfare of society (ibid.). For that purpose, three market imperfections need to be addressed: positive externalities, imperfect financial markets and incomplete or asymmetric information (see Druce *et al.* 2016). These market imperfections may be addressed either by modifying the market environment, for example, by reflecting positive externalities in the return; or by addressing the consequences of the imperfection through compensation. The latter could, for example, be achieved by offering public provision of improved climate risk information (to address asymmetric information) or through government-based financing support or risk sharing (Gardiner *et al.* 2015; Bisaro and Hinkel 2018; Woodruff, Mullin and Roy 2020; Pauw *et al.* 2022b). For example, the Government of Malaysia developed the concept of a mixed-use tunnel allowing for traffic flow under normal circumstances and providing for storm water diversion during heavy rain. Private investments were secured by compensating the positive externality (public benefits of stormwater diversion) by allowing a portion of the tunnel to be tolled for traffic in a more long-term contract between the government and the private investor (Gardiner *et al.* 2015; Pauw *et al.* 2022b). Various instruments can be used to address market imperfections. These typically involve blended finance arrangements that bring together concessional public capital and private capital (Gouett 2023). For example, guarantees and insurance can provide protection to private investors. Concessional finance can help encourage or de-risk private-sector investment and reduce the cost of capital, with the potential to also include technical assistance funds (grants) to help strengthen financial viability or provide support on key issues (UNFCCC 2022). Other instruments include resilience bonds (Bascunan, Molloy and Sauer 2020) and public-private partnerships to engage private-sector actors in infrastructure or service provision through a long-term contract with a government entity (UNFCCC 2022).

Additional approaches to bridge the adaptation finance gap

There are at least four additional approaches that could help bridge the finance gap.

Remittances are a potential supplementary source of finance to bridge the adaptation gap at the local level, although more discussion is needed on fairness aspects as well as limitations of nudging recipients to spend remittances on adaptation. Remittances – money sent by migrants to their families and friends in their countries of origin – have potential for three reasons (Bendandi and Pauw 2016). First, the recorded volume of these flows to developing countries rose rapidly to US$791 billion in 2021 (World Bank 2022). Moreover, while most of the largest remittance recipients are middle-income countries, in some of the LDCs, remittances account for 29 per cent (the Gambia) and 23 per cent (Nepal) of the gross domestic product (ibid.). Second, remittances directly address the household level. Action at this 'hyperlocal' level is central to adaptation (Castro and Sen 2022), but often hard to reach through public interventions. Third, in contrast to private finance, the motivation to remit is not only based on financial returns but also on personal bonds, which allows for investments where adaptation needs might be high but not have a return on investment. For example, Musah-Surugu *et al.* (2018) demonstrate that remittances in Ghana allow households to invest in climate resilience over time; can reduce households' vulnerability by closing their financial exclusion gap; and partially absorb economic losses owing to climate-related natural disasters, thereby lessening relief service required from local and central governments. In Moldova, remittances increase the likelihood of water-efficient irrigation facilities being used in dry areas (Pilarova, Kandakov and Bavorova 2022). Governments could help increase autonomous household adaptation through remittances. Maduekwe and Adesina (2022) find limited differences in exposure and adaptation action taken by Nigerian households that receive remittances compared to those that do not, but argue that government action to increase climate change literacy could change this. More research is required on the extent to which governments can nudge remittances to support adaptation and on climate justice concerns regarding such government action, and the fact that remittance recipients would use their money to adapt to a problem they may not have contributed to.

Increase financing for SMEs: SMEs hold considerable potential in unlocking climate adaptation solutions and engaging the private sector (see also Schaer and Kuruppu 2018; Global Center on Adaptation and Climate Policy Initiative 2021). Since SMEs comprise the bulk of the economy in many developing countries, financing mechanisms can be tailored to meet their individual needs and stimulate their potential to offer adaptation-related products and services. Initiatives at the global level, such as the G20 members' Global Partnership for Financial Inclusion, can help to mobilize and scale adaptation finance for SMEs. Regional initiatives such as those in Latin America (Botero *et al.* 2020), Asia (Papadavid 2021) and Africa (African Development Bank 2023) are salient examples. Moreover, financial de-risking mechanisms can be adapted to include the needs of SMEs, such as in financing small-scale energy projects. Although financial de-risking is occurring in various parts of the world, smaller countries with limited financial markets have inadequate access to financial de-risking instruments (World Bank 2016). Targeted investments in SMEs can also enable them to address priority areas identified in countries' nationally determined contributions (NDCs), with evidence showing that some SMEs already invest in adaptation in, for example, tourism (Hess 2020; Rasul *et al.* 2020) and agriculture (Gannon *et al.* 2021).

