The Adaptation Finance Gap Report

Puig, Daniel; Olhoff, Anne; Bee, Skylar; Dickson, Barney ; Alverson, Keith

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

UNEP

THE ADAPTATION GAP

FINANCE REPORT

Published by the United Nations Environment Programme (UNEP), May 2016

Publication: Adaptation Finance Gap Report
ISBN: 978-92-807-3498-0
Job Number: DEP/1912/NA

DISCLAIMERS

Cover photos: Left: © Michael Foley, © B. Saugat (Biodiversity International), © Karen Kasmauski (MCHIP)

CITATION

This document may be cited as:
UNEP 2016. The Adaptation Finance Gap Report 2016. United Nations Environment Programme (UNEP), Nairobi, Kenya

A digital copy of this report along with a supporting appendix (online only) is available at:
http://www.unep.org/climatechange/adaptation/gapreport2016/

This report was funded through contributions made to the United Nations Environment Programme by the Swedish International Development Cooperation Agency and the Government of Norway. Climate Analytics, Climate Policy Initiative, Fondazione Enrico Mattei, German Development Institute, Netherlands Ministry of Foreign Affairs, Organisation for Economic Cooperation and Development, Overseas Development Institute, Paul Watkiss Associates, Stockholm Environment Institute, Umeå University, United Nations Development Programme, United Nations Institute for Training and Research, United Nations World Food Programme, and Vivid Economics contributed to the report in-kind, through the time spent by the authors and members of the steering committee. This is greatly acknowledged.

UNEP

THE ADAPTATION GAP

FINANCE REPORT

ACKNOWLEDGEMENTS

The United Nations Environment Programme (UNEP) would like to thank the steering committee members, the lead and contributing authors, and the project coordination team for their contribution to the development of this report. The following individuals have provided input to the report. Authors and reviewers contributed to this report in their individual capacity and their affiliations are only mentioned for identification purposes.

PROJECT STEERING COMMITTEE

Keith Alverson (UNEP), Barbara Buchner (Climate Policy Initiative), Muyeye Chambwera (United Nations Development Programme), Barney Dickson (UNEP), Sandra Freitas (Climate Analytics), Anil Markandya (Basque Centre for Climate Change), Youssef Nassef (United Nations Framework Convention on Climate Change), Martin Parry (Imperial College London)

CHAPTER 1

Lead Author: Skylar Bee (UNEP DTU Partnership)
Contributing authors: Aaron Atteridge (Stockholm Environment Institute), Pieter Pauw (German Development Institute), Pieter Terpstra (Netherlands Ministry of Foreign Affairs), Paul Watkiss (Paul Watkiss Associates)

CHAPTER 2

Lead Authors: Paul Watkiss (Paul Watkiss Associates), Florent Baarsch (Climate Analytics), Nick Kingsmill (Vivid Economics)
Contributing authors: Francesco Bosello (Fondazione Eni Enrico Mattei), Federica Cimato (Paul Watkiss Associates), Kelly de Bruin (Umeå University), Enrica de Cian (Fondazione Eni Enrico Mattei)

CHAPTER 3

Lead Authors: Chiara Trabacchi (Climate Policy Initiative), Gisela Campillo (Organisation for Economic Co-operation and Development), Stephanie Ockenden (Organisation for Economic Co-operation and Development)
Contributing Authors: Ilaria Gallo (United Nations Institute for Training and Research), Pradeep Kurukulasuriya (United Nations Development Programme), Joanne Manda (United Nations Development Programme), Angus Mackay (United Nations Institute for Training and Research), Mariana Mirabile (Organisation for Economic Co-operation and Development), Charlene Watson (Overseas Development Institute)

CHAPTER 4

Lead Authors: Aaron Atteridge (Stockholm Environment Institute), Pieter Pauw (German Development Institute), Pieter Terpstra (Netherlands Ministry of Foreign Affairs)
Contributing Authors: Fabio Bedini (World Food Programme), Lorenzo Bosi (World Food Programme), Cecilia Costella (World Food Programme)

CHAPTER 5

Lead Author: Anne Olhoff (UNEP DTU Partnership)

EDITORIAL TEAM

Daniel Puig (UNEP DTU Partnership), Anne Olhoff (UNEP DTU Partnership), Skylar Bee (UNEP DTU Partnership), Barney Dickson (UNEP), Keith Alverson (UNEP)

PROJECT COORDINATION

Anne Olhoff (UNEP DTU Partnership), Skylar Bee (UNEP DTU Partnership), Daniel Puig (UNEP DTU Partnership), Jesica Andrews (UNEP), Rebecca Rotich (UNEP), Lucy Ellen Gregersen (UNEP DTU Partnership), Annahita Maria Boje Nikpour (UNEP DTU Partnership)

MEDIA SUPPORT
Mette Annelie Rasmussen (UNEP DTU Partnership), Kelvin Memia (UNEP), Surabhi Goswami (UNEP DTU Partnership), Shereen Zorba (UNEP), Miles Amoore (UNEP), David Cole (UNEP), Michael Logan (UNEP), Nicolien Delange (UNEP), Roxanna Samii (UNEP), Salome Mbeyu (UNEP), Tamiza Khalid (UNEP)

REVIEWERS
Bhim Adhikari (International Development Research Centre), Mozaharul Alam (UNEP), Preety Bhandari (Asian Development Bank), Ian Burton (University of Toronto), Stuart Crane (UNEP), Edgar Cruz (UNEP), Robert Dellink (The Organisation for Economic Co-operation and Development), Andrew Deutz (The Nature Conservancy), Philip Drost (UNEP), Ermira Fida (UNEP), Jens Fugl (European Comission), Andreas Hof (PBL Netherlands Environmental Assessment Agency), Livia Hollins (United Nations Framework Convention on Climate Change), Cornelia Jäger (European Commission), Xianfu Lu (United Nations Framework Convention on Climate Change), Alexandre Magnan (The Institute for Sustainable Development and International Relations), Rojina Manandhar (United Nations Framework Convention on Climate Change), Ulf Moslener (Frankfurt School of Finance and Management), Michael Mullan (The Organisation for Economic Co-operation and Development), Richard Munang (UNEP), Xolisa Ngwadla (South Africa's Council for Scientific and Industrial Research), Ian Noble (Notre Dame Global Adaptation Index), Janak Pathak (UNEP), Elena Pita (UNEP), Loreta Rufo (Asian Development Bank), Erin Schiffer (UNEP), George Scott (UNEP), Jason Spensley (Climate Technology Centre and Network), Merlyn Van Voore (UNEP), Yolando Velasco (United Nations Framework Convention on Climate Change), Sáni Zou (The Institute for Sustainable Development and International Relations)