The domestic financial sector should also be engaged and supported to help financing adaptation by SMEs. Local banks are the natural structuring agents and sources of project development funding and connecting operating projects to local institutional investors mitigates currency risk (Lankes 2021).

Reform of the global financial architecture (including Bretton-Woods institutions). The Bretton-Woods architecture, which includes the International Monetary Fund (IMF), the World Bank and the World Trade Organisation, was originally designed for the post-World War II era. After the 2009 financial crisis and the COVID-19 pandemic, it has become evident that this system is no longer fit to address today's global challenges (Chhibber 2022). This architecture, together with other financing institutions such as multilateral development banks (MDBs), holds a large and unused potential for helping developing countries to tackle twenty-first century problems, including adaptation (Georgieva and Verkooijen 2021). The Bridgetown Initiative (Barbados 2022) sought to orientate such reforms, highlighting:

- Access by low-income countries to IMF's rapid credit financing facilities to COVID-19 crisis period levels. These financing windows are unconditional, have zero interest rates and can be used particularly after large natural disasters.
- Debt Service Suspension clauses, which provide temporary relief through suspension of debt repayment for countries in distress. This way, countries can focus on addressing specific crises or on reconstruction efforts after a climate catastrophe. Debt suspension has already been used to some extent by the G20 members (World Bank 2022), the Inter-American Development Bank (IADB 2023), and in bilateral cooperation by UK Export Finance (United Kingdom 2022), and can be coupled with adaptation-related requirements, as the case of debt-for-climate or debt-for-adaptation swaps (Fuller *et al.* 2018; Hebbale and Urpelainen 2023).
- Re-channelling unused special drawing rights. Special drawing rights are unconditional support by the IMF to countries' foreign reserves that do not add to the national debt and have significant potential when redesigned for bolstering climate resilience. They can give fiscal space to governments against economic challenges or be exchanged for hard currency, also working to reduce exchange rate risks and borrowing costs (Andrés Arauz, Cashman and Merling 2022).
- Other proposals include the operationalization of the IMF's Resilience and Sustainability Trust, aimed at providing long-term financing; the expansion of lending by MDBs by US$1 trillion, with focus on building climate resilience in climate-vulnerable countries through increased risk appetite, guarantees and holding of special drawing rights to expand lending to governments; a global mechanism for raising reconstruction grants for any country facing climate disasters; and a multilateral agency that accelerates private investments in the low-carbon transition.

Outside the Bridgetown Initiative, a more adaptation-conscious South-South cooperation may also help bridge the gap. This could include the creation and expansion of new multilateral institutions, for example with the New Development Bank of Brazil, Russian Federation, India, China and South Africa (formerly the BRICS development bank).

Implementation of article 2.1(c) of the Paris Agreement.[1] Article 2.1 (c) contains, but goes much further than, the international climate finance that contributes to the US$100 billion target to also contain private finance (including bonds, banking credit and equity) as well as public finance (including subsidies, loans and export credit). Despite being a global goal, its implementation offers developing countries the potential to help close the adaptation gap (see points 1, 2 and 3 below). However, it also brings along risks (d) that need to be addressed by the UNFCCC while further developing guidance on how to scale up climate resilience through the financial system.

1. Standardized reporting on article 2.1(c), such as with the Global Resilience Index Initiative and the Risk Information Exchange of the United Nations Office for Disaster Risk Reduction (United Nations Office for Disaster Risk Reduction and UK Centre for Greening Finance and Investment 2022) would create a proxy for monitoring the penetration of adaptation rationale across both public and private sectors, and bottom-up from firm and project levels. Even if such metrics and monitoring would not correspond to finances spent specifically on adaptation, it could indicate the pace at which identification and management of climate-related risks is mainstreamed across different economies. While reducing risks in the medium to long term, thus helping limit the adaptation gap, the alignment of finance flows with climate-resilient development should also uncover private opportunities and public investment needs for climate adaptation, at the firm and project levels.

2. Currently in its early development, MDBs' alignment of operations with the Paris Agreement offers meaningful lessons learned. As jointly agreed in 2021,[2] MDBs are moving to apply climate alignment methodologies in all of their operations. The aim is to ensure that projects do not contradict countries' climate strategies, including low-carbon pathways towards net zero emissions and national adaptation priorities. Under the adaptation methodology ('building block 2') the focus is to identify and address local risks to both lower material risks for the banks by improving the project's viability over time and seek opportunities to improve final beneficiaries' resilience through inclusion of more transformational components. The methodology applies to direct operations and policy-based lending finance while guiding MDBs' work with financial intermediaries and corporates (general corporate purpose finance), seeking a cascading effect through partners such as public banks, private financial institutions, investment funds, companies and so on. This cascading effect should also push the development of climate resilience-related services in different markets and for different sectors. MDBs' experience also offers an important lens for understanding the difference and synergies between resilience building under article 2.1(c), and climate adaptation finance. The latter follows similar steps in terms of methodology, but accounts only for the shares of projects used to address adaptation in specific (European Investment Bank 2022). In this case, MDBs' targets focus on the sum of mitigation and adaptation costs, thus excluding non-cost solutions, with the possibility to disaggregate adaptation amounts in their reporting.

3. Incorporating climate risks into the financial industry's decision-making strengthens the signal to companies about the need to build and demonstrate climate preparedness. Whether for managing creditworthiness, accessing mortgages or holding reasonably priced insurance, addressing risks related to climate impacts is progressively attached to the ability of companies and government entities to manage their financial health (Choi *et al.* 2023), as reflected by different credit rating agencies' evaluations of corporates and companies, as well as municipalities and national governments (Moody's Investors Service 2017a).

4. While the identification and disclosure of climate-related risks should contribute to adaptation, in the shorter term, it can negatively impact countries' economies. In finance, risks relate closely to costs. Broadly speaking, the identification of climate-related risks at the firm or project level can lead to three scenarios. In the best-case scenario, measures are taken to address these climate-related risks at low-cost or no-cost adjustments in design. In the second best-case scenario, financial solutions to address the risks come at a higher price, for example through insurance, guarantees and other de-risking instruments. In the worst-case scenario, identification of climate-related risks deems investments prohibitively expensive or unprofitable. From a macro perspective, advancing article 2.1(c) solely driven by financial materiality might lead to an increase in perceived risks and negative biases against the most vulnerable populations, such as those located in islands and LDCs (Moody's Investors Service 2017b; Fitch Ratings 2021), or the most exposed sectors, such as agriculture, natural capital and infrastructure.

1 Paris Agreement Article 2.1(c): *making finance flows consistent with a pathway towards low greenhouse gas emissions and* climate-resilient *development*

2 See https://www.eib.org/attachments/documents/cop26-mdb-paris-alignment-note-en.pdf

Annex 3.A: Countries providing adaptation finance needs information in their NDCs or NAPs

Table A.1 List of countries providing adaptation finance needs information in their NDCs or NAPs

Geographic region	Country	Income group	LDC/SIDS	Type of document	Costs by sector
East Asia & the Pacific	Kiribati	LMIC	LDC/SIDS	NDC	Yes
	Lao People's Democratic Republic	LMIC	LDC	NDC	No
	Papua New Guinea	LMIC	SIDS	NDC	Yes
	Cambodia	LMIC	LDC	NDC	Yes
	Mongolia	LMIC		NDC	No
	Solomon Islands	LMIC	LDC/SIDS	NDC	No
	Nauru	HIC	SIDS	NDC	Yes
	Tonga	UMIC	SIDS	NAP	No
	Vanuatu	LMIC	SIDS	NDC	Yes
	Viet Nam	LMIC		NDC	No
Europe & Central Asia	Georgia	UMIC		NDC	No
	Kyrgyzstan	LMIC		NDC	Yes
	Moldova	UMIC		NDC	Yes
	Armenia	UMIC		NAP	Yes
	Bosnia and Herzegovina	UMIC		NAP	Yes
	Tajikistan	LMIC		NDC	No
	Turkmenistan	UMIC		NDC	No