DESIGN AND LAYOUT
Phoenix Design Aid

GRAPHS
Weeks.de

PRINTING
Frederiksberg Bogtrykkeri A/S

CONTENTS

Glossary ..... **vii**
Acronyms ..... **ix**
Foreword ..... **xi**
Executive summary ..... **xii**

CHAPTER 1

Introduction **1**
1.1 Context and objectives of the report 2
1.2 Adaptation finance in international climate negotiations 3
1.3 Key concepts underlying the adaptation finance gap assessment 5
1.4 Structure of the Report 6

CHAPTER 2

The costs of adaptation **9**
Key findings 10
2.1 Introduction 10
2.2 Global level estimates of the costs of adaptation in developing countries 11
2.3 National and sector estimates of the costs of adaptation in developing countries 12
2.3.1 National studies 13
2.3.2 Sector studies 13
2.4 Why cost estimates differ 14
2.4.1 Coverage 14
2.4.2 Objectives and quantification methods 15
2.4.3 Time-scales, and future greenhouse-gas emission pathways 15
2.4.4 Uncertainty 16
2.4.5 Limits of adaptation 16
2.4.6 Aggregation 16
2.4.7 Adaptation deficit 16
2.4.8 Additional cost categories and soft versus hard adaptation 16
2.4.9 Learning, innovation, scale and the private sector 16
2.4.10 Implementation costs and effectiveness 16
2.5 Moving toward practice 18

CHAPTER 3

Adaptation finance **21**
Key findings 22
3.1 Introduction 22
3.2 An overview of adaptation finance levels and trends 23
3.2.1 Public adaptation finance flows 23
3.2.2 Key sources of international public adaptation finance 24
3.2.3 Key instruments channelling international public adaptation finance 25
3.2.4 Sectoral uses and geographical distribution of international public adaptation finance 27
3.3 Tracking adaptation finance 28
3.3.1 Increased data comparability 28
3.3.2 Improved data accessibility 28
3.3.3 Expanded knowledge on the linkages between public and private finance 28

CHAPTER 4

Private sector finance for adaptation **31**
Key findings 32
4.1 Introduction 32
4.2 Evidence about private sector financing for adaptation 33
4.2.1 Climate bonds 33
4.2.2 Remittances 34
4.2.3 Domestic private investment 35
4.3 Mobilising private sector financing for adaptation 35
4.3.1 Non-financial interventions 35
4.3.2 Financial interventions 36

CHAPTER 5

The adaptation finance gap and prospects for bridging it **39**
5.1 Introduction 40
5.2 The adaptation finance gap – now and in the future 40
5.3 Bridging the adaptation finance gap 42
5.3.1 Enhancing mitigation ambition 42
5.3.2 Making development climate resilient 42
5.3.3 Scaling up finance for adaptation 42
5.3.4 Ensuring effectiveness and efficiency of resource use 43
5.4 The Paris Agreement and the way forward 44

References **46**

GLOSSARY

The entries in this glossary are adapted from definitions provided by authoritative sources, such as the Intergovernmental Panel on Climate Change (IPCC).

Adaptation	In human systems, the process of adjustment to actual or expected climate and its effects in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate.
Adaptation benefits	The avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures.
Adaptation costs	Costs of planning, preparing for, facilitating, and implementing adaptation measures, including transaction costs.
Adaptation deficit	The gap between the current state of a system and a state that minimizes adverse impacts from existing climate conditions and variability.
Adaptive capacity	The combination of the strengths, attributes and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities.
Anticipatory adaptation	Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
Attribution	The process of evaluating the relative contributions of multiple causal factors to a change or event with an assignment of statistical confidence.
Autonomous adaptation	Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or *welfare* changes in *human systems*.
Baseline	State against which change is measured. It might be a current baseline, in which case it represents observable, present-day conditions. It might also be a 'future baseline', which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines.
Climate	Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.
Climate (change) impacts	The effects of climate change on natural and human systems.
Climate (change) scenario	A plausible and often simplified representation of the future climate based on an internally consistent set of climatological relationships and assumptions of radiative forcing, typically constructed for explicit use as input to climate change impact models. A 'climate change scenario' is the difference between a climate scenario and the current climate.

Climate change	Any change in climate over time, whether due to natural variability or as a result of human activity.
Expenditure	The ultimate payment of costs for goods and services (such as infrastructure, technology, equipment, information/knowledge, labour and finance itself), including in-kind or non-monetary contributions.
Finance	The allocation of investment capital, and the way such capital is mobilised and delivered. Through intermediary institutions, investment capital is made available as finance to different public and private actors in need of funding for expenditure.
Maladaptation	Actions that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future.
Mitigation	An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.
Planned adaptation	Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.
Private adaptation	Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's rational self-interest.
Public adaptation	Adaptation that is initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs.
Reactive adaptation	Adaptation that takes place after impacts of climate change have been observed.
Scenario	A plausible and often simplified description of how the future may develop based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections but are often based on additional information from other sources, sometimes combined with a 'narrative storyline'.
Uncertainty	An expression of the degree to which a value (for example, the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (such as a range of values calculated by various models) or by qualitative statements (for example, reflecting the judgement of a team of experts).
Vulnerability	The propensity or predisposition to be adversely affected.

ACRONYMS

AF	Adaptation Fund
ASAP	Adaptation for Smallholder Agriculture Programme
CBI	Climate Bonds Initiative
CCRA	Climate Change Risk Assessment
CoP	Conference of Parties
CPEIR	Climate Public Expenditure and Institutional Review
DFIs	Development Finance Institutions
EACC	Economics of Adaptation to Climate Change
ECA	Export Credit Agency
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GHG	Greenhouse Gases
IAM	Integrated Assessment Modelling
IFC	International Finance Corporation
IFF	Investment and Financial Flows
IPCC	Intergovernmental Panel on Climate Change
LAC	Latin America and the Caribbean
LDCF	Least Developed Countries Fund
LDCs	Least Developed Countries
MDBs	Multilateral Development Banks
MIGA	Multilateral Investment Guarantee Agency
MSME	Micro, Small and Medium Enterprises
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
OECD DAC	Organisation for Economic Cooperation and Development, Development Assistance Committee
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
PPCR	Pilot Programme for Climate Resilience
PPP	Public Private Partnership
SCCF	Special Climate Change Fund
SIDS	Small-island Developing States
SME	Small- and Medium-sized Enterprises
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

FOREWORD

The Paris Agreement has raised the political profile of climate resilience. There is now a global goal for climate change adaptation and it is recognized that adaptation represents a challenge with local, national and international dimensions.

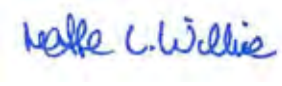
The 2016 Adaptation Finance Gap Report explores the costs of meeting adaptation needs and assesses the funding that is available for doing so. It suggests that although international public funding for adaptation has increased in recent years, the previous assessments of the costs of adaptation have involved significant underestimates. This leaves us with a gap – the adaptation finance gap – which we need to fill if we are to meet the ambitions of the Paris Agreement.

The Report considers the options for bridging the finance gap. One of the strong messages emerging from the report is that mitigation is the best first option. Because adaptation is a function of a missed mark for mitigation, it is important that there remains an emphasis on emission reductions. Nevertheless, even if emissions can be cut effectively, a very large adaptation burden will remain and the communities least equipped to bear this burden will face the greatest impacts.

It is for this reason that sustainable development and climate solutions are closely linked. Without addressing climate change impacts, sustainable development is undermined, and investments are lost. We can ill afford such losses.

The Report considers the way in which private finance can help to bridge the adaptation gap. It details four ways governments and business can work together to encourage better integration of adaptation practices, including providing businesses with access to the information and tools they need to integrate adaptation into investment decisions.

Greater emphasis must be put on the question of effectiveness. Increasing the volume of finance only increases resilience if it is spent wisely. Adaptation is not only about responding to specific impacts, but about creating resilience to a range of uncertainties. Investing in the underlying capacity of the most vulnerable people and ecosystems therefore, is at the heart of truly sustainable adaptation.



Mette Løyche Wilkie
Director
Division of Environmental Policy and Implementation

EXECUTIVE SUMMARY

The adoption of the Paris Agreement at the twenty-first session of the Conference of the Parties (CoP21) to the UN Framework Convention on Climate Change in November 2015 was a landmark achievement, with 195 countries endorsing an ambitious climate change agreement that includes a global goal on adaptation. **More robust information on adaptation needs, costs, and finance is needed to guide and inform the successful implementation of the Paris Agreement**. To support the provision of such information, the 2016 Adaptation Finance Gap Report presents an indicative assessment of the current knowledge on global adaptation costs, the finance available to meet these costs, and the anticipated difference between these two figures – the adaptation finance gap.

The report builds on a 2014 assessment by the United Nations Environment Programme, which laid out the concept of adaptation gaps and outlined three such gaps: technology, finance and knowledge. Like the 2014 report, the 2016 report focuses on developing countries, where adaptation capacity is often the lowest and needs are the highest, and concentrates on the period up to 2050, as the short to medium term is considered the most relevant for decision-making related to adaptation.

The report highlights trends and challenges associated with measuring progress towards bridging the adaptation finance gap, while informing national and international efforts to advance adaptation. It analyses adaptation finance against the background of the provisions laid out in the Paris Agreement, and benefits from the insights included in the NDCs.

The Paris Agreement includes several provisions to advance adaptation, of which three are particularly important for the assessment in this report: the adoption of a global goal for adaptation, the commitment to increase UNFCCC developed country-party funding flowing to developing country parties, and the requirement for parties to draw-up and regularly update adaptation plans and strategies. In addition, the Paris Agreement calls on parties to the UNFCCC to "engage in adaptation planning processes and the implementation of actions" (Article 7.9), as well as to report on progress every five years (Article 7.10). Recognising that the methodologies needed to underpin adaptation planning and implementation are poorly developed, the Paris Agreement also includes a range of provisions concerning methodology development.

THE COSTS OF ADAPTATION

Cost estimates vary strongly with the level of global warming, the methods used to estimate them, the ethical choices made, the economic framework applied, and the assumptions made. As such, **there is no single estimate of the costs of adaptation.** The report provides an indicative range of costs, based on an assessment of the literature.

Building on the 2014 Adaptation Gap Report, a more in-depth review of national and sector cost estimates has been undertaken for the preparation of this report. This work confirms and reinforces the findings presented in the 2014 report: **the costs of adaptation are likely to be two-to-three times higher than current global estimates by 2030, and potentially four-to-five times higher by 2050.** Previous global estimates of the costs of adaptation in developing countries have been placed at between US$70 billion and US$100 billion a year for the period 2010-2050. However, the national and sector literature surveyed in this report indicates that the costs of adaptation could range from US$140 billion to US$300 billion by 2030, and between US$280 billion and US$500 billion by 2050. This literature highlights that assumptions have a strong influence on the cost estimates, and that **studies that focus on policy**

Adaptation gap definitions

The adaptation gap can be defined generically as the difference between the level of adaptation actually implemented and a societally set target or goal, which reflects nationally determined needs related to climate change impacts, as well as resource limitations and competing priorities.

The adaptation finance gap can then be defined and measured as the difference between the costs of, and thus the finance required, for meeting a given adaptation target and the amount of finance available to do so. Assessment of the adaptation finance gap is facilitated by the availability of a common monetary metric. However it must be noted that finance is a means rather than an end – availability of funds does not guarantee that they are used efficiently and effectively to increase climate resilience and reduce vulnerability.

implementation and national circumstances generally report higher adaptation costs.

The costs of adaptation in developing countries are increasing, strengthening the case for immediate and enhanced mitigation action. Global, national and sector studies show that adaptation costs increase under higher emissions scenarios. This reinforces the notion that deep mitigation actions are the best insurance against rapidly rising adaptation costs and the potential limits of adaptation.