Latin America & the Caribbean	Guyana	UMIC	SIDS	NDC	No
	Suriname	UMIC	SIDS	NDC	No
	Grenada	UMIC	SIDS	NAP	Yes
	St. Vincent and the Grenadines	UMIC	SIDS	NAP	No
	Dominican Republic	UMIC	SIDS	NDC	Yes
	Colombia	UMIC		NDC	Yes
	Belize	UMIC	SIDS	NDC	Yes
	St. Kitts and Nevis	HIC	SIDS	NDC	Yes
	Peru	UMIC		NAP	Yes
	Dominica	UMIC	SIDS	NDC	Yes
	Antigua and Barbuda	HIC	SIDS	NDC	No
	El Salvador	LMIC		NDC	No
	Haiti	LMIC	LDC/SIDS	NAP & NDC	Yes
Middle East & North Africa	Djibouti	LMIC	LDC	NDC	No
	Iran (Islamic Republic of)	LMIC		NDC	No
	Palestine	LMIC		NAP	Yes
	Jordan	UMIC		NDC	Yes
	Morocco	LMIC		NDC	No
	Tunisia	LMIC		NDC	Yes
	Egypt	LMIC		NDC	Yes
South Asia	Afghanistan	LIC	LDC	NDC	Yes
	Sri Lanka	LMIC		NAP	Yes
	Pakistan	LMIC		NDC	No
	Nepal	LMIC	LDC	NAP	Yes
	India	LMIC		NDC	No
	Bangladesh	LMIC	LDC	NAP & NDC	Yes

Sub-Saharan Africa	Zambia	LIC	LDC	NDC	No
	Eritrea	LIC	LDC	NDC	Yes
	Guinea-Bissau	LIC	LDC/SIDS	NDC	No
	South Africa	UMIC		NDC	No
	Zimbabwe	LMIC		NDC	No
	Tanzania	LMIC	LDC	NDC	No
	Kenya	LMIC		NAP & NDC	Yes (only in the NAP)
	Rwanda	LIC	LDC	NDC	Yes
	Ethiopia	LIC	LDC	NAP & NDC	No
	Cabo Verde	LMIC	SIDS	NAP & NDC	No
	Angola	LMIC	LDC	NDC	Yes
	Congo	LMIC		NDC	Yes
	Guinea	LIC	LDC	NDC	No
	Liberia	LIC	LDC	NDC	No
	Malawi	LIC	LDC	NDC	Yes
	Namibia	UMIC		NDC	Yes
	Seychelles	HIC	SIDS	NDC	Yes
	Somalia	LIC	LDC	NDC	Yes
	Sierra Leone	LIC	LDC	NDC	Yes
	South Sudan	LIC	LDC	NDC	Yes
	Mauritius	UMIC	SIDS	NDC	No
	Ghana	LMIC		NDC	Yes
	Gambia	LIC	LDC	NDC	Yes

	Sudan	LIC	LDC	NDC	Yes
	Uganda	LIC	LDC	NDC	No
	Equatorial Guinea	UMIC		NDC	No
	Central African Republic	LIC	LDC	NDC	Yes
	Burkina Faso	LIC	LDC	NDC	Yes
	Burundi	LIC	LDC	NDC	Yes
	Cameroon	LMIC		NAP & NDC	Yes
	Chad	LIC	LDC	NAP & NDC	No
	Democratic Republic of the Congo	LIC	LDC	NAP & NDC	Yes
	Mali	LIC	LDC	NDC	Yes
	Senegal	LMIC	LDC	NDC	Yes
	Togo	LIC	LDC	NAP & NDC	Yes
	Benin	LMIC	LDC	NAP & NDC	Yes
	Madagascar	LIC	LDC	NAP & NDC	Yes (only in the NAP)
	Niger	LIC	LDC	NAP & NDC	Yes (only in the NAP)
	Côte d’Ivoire	LMIC		NDC	No
	Mauritania	LMIC	LDC	NDC	Yes
	Comoros	LMIC	LDC/SIDS	NDC	No
	Mozambique	LIC	LDC	NAP	Yes

Notes: Countries providing adaptation finance needs in a single document are highlighted in light green. Countries providing adaptation finance needs in multiple documents (e.g. NDC and NAP) are highlighted in dark green.

Number of countries with costing: 85.