Improved estimates of the costs of adaptation require more and better-designed studies to be conducted. Additional empirical studies are especially needed for sectors or risks that are currently understudied, notably biodiversity and ecosystem services. Testing how the choice of method and assumptions affect cost estimates, possibly through sensitivity testing and multi-model analysis, is equally important. Not least, follow-up analyses are required, to better understand the magnitude of opportunity, transaction and implementation costs.

ADAPTATION FINANCE

Total bilateral and multilateral finance for climate change adaptation reached US$25 billion in 2014, of which US$22.5 billion targeted developing countries, highlighting a steady rise over the past five years. Most funds originate from development finance institutions (US$21 billion, or 84 per cent of the total) and are delivered through low-cost or market-rate project debt (53 per cent and 26 per cent of the total, respectively). Developing countries in East Asia and the Pacific attract almost half of the funding (some 46 per cent of the total). Over half of the total finance (55 per cent) is directed to water and wastewater management projects.

Dedicated climate funds help break down barriers to investment in adaptation projects in developing countries and play an important role in catalysing a wide range of adaptation-related investments. They do this by strengthening the capacities of local stakeholders, creating incentives for institutions and investors (for example, by offering concessional terms) and, ultimately, by taking on risks from which commercial financiers will typically shy away.

The US$1.2 billion Pilot Programme for Climate Resilience and the almost US$1 billion Least-developed Countries Fund are the largest adaptation-targeted funds. **Yet developed-country contributions to these funds are low when compared to contributions to mitigation-focused funds.** The Green Climate Fund, which recently entered into operation, is expected to play a significant role in financing adaptation, as it seeks to reach an equal split between adaptation and mitigation.

By the end of 2015, just over US$35 billion, corresponding to 76 per cent of the resources pledged to adaptation-focused climate funds, had been approved for disbursement. The trend for the period 2011-2015 is one of growth, and includes the approval of the Green Climate Fund's first eight projects, four of which are adaptation projects. **Some of the poorest countries in sub-Saharan African, and South Asia have been the main recipients of funding for adaptation from dedicated climate funds. Small-island developing states are among the main recipients of adaptation finance for disaster risk reduction.**

A proper measurement, tracking, and reporting system for adaptation investments is indispensable to ensure that finance is used efficiently and targeted where it is most needed. Significant progress has been made over the past ten years in tracking international adaptation finance. **Improved tracking of, and reporting on, financial flows has the potential to increase the efficiency with which international adaptation finance is used.** In recent years, a number of steps have been taken to this end: in February 2016 an improved definition of the OECD Rio Marker for tracking bilateral official development assistance targeting adaptation was adopted, and in early 2015, six large multilateral development banks and the International Development Finance Club agreed on a set of common principles for tracking climate finance.

PRIVATE SECTOR FINANCE FOR ADAPTATION

Despite progress, data gaps and difficulties in measuring and reporting private financial flows persist. **Climate-resilience activities are often integrated into development interventions or business activities, and therefore rarely stand-alone.** For this reason, private sector adaptation-related investments are difficult to identify and classify, which results in the data gaps mentioned above. Yet the private sector plays a key role in adaptation. Beyond management of its own exposure to climate risks, **different kinds of private finance – debt, equity, insurance products – hold potential for helping to bridge the**

adaptation finance gap. Improving our understanding of private sector financing for adaptation is key to unleash this potential.

Outside of a purely adaptation-related context, private sector contributions – from foreign direct investment, private debt, remittances and official development assistance – make-up the largest components of financial inflows to developing countries. **The distribution of flows is uneven, with least-developed countries struggling to attract significant volumes of private debt or equity outside resource sectors.**

While quantitative estimates of financial flows are not available, private domestic investment and remittances are good examples of adaptation-relevant investments. Private domestic investment levels are rising in developing countries and, if this trend holds true for micro- and small-sized enterprises, a portion of those funds is likely to be spent on adaptation-relevant activities, particularly for those enterprises active in agriculture, a sector that is especially sensitive to climate change.

Remittances are currently around 3.5 times larger than the total flows of official development assistance, and play a major role in developing country economies, for individual households, and for small businesses and entrepreneurs. Although data availability prevents assessing the share of remittances going to adaptation-related uses, remittances may be valuable from an adaptation perspective because they tend to increase in cases of catastrophic weather events and natural disasters in migrants' countries of origin. Furthermore, remittances reach households directly, including those in remote and vulnerable areas, more rapidly than public finance flows.

Generic barriers to private sector investment in developing countries are well known, and include poor legal, economic and regulatory frameworks, immature financial markets, and currency exchange risks. These generic barriers obstruct private sector adaptation to climate change. Adding to these are barriers that are specific to climate change, such as the cost-saving nature of adaptation investment, which contrasts with the revenue-creation motivation of the private sector, or various social and cultural barriers.

Domestic government agencies and development institutions can help break down barriers to private sector adaptation by undertaking targeted financial and non-financial interventions. Strengthening the ability of development banks to mobilise private sector investment is the financial intervention that has been used most. Key non-financial interventions include improving the provision of data and information, and introducing policies that are conducive to private sector investment, notably economic inducements.

THE ADAPTATION FINANCE GAP

Today, developing countries already face an adaptation finance gap. This gap is large and likely to grow substantially over the coming decades, unless significant progress is made to secure new and additional finance for adaptation, and to put into effect ambitious mitigation measures. This finding emerges from assessing the costs of adaptation against available international public adaptation finance.

Adaptation finance flows have increased in recent years, but current finance levels fall short of present-day adaptation costs and are likely to do so in the future. **Current adaptation costs are likely to be at least 2 to 3 times higher than international public finance for adaptation.** Looking forward to 2030, the assessment of national and sector studies shows that adaptation costs in the period around 2030 are likely to be in the range of US$140-300 billion per annum, whereas international public finance for adaptation in 2014 was around US$22.5 billion. While the two figures are for different points in time and differ in terms of definition and coverage, they illustrate that, **to meet finance needs and avoid an adaptation gap, the total finance for adaptation in 2030 would have to be approximately 6 to 13 times greater than international public finance today.** Moreover, the potential adaptation finance gap in 2050 would be much larger – in the order of between twelve-to-twenty-two times current flows of international public adaptation finance.

Integrated assessment model estimates of the costs of adaptation globally suggest that costs could be even higher than the estimates produced in the context of national and sector studies. Furthermore, model estimates illustrate the emissions-dependency of adaptation costs, and highlight that adaptation cost levels for different warming scenarios could diverge as early as the 2030s. **It follows that enhanced mitigation ambition and pre-2020 action is central for limiting adaptation costs.**

Scaling up both public and private sources of finance is required to bridge the adaptation finance gap, now and in the future. Current estimates of adaptation finance flows are partial, as data limitations and methodological challenges prevent the inclusion of private sector and domestic public finance flows for adaptation. However, exclusion of these flows is unlikely to change the conclusions regarding short- and medium-term adaptation finance gaps, as current adaptation finance falls well short of needs.

The Paris Agreement restated the 2020 commitment by developed country parties of mobilizing US$100 billion per year for adaptation and mitigation until 2025, and requires parties to increase that commitment after 2025. Assuming an equal allocation of finance between adaptation and mitigation (as called for in the Paris Agreement), this

commitment could go a long way toward bridging the adaptation finance gap.

The Paris Agreement and its implementation offer opportunities for significantly bolstering progress with adaptation to climate change and addressing the adaptation finance gap. **The Paris Agreement recognises that adaptation is a global challenge with multifaceted local, subnational, national, regional and international dimensions and provides a framework for enhancing global and national adaptation action.** Implementation of the methodological provisions in the Paris Agreement would address many of the challenges identified in this report with regard to estimating adaptation costs, and (tracking and) mobilising additional financial flows for adaptation, including from the private sector.

The Nationally Determined Contributions (NDCs) represent a valuable starting point for such efforts, and the adaptation components in the NDCs indicate that current costs exceed current finance levels. Furthermore, the NDCs illustrate that there are similarities between the types of climate risks and adaptation responses that communities, sectors, countries and regions are facing, and provide a stepping stone for framing clearer goals, targets and metrics for adaptation, which can help set the direction for adaptation action and facilitate tracking progress.

01

CHAPTER 1

INTRODUCTION

LEAD AUTHOR
SKYLAR BEE (UNEP DTU PARTNERSHIP)

CONTRIBUTING AUTHORS (alphabetical)
AARON ATTERIDGE (STOCKHOLM ENVIRONMENT INSTITUTE), PIETER PAUW (GERMAN DEVELOPMENT INSTITUTE), PIETER TERPSTRA (NETHERLANDS MINISTRY OF FOREIGN AFFAIRS), PAUL WATKISS (PAUL WATKISS ASSOCIATES)

Photo: *© Skylar Bee (UNEP DTU Partnership)*

1.1 CONTEXT AND OBJECTIVES OF THE REPORT

The adoption of the Paris Agreement at the twenty-first session of the Conference on the Parties (CoP21) to the United Nations Framework Convention of Climate Change (UNFCCC) in November 2015 was a landmark achievement, with 195 countries endorsing an ambitious climate change agreement that includes a global goal on adaptation. More robust information on adaptation needs, costs and finance will be central to guide and inform the successful implementation of the Paris Agreement. To support the provision of such information, the 2016 Adaptation Finance Gap Report provides an assessment of adaptation needs and costs, the finance available to meet those needs, and the anticipated difference between these two figures – the adaptation finance gap. The report builds on the 2014 Adaptation Gap Report by the United Nations Environment Programme (UNEP), which reviewed three areas – finance, technology and knowledge – that contribute to successful adaptation. In addition, the 2014 report put forward a conceptual framework for assessing adaptation gaps associated to meeting (hypothetical) goals in each of those areas.

The conceptual framework developed by the 2014 Adaptation Gap Report assumes that an adaptation goal can be established for the area of interest. It defines the adaptation gap as the difference between the adaptation levels that would be consistent with the agreed adaptation goal at a given point in time, and the levels achieved through the adaptation measures actually implemented (Box 1.1).

While it was presented in the context of the above three areas only, the framework was designed to be applicable across other areas that may be relevant to climate change adaptation. The present report hones in on one such area – finance – and provides an assessment of the literature concerning the adaptation finance gap in a developing country context. The adaptation finance gap is defined as the difference between the costs of adaptation and the financing available to meet them at a given point in time. Furthermore, the present report expands on the preliminary findings presented in a 2015 brochure by UNEP (UNEP 2015), which also included an overview of the adaptation components in the nationally determined contributions (NDCs).

The 2016 report reinforces the findings of the 2014 report. It includes a more in-depth review of national-level cost estimates (bottom-up studies), and global-level, sector-specific estimates, while providing additional global-level model estimates (top-down estimates).[1] It updates and complements information on climate finance for adaptation presented in the 2014 report, for example, by highlighting barriers to, and potential enablers of, adaptation finance.

Data and methodological issues remain, however, particularly with the tracking of adaptation finance in both domestic budgets as well as the private sector. This report takes a closer look at the challenges and opportunities for improvements in tracking adaptation finance, with a focus on the private sector and the barriers and opportunities for mobilising adaptation finance within it. It concludes by assessing the state of the adaptation finance gap from now until 2050, and the options for bridging it.

1 Bottom-up studies calculate costs by adding up the costs of each of the measures in a specific, pre-determined portfolio of adaptation actions. Typically, these actions are national or sub-national in scope. In contrast, top-down studies calculate costs by relating total impacts with impact damages, often at the global level and on the basis of a sectoral breakdown of cost elements.

Box 1.1: Adaptation gap definitions

The adaptation gap can be defined generically as the difference between the level of adaptation actually implemented and a societally set target or goal, which reflects nationally determined needs related to climate change impacts, as well as resource limitations and competing priorities.

The adaptation finance gap can then be defined and measured as the difference between the costs of, and the finance required for, meeting a given adaptation target and the amount of finance available to do so. Assessment of the adaptation finance gap is facilitated by the availability of a common monetary metric. However, it must be noted that finance is a means rather than an end – availability of funds does not guarantee that they are used efficiently and effectively to increase climate resilience and reduce vulnerability.