Number of NDCs/NAPs with sectoral breakdowns: 58 (this only includes submissions that provided finance needs for at least three sectors).

Number of countries with sectoral breakdowns: 52 (this only includes submissions that provided finance needs for at least three sectors).

LIC = low-income country; LMIC = lower-middle-income country; UMIC = upper-middle-income country; HIC = high-income country.

Annex 3.B: Adaptation finance needs by sector in different world regions

Table A.2 Adaptation finance needs by sector in different world regions

Sectors	East Asia & the Pacific	Europe & Central Asia	Latin America & the Caribbean	Middle East & North Africa	South Asia	Sub-Saharan Africa
Agriculture	18.07	13.46	31.40	30.90	14.48	20.57
Water	13.36	65.79	8.92	23.21	40.77	17.50
Infrastructure and settlement	54.22	2.47	17.86	0.30	13.09	23.50
Forests and ecosystems	1.99	3.21	32.06	0.19	10.31	6.35
Climate-induced disaster	0.07	4.43	0.16	0.37	11.32	5.68
Human health	0.48	4.49	5.51	0.04	1.48	7.11
Energy	0.64	3.11	0.00	1.51	1.07	7.48
Coastal and marine resources	2.07	0	3.59	0.25	5.22	4.10
Tourism	0.66	0.16	0.14	0.02	0.35	1.29
Other sectors	8.43	2.90	0.37	43.21	1.91	6.42

Table A.3 Developing countries' adaptation finance needs by region for 2021–2030

Region	Annual adaptation finance needs in US$ billion (2021 value)	
	Median	Min–Max
East Asia & the Pacific	352	47–763
South Asia	101	31–179
Latin America & the Caribbean	81	9–180
Sub-Saharan Africa	66	13–134
Middle East & North Africa	45	14–82
Europe & Central Asia	9	1–19
Global	**655**	**115–1,356**

Note: The values are based on extrapolation to all developing countries using the median and IQ range of income-level-specific adaptation finance needs as an equivalent percentage of GDP (figure 3.6, panel B).

Annex 4.A: Challenges in estimating international adaptation finance flows

The lack of universally agreed approaches to account for international adaptation finance has given rise to multiple accounting practices. Bilateral and multilateral adaptation finance providers interpret key accounting parameters in different ways. This makes it very difficult to compare the reported adaptation finance figures of countries and institutions and to interpret multi-year changes.

Defining adaptation: The Adaptation Gap Report (AGR) takes a highly context-specific view of adaptation. It must take into account multiple future climate scenarios, uncertainty within these scenarios, and socioeconomic factors that cause vulnerability. Differentiating between adaptation and sustainable development can be complicated because actions to adapt to climate change and pursue sustainable development are closely connected. Therefore, measuring adaptation finance as a separate category from development finance can be challenging.

According to the Organisation for Economic Co-operation and Development (OECD) Rio marker for adaptation – which is used to guide reporting by climate finance funders on their financial contributions – an activity should be classified as adaptation-related if “it intends to reduce the vulnerability of human or natural systems to the current and expected impacts of climate change, including climate variability, by maintaining or increasing resilience, through increased ability to adapt to, or absorb, climate change stresses, shocks and variability and/or by helping reduce exposure to them. This encompasses a range of activities from information and knowledge generation, to capacity development, planning and the implementation of climate change adaptation actions” (OECD 2016). In addition, private-sector actors might not realize that their activities are contributing to adaptation to climate change, instead referring to them as ‘business continuity’ or ‘contingency planning’, for example. To address the potential challenge of defining and measuring adaptation, the Adaptation Solutions Taxonomy (Trabacchi *et al.* 2020) establishes an approach for identifying companies that are supportive of adaptation and climate resilience.

Precision: Only a small number of providers (mainly multilateral) have component-level adaptation finance accounting (where only a share of the project volume is counted as adaptation finance). Most providers count the whole amount of an adaptation project as adaptation finance. This can lead to huge differences in accounting, particularly for climate-resilient infrastructure, where the largest share of the total amount is not adaptation-related.

Financial instruments: While some providers only account for concessional flows that meet the strict official development assistance (ODA) criteria, others also account for non-concessional loans, equity or guarantees under adaptation finance. Adaptation finance provision is often reported at face value (instead of, for example, as grant equivalents). This can mean the financial contributions of such providers appear considerably larger on paper than in practice.