Source: UNEP (2015)

KEY FINDINGS FROM 2014

The first Adaptation Gap Report (UNEP 2014) reviewed the evidence base on the costs of adaptation, collating and comparing the results of global and national studies, and found that a major adaptation finance gap is likely. The analysis considered the existing evidence base of national and sector studies, and used this to provide an initial assessment of the possible aggregated global costs of adaptation. The review concluded that existing estimates of the global costs of adaptation of US$70 billion to US$100 billion per year globally for the period up to 2050[2] were likely to be a significant underestimate. It indicated that the costs of adaptation could be two-to three times higher than this by 2030, and plausibly four-to-five times higher by 2050. The review also reported that future adaptation costs would not be equally distributed, with the least-developed countries (LDCs) and small-island developing states (SIDS) concluded to have much higher (relative) adaptation needs, highlighting the priority for adaptation in these regions.

In regards to finance, the 2014 Adaptation Gap Report found that the amount of public finance committed to adaptation objectives was within the range of US$23-26 billion in 2012-2013, with 90 per cent of flows invested in developing countries. Official development assistance (ODA), climate funds, and commitments from development finance institutions (DFIs) accounted for the majority of expenditures, with the 2014 report finding evidence of increased financial commitments for adaptation across all sources of finance, with adaptation finance being increasingly mainstreamed into development cooperation activities.

1.2 ADAPTATION FINANCE IN INTERNATIONAL CLIMATE NEGOTIATIONS

The Paris Agreement, capturing the outcomes of the 2015 CoP21, includes several provisions to advance adaptation, of which three are particularly important and relevant to this report: the adoption of a global goal on adaptation, the commitment to increase UNFCCC developed country-party funding flowing to developing country parties, and the requirement on parties to draw up and regularly update adaptation plans and strategies.

In Article 7.1, the Paris Agreement states that, "Parties hereby establish the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2" (UNFCCC 2015). While the goal does not represent an operational tool through which progress can be tracked in quantitative terms, agreement by parties to adopt such a goal signifies the increased attention to adaptation in international climate change negotiations. Not least, the explicit reference to the temperature goal underscores that the efforts required to adapt to climate change are dependent on the extent and timing of climate change mitigation efforts.

The Paris Agreement also restates the 2020 commitment by developed country parties of mobilising US$100 billion per year until 2025, and requires these parties to increase that commitment after 2025. In what constituted an unprecedented provision in international climate change negotiations, Article 9.4 of the Agreement calls for a balance between adaptation and mitigation finance and support, thus responding to a longstanding demand from developing country parties. Notwithstanding, the split between adaptation and mitigation is not specified, in spite of demands by some developing country parties. The Agreement further recognises the need for public and grant-based resources for climate change adaptation, in particular with regard to least-developed countries and small-island developing states.

In addition, the Paris Agreement calls on parties to the UNFCCC to "engage in adaptation planning processes and the implementation of actions" (UNFCCC 2015, Article 7.9), as well as to report on progress every five years (UNFCCC 2015, Article 7.10). Recognising that the methodologies needed to underpin adaptation planning and implementation are poorly developed, the Paris Agreement includes a range of provisions concerning

2 The World Bank EACC study estimated the costs of planned adaptation at US$70 billion to US$100 billion a year in the period 2010–2050 for developing countries (World Bank 2010). This study was cited in the IPCC 5th Assessment Report (Chambwera *et al.* 2014), although the IPCC report noted there was little confidence in these numbers, and that there was strong evidence of important omissions and shortcomings in data and methods, rendering these estimates highly preliminary.

methodology development. Similarly, acknowledging that most developing country parties are likely to require external assistance to conduct this work, the Agreement calls for support to these parties. In addition to fostering adaptation efforts at the national level, national reports are intended to underpin a global-level stocktake of progress toward meeting the aforementioned adaptation goal, a process that will also run in five-year cycles.

Intended Nationally Determined Contributions

In the lead-up to CoP21, parties to the UNFCCC prepared intended nationally determined contributions (INDCs), wherein countries publicly outline the post-2020 climate actions and agendas they plan to implement under a new international climate agreement. The majority of INDCs with a strong focus on adaptation came from developing country parties, and underlined the party's key needs in relation to adaptation to climate change. These overviews highlighted that (i) financing is a key concern for all developing country parties, particularly in regards to cost estimations and identifying sources of finance, and (ii) consistent methodologies and metrics around adaptation costs and finance are needed to gauge progress toward adaptation (UNEP 2015). After the Paris Agreement enters into force in 2016, INDCs become nationally determined contributions (NDCs). As such, this report refers to NDCs throughout.

Photo: *© Asian Development Bank*

1.3 KEY CONCEPTS UNDERLYING THE ADAPTATION FINANCE GAP ASSESSMENT

This report seeks to assess the evidence regarding estimates of both the costs of, and financing available for, adaptation to climate change. The assessment is undertaken to explore the potential implications for current and future adaptation finance gaps, defined and measured as the difference between the costs of meeting a given adaptation target and the amount of finance available to do so at a given point in time. The adaptation finance gap is one dimension of the overall adaptation gap, that is, the difference between the level of adaption required to reach a specific adaptation goal and the level of adaptation actually implemented.

An important point to bear in mind throughout this report is that in general, countries, cities and communities are not adequately adapted to existing climate risks. In other words, there is an existing adaptation gap. In the literature, this existing gap is often referred to as an adaptation deficit (see for example Burton 2004). There is broad recognition that this existing adaptation gap (or deficit) is a subset of a larger development gap (or deficit). As noted in UNEP's preliminary Adaptation Gap Report (UNEP 2014), delays in both adaptation and mitigation action are likely to increase the development gap (IPCC 2014), thereby adding to the adaptation gap. To build future adaptive capacity and lower the costs of adaptation in the future, it is important to reduce the existing adaptation gap.

Future climate change will lead to wide ranging economic costs in market and non-market sectors. Adaptation can moderate these impacts. The benefits of adaptation are the reduction in these future climate impacts (the avoided damage cost), which can be compared to the costs of planning, facilitating, and implementing adaptation (the costs of adaptation). However, there is a further trade-off with the impacts (and costs) of climate change after adaptation, that is, the residual damage. The costs of adaptation can be estimated for different aggregation levels and using different frameworks, objectives and methods. In this report, which is focused around the national to global domain, two main lines of evidence are used. Firstly, global estimates are provided. These are provided by global studies and models which operate at an aggregated scale, and are referred to in this report as top-down studies. Secondly, national and sectoral estimates are provided, which include more detailed assessments and are referred to in this report as bottom-up studies. Both approaches have strengths and weaknesses and the adaptation gap assessment combines the evidence from both to provide a more comprehensive and robust analysis.