Newness and additionality: Some providers account for and report as adaptation finance only the financial flows that they consider “new and additional” to ODA. The terms “new and additional” are included in article 4.3 of the United Nations Framework Convention on Climate Change (UNFCCC). However, the interpretation of these terms varies considerably among providers.

Coverage of sectors and sources: While there is good coverage around international concessional public finance flows (predominantly ODA from OECD countries), there are far fewer data around mobilized finance from domestic and private-sector sources. As data coverage increases, care must be taken to ensure it does not lead to overestimates of resources devoted to adaptation that are in fact the product of better data availability.

Double counting: Climate finance contributors use multiple mechanisms for reporting (for example, OECD Development Assistance Committee [OECD DAC] and biennial reporting to the UNFCCC). Climate finance can also flow through institutions (for example, contributor countries provide resources to climate funds implemented by multilateral development banks [MDBs], which report both these and their own resources annually). This means care must be taken when aggregating data to avoid overinflating climate finance flows.

Other parameters: Currency conversions to increase comparability can be challenging. In addition, while some providers report committed adaptation finance, other providers report disbursement figures. For large multi-year loans, significant differences and fluctuations could be observed between yearly commitments and disbursements.

Changing accounting methodologies: Many providers have changed their climate finance accounting methodologies over time, making multi-year comparisons almost impossible.

Differing accounting methodologies: There are also unresolved methodological differences with respect to climate finance accounting, for example between MDBs and many bilateral providers of adaptation finance, that are yet to be reconciled.

Sources: Adapted from UNEP (2021) and based on Weikmans and Roberts (2019); UNFCCC Standing Committee on Finance (2018).

Annex 4.B: Finance flows – Data sources, data limitations, and methodology for calculating finance flows from OECD DAC

4.B.1 Finance flows – Data sources and data limitations

Biennial Reports submitted by Annex II Parties[1] are the official channel for disclosing information on climate finance under the UNFCCC (i.e. climate-specific amounts). The most recent finance flows included in the latest biennial assessment (UNFCCC Standing Committee on Finance 2021) are from 2020, and data for 2021 onward are still emerging.

International public bilateral and multilateral finance flows as reported by providers are aggregated in the OECD DAC database (OECD 2022c) up to 2021. However, in their reporting to the UNFCCC, Annex II Parties use different coefficients to account for activities that are only partially adaptation-related according to the Rio markers (OECD 2022b). Therefore, by using climate-related data from the OECD DAC data and applying the coefficients, it is possible to estimate the climate-specific data. In addition, there are coefficients for estimating the multilateral climate finance commitments attributable to developed countries.

OECD DAC data sources and scope

Data on climate-related financial support from the External Development Finance Statistics on Climate Change compiled by the OECD DAC are used to quantify the financial commitments reported as international public finance targeting climate adaptation. The data cover ODA and Other Official Flows (OOF). ODA consists of concessional financial contributions (grants and low-interest loans) with a primary objective of promoting economic development and welfare in developing countries. OOF are official transactions that do not meet the concessionality conditions to qualify as ODA, either because they have an insufficient grant element, or because their primary objective is not development-based (OECD 2009). The data in this report's analysis cover the 2017–2021 period. The finance amounts are presented in constant prices, with inflation and exchange rate variations taken into account by adjusting to the base-year 2021, as recommended by the OECD DAC.

Methodologies for reporting climate-related finance

Two methodologies are currently used across the landscape of bilateral and multilateral funders to track and report climate change finance. MDBs have their own methodology called "climate components" in OECD DAC, while all other funders use the Rio marker methodology. Both methodologies use compatible definitions of climate mitigation and adaptation (OECD 2018).

According to the Rio marker methodology, adaptation and mitigation can be marked as a "principal" objective (where mitigation or adaptation "is explicitly stated as fundamental in the design of, or the motivation for, the activity"), a "significant" objective (where mitigation or adaptation "is explicitly stated but […] is not the fundamental driver or motivation for undertaking [the activity]") or an activity may not be targeted at all ("not targeted") (OECD 2016). The "principal" and "significant" markers used under the Rio marker approach are not mutually exclusive. For example, the same financial transaction can be reported as contributing to both mitigation and adaptation at the same time.

MDBs track and report data on their climate-related contributions following their own climate components methodology (Bennett 2019). Under this approach, MDBs determine the specific components of a transaction that directly contribute to mitigation, adaptation or both simultaneously.

The Rio marker methodology was established to assess the degree to which the objectives of the Rio conventions are mainstreamed into ODA, allowing for further cross-cutting analyses (for example, on the extent to which adaptation finance is targeting gender equality). The methodology has been used as a basis for Annex II Parties to report on climate finance since 2010 (Weikmans *et al.* 2017; OECD 2020). To account for the fact that the Rio markers methodology was not originally designed to monitor financial pledges, most Annex II Parties 'scale down' the volume of finance associated with the Rio markers in their financial reporting to the UNFCCC. They do so by using coefficients to differentiate

1 Annex II countries: Australia, Austria, Belgium, Canada, Denmark, the European Economic Community, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, the United States of America.

between funding marked as targeting adaptation as a "significant" objective – reflecting that these projects have other "principal" objectives (such as biodiversity conservation or gender). These coefficients differ across Annex II Parties and range from 0 per cent to 100 per cent (OECD 2019a; OECD 2019b; Oxfam International 2020). These coefficients, available in OECD (2022b), were used to calculate the adaptation finance amounts presented in this report. For the seven Parties that do not use the Rio markers as a basis for their UNFCCC reporting, a general 40 per cent coefficient is applied to the "significant" marked activities.

In addition, coefficients exist to estimate the multilateral climate finance commitments attributable to developed countries. These coefficients differ across MDBs and range from 0 to 100 per cent (with the remainder being attributable to developing countries). These coefficients, available in OECD (2022a), were used to calculate the adaptation finance contributions of MDBs presented in this report.

In the analysis, amounts reported using the two different methodologies were taken at face value, as reported to the OECD DAC.

Data limitations

Self-reporting comes with some limitations. The attribution of financial support is subjective because the judgment and reporting is made by the funders and is not independently verified. The definition of adaptation used by both methodologies leaves room for interpretation and the accounting methods differ. Several studies claim that the self-reporting of finance providers and the lack of independent quality control result in low data reliability and sometimes substantial overestimations of finance flows (Toetzke, Stünzi and Egli 2022; Junghans and Harmeling 2012; Weikmans *et al.* 2017), especially for activities tagged as "significant" (Weiler, Klöck and Dornan 2018). For example, last year's Adaptation Gap Report (AGR 2022) found that more than one third of activities marked as having adaptation as a principal objective did not meet the respective OECD criteria (UNEP 2021).

Finally, historical data of loan amounts are reported by the funders at face value, instead of using the grant-equivalent amounts, resulting in overestimates of loan amounts (Oxfam International 2020; Timmons Roberts *et al.* 2021). Moreover, financial flows reported include the administrative costs of finance providers, which in some cases can be high (Atteridge and Savvidou 2020). Furthermore, there may be adaptation-related finance flows that are not captured because not all financial transactions in the OECD DAC databases are screened against the Rio marker for adaptation (Savvidou *et al.* 2021).

The establishment of standardized reporting mechanisms (UNFCCC Standing Committee on Finance 2018) would enhance data quality. Despite the aforementioned limitations, OECD DAC data provide the most comprehensive and comparable picture on international development finance for climate change (Weiler and Sanubi 2019; Doshi and Garschagen 2020; UNEP 2021).

Substantially more allocations are tagged as "significant" than "principal". Although there is no firm evidence on this trend, it may reflect efforts by countries to make their finance flows consistent with climate-resilient development pathways (article 2.1(c) of the Paris Agreement) as part of mainstreaming, which integrates climate adaptation into existing policies, programmes and plans. However, analyses identify overreporting of adaptation-related finance due to ambiguous definitions (Weikmans *et al.* 2017) and political motives in reporting among funder institutions (Michaelowa and Michaelowa 2011; Junghans and Harmeling 2012; AdaptationWatch 2015). This means that caution must be exercised when interpreting the data and trends.

Finally, it is important to acknowledge that tracking the provision and reporting of finance does not provide much information about effective use of funds. It is therefore necessary to also examine the effectiveness of financial contributions (Savvidou *et al.* 2021; UNEP 2021).