Adaptation has been defined as "the process of adjustment to actual or expected climate and its effects" (IPCC, 2014). Adjustment can take two main forms: interventions that seek to exploit beneficial opportunities brought about by climate change and interventions that seek to avoid the harm resulting from it. Those interventions, which typically face trade-offs with other policy objectives, are undertaken by both public and private sector agents (Chambwera *et al.* 2014).

Partially reflecting the aforementioned definition of adaptation that distinguishes between responses to actual and expected climate impacts, it is common to distinguish between reactive adaptation (taking place after impacts of climate change are observed) and anticipatory adaptation (taking place before impacts of climate change are observed), as well as between autonomous and planned adaptation. Autonomous adaptation can be defined as "adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or *welfare* changes in *human systems*" (IPCC 2014). Autonomous adaptation is typically used to describe actions by households, businesses or communities acting on their own without public intervention, but within an existing public policy framework. Actions by these actors are also sometimes referred to as private adaptation, and usually reflect the actor's self-interest. In contrast, planned adaptation results from deliberate policy decisions aimed at returning, maintaining or elevating resilience conditions to a desired state, and is mostly used to describe public adaptation. Public adaptation is usually directed at collective, societal needs.

Much of the literature on adaptation costs and available data for adaptation financing focuses on planned public adaptation and omits autonomous and private adaptation. Including autonomous and private adaptation in the analysis of the costs of adaptation will increase cost estimates, potentially significantly.

Adaptation finance can take one of four forms: international public finance, public domestic finance, private international finance, or private domestic finance. This report reports primarily on financing for international public planned adaptation, as defined above. The public sector is the main funder of such activities, channelling domestic and international budgets into a wide range of projects aimed at increasing resilience to climate change. International budgets are earmarked, as they follow certain rules aimed at facilitating the tracking of such financing. Conversely, domestic budgets are typically managed by line ministries and are seldom earmarked as supporting adaptation to climate change. For this reason, while data concerning international public finance is relatively complete, data on domestic budgets is limited.

Engaging the private sector in financing adaptation, both nationally and internationally, involves a wide range of private, as well as public, actors. These include businesses (both domestic and international, in all sectors), private finance institutions, and ultimately, those who provide the source of the investment capital in the first place (including household savings, as well as major institutional investors such as pension funds) and insurance companies. On the public side, relevant actors include public institutions (notably development cooperation agencies and finance institutions), who source private capital and provide public revenue towards catalysing private investment, and blend private and public finance. It also includes governments, who in addition to finance, can also utilize policy and regulation to create enabling conditions for private investment.

Finance versus expenditure

The term finance is generally used to refer to both the allocation of investment capital, and the way such capital is mobilised and delivered. Through intermediary institutions, investment capital is made available as finance to different public and private actors in need of funding for expenditure. Expenditure refers to the ultimate payment of costs for goods and services (such as infrastructure, technology, equipment, information and knowledge, labour and finance itself), including in-kind or non-monetary contributions. Without finance, even expenditure that yields a positive economic return may not be possible due to, for instance, the way costs (or risks) are concentrated or distributed over time or in the market.

1.4 STRUCTURE OF THE REPORT

The report consists of four additional chapters, covering the following issues:

- **Chapter 2** includes an overview of estimates of the costs of adaptation. This overview seeks to contrast bottom-up estimates (national-level studies) with top-down estimates (global-level studies) of varying scope, to provide an estimate of the costs of adaptation at the global level.

- **Chapter 3** provides a summary of current finance levels, broken down by source, use and role. In addition, the chapter reports on progress with tracking adaptation finance.

- **Chapter 4** focuses on private sector financing, highlighting trends in private finance and expenditure, as well as barriers to the scale up of these trends. The chapter reports on financial and non-financial mechanisms that can be used to increase the level of financing for adaptation.

- **Chapter 5** provides a preliminary estimate of the adaptation finance gap. It concludes by exploring how the findings in the report may support international climate change negotiations. Special attention is paid to the way in which the adaptation gap concept can support implementation of the Paris Agreement.

The report has been written by 12 lead authors, supported by 13 contributing authors, affiliated to 15 organisations. An advanced draft of the report was reviewed by 31 individuals, working on all continents.

Photo: *© Caroline Schaer (UNEP DTU Partnership)*


02

CHAPTER 2

THE COSTS OF ADAPTATION

LEAD AUTHORS
PAUL WATKISS (PAUL WATKISS ASSOCIATES), FLORENT BAARSCH (CLIMATE ANALYTICS), NICK KINGSMILL (VIVID ECONOMICS)

CONTRIBUTING AUTHORS (alphabetical)
FRANCESCO BOSELLO (FONDAZIONE ENI ENRICO MATTEI), FEDERICA CIMATO (PAUL WATKISS ASSOCIATES), KELLY DE BRUIN (UMEÅ UNIVERSITY), ENRICA DE CIAN (FONDAZIONE ENI ENRICO MATTEI)