Description of the steps followed to prepare the data

Description of the steps followed to prepare the data based on the External Development Finance Statistics on Climate Change

Several steps were followed to prepare the data before calculating the amounts presented in this study. Data are publicly available at http://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/climate-change.htm under "Climate-related development finance at the activity level".

First, five recipient-perspective spreadsheets were downloaded to cover the period of our analysis (called 2017, 2018, 2019, 2020, 2021). The data sets were then merged, representing the climate-related development finance between 2017 and 2021, the five years that followed Paris Agreement's entry into force. To prepare this single combined data set for analysis, we undertook the following steps:

a. We filtered the data set to include only those recipient countries within our intended geographical scope (non-Annex I countries) using the column called "Recipient".

b. We filtered the data set to include only those finance provider countries within our intended geographical scope (Annex II countries) using the column "Provider (detailed)".

c. We excluded any data on export credits using the column called “Financial Instrument”.

d. We excluded any data on “Administrative Costs of Donors” using the column called “Sector (detailed)”.

e. We filtered out all private funders from the “Provider Type” column, since we are interested in public finance only (and the small number of private philanthropies included as private funders in the data constitute only a small share of the total adaptation-related finance).

f. We added a new column called “Regions” to denote the subregion within Africa, South America and Asia to which the recipient country for each transaction belongs.

g. In order to avoid double counting, we created two new columns: one that calculates the amounts for adaptation only and one for mitigation only, called “Adaptation Only” and “Mitigation Only” respectively.

h. To estimate the finance flows based on the coefficients used to account for activities that are only partially adaptation-related according to the Rio markers (OECD 2022b) as well as the coefficients to estimate the multilateral climate finance commitments attributable to developed countries, we added six new columns: 1. Coefficients Ada Only, 2. Ada Only with coefficients applied, 3. Coefficients Mit Only 4. Mit Only with coefficients applied, 5. Coefficients overlap, 6. Overlap with coefficients applied. These columns were used to estimate the finance flows in this analysis. For the finance providers Global Green Growth Institute and the Food and Agriculture Organization of the United Nations (FAO), no coefficients were applied i.e. the original amounts reported to the OECD DAC were used.

i. In order to estimate the amount of finance to the local level, a column called “Finance to local level” was added. This column provides all activities that in their project description contain the keywords from table 4.B.1.

j. In taking all the above steps, any coal-related finance flows and flows under the sector “In-donor refugee cost” were already filtered out, so we did not need to take any further actions to exclude them.

Commitments relevant for adaptation are found in columns “Adaptation-related development finance - Commitment - Current USD thousand” and “Adaptation-related development finance - Commitment - 2021 USD thousand”, which show the current and constant amounts respectively. Similarly, there are two columns showing current and constant amounts of finance for mitigation, adaptation and both simultaneously (which in the data set is denoted as “Overlap”) and for total climate-related finance. Following the recommendations of the OECD DAC for analysing trends over periods of time, we used the latter column, thus presenting finance in constant prices.

Table 4.B.1: Keywords used for tracking finance flows to the local level

civic	indigenous	Smallholders (smallholder)
Community (communit)	local	SMEs
cooperative	municipal	subnational
decentralised (decentrali)	province	town
home	rural	village
household	Slums (slum)	

Note: If a shorter version was used to increase hits, the word is provided in brackets.

Description of the steps followed to prepare the data based on the Creditor Reporting System (CRS) database for disbursement analysis

The CRS database is publicly available from OECD Statistics at https://stats.oecd.org/Index.aspx?DataSetCode=CRS1. We downloaded the data by selecting “Development/Flows based on individual projects (CRS)/ Creditor Reporting System (CRS)/ Export/ Related files”. To prepare data for the calculation of disbursement ratios, we downloaded five text files covering the years 2017 to 2021 from the CRS. The files were merged into one data set, and following this, a number of steps were taken. Some of these were the same steps undertaken for the data based on the External Development Finance Statistics on Climate Change mentioned above. To calculate aggregated disbursement ratios, the total amount disbursed was divided by the total amount committed.

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Chapter 1

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Chapter 3

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For more information: unep.org/environment-fund

UN environment programme

For more information:
unep-communication-director@unep.org
United Nations Avenue, Gigiri
P O Box 30552, 00100
Nairobi, Kenya

unep.org