Photo: *© Stuart Price (AMISOM)*

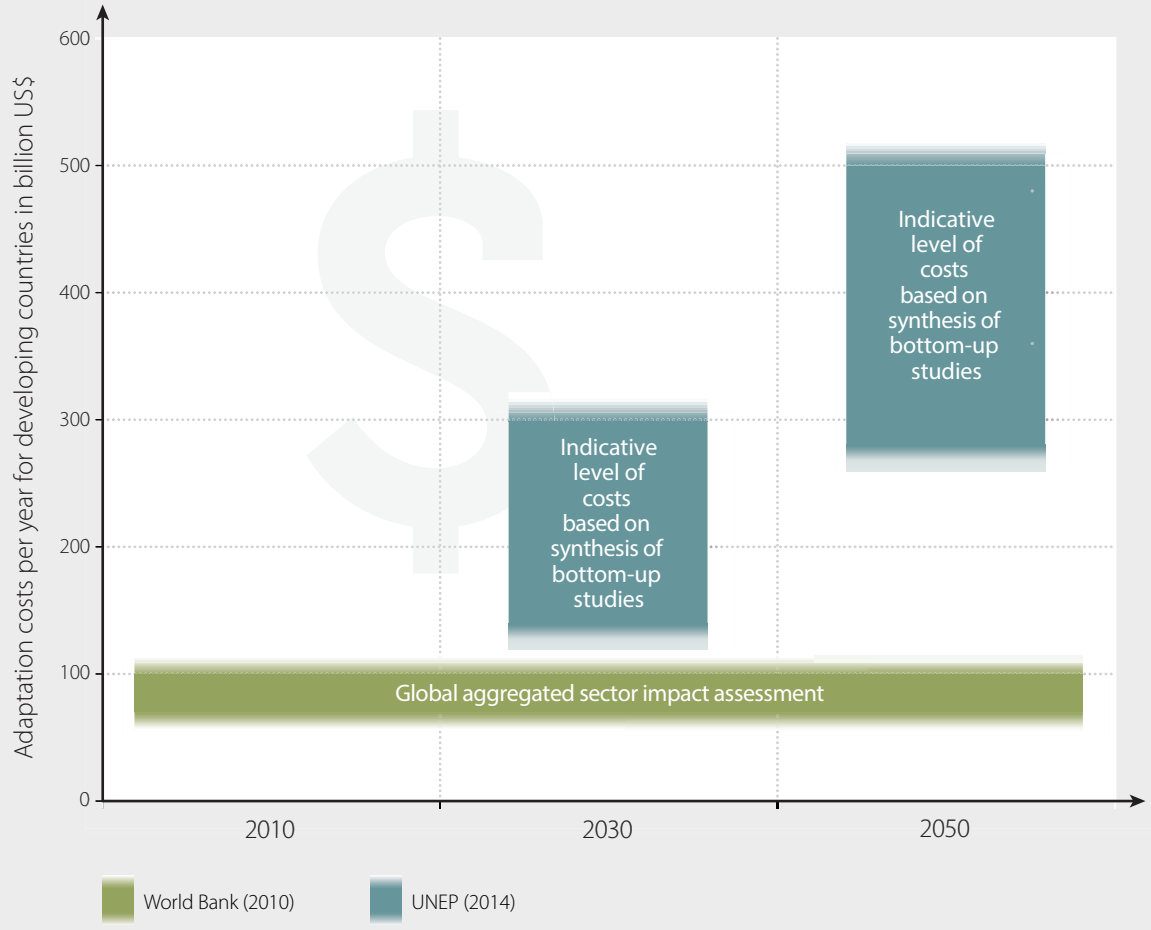
KEY FINDINGS

- Estimates of the costs of adaptation vary strongly, depending on the methodology used, the analytical principles applied, and the assumptions made. These choices involve complex and often subjective issues and, as such, there are different views on them. Therefore, there is no single estimate of the costs of adaptation.
- Previous estimates of the costs of adaptation in developing countries are likely to be underestimates. A review of the literature on national- and sector-level studies reinforces the findings presented in the 2014 Adaptation Gap Report: by 2030, the costs of adaptation could be two-to-three times higher than the range cited in the literature and four-to-five times higher by 2050.
- In light of limited financing and uncertainties about future impacts, developing country adaptation actions are placing heightened emphasis on early adaptation actions, low-regrets options, options that build-in flexibility and robustness for longer-term decisions, and early planning for likely major future risks.

2.1 INTRODUCTION

The Fifth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) reported global estimates of the costs of adaptation in developing countries of between US$70 billion and US$100 billion per year for the period

Figure 2.1: Indicative adaptation costs



between 2010 and 2050 (IPCC 2014). These estimates are largely based on a 2010 study by the World Bank (World Bank 2010). The IPCC report notes that there is low confidence in these estimates due to methodological challenges and data shortcomings.

Over recent years, the number of national- and sector-level assessments on the costs of adaptation has increased significantly. These assessments, which were reviewed in the 2014 Adaptation Gap Report, show that the World Bank estimates are likely to underestimate the costs of adaptation in developing countries. Compared to the 2014 Adaptation Gap Report, this chapter presents additional information on national- and sector-level assessments. The information summarised in the chapter represents the most up-to-date and scientifically robust evidence available on the costs of adaptation in developing countries.

The chapter is structured around four sections in addition to this introduction. Section 2.2 offers a brief summary of global-level studies on the costs of adaptation. Section 2.3 provides a critical review of the national- and sector-level studies mentioned above. Section 2.4 examines the assumptions and choices that affect this kind of assessment, putting cost estimates in context. Section 2.5 outlines how adaptation planning and implementation in developing countries is evolving, not least in light of limited finance and uncertainty about future impacts (and the costs associated with reducing those impacts).

2.2 GLOBAL LEVEL ESTIMATES OF THE COSTS OF ADAPTATION IN DEVELOPING COUNTRIES

Since the mid-2000s, a number of different approaches, often termed top-down approaches, have been used to estimate the costs of adapting to climate change at the global level. These include investment and financial flow assessments, aggregated sectoral impact assessments, and integrated assessment modelling. Each approach is briefly outlined in this section. More recently, some experts have argued that approaches based on alternative and more advanced models, such as dynamic stochastic computable general equilibrium models and agent-based models, should play an increasing role in estimating the costs of adaptation (Stern 2016).

The earliest widely-cited estimate of the costs of adaptation is based on a study sponsored by the United Nations Framework Convention on Climate Change (UNFCCC 2007). The study was based on an **investment and financial flow assessment approach** that increased investment needs by a certain amount, depending on the perceived adaptation requirements. The study focused on the agriculture, forestry and fishery, water supply, human health, coastal, and infrastructure sectors. It ultimately suggested overall adaptation costs of US$48 billion to US$171 billion per year by 2030, of which between half and two-thirds would be borne in developing countries. A 2009 critique of this work highlighted a number of shortcomings of its approach – notably in relation to the adaptation deficit and the initial investment levels needed. This critique suggested that, due to limited coverage of sectors and risks, the study may have underestimated the costs of adaptation by a factor of two-to-three (Parry *et al*. 2009).

In 2010, the World Bank published a study that followed a global scenario-based **aggregated sectoral impact assessment approach** (World Bank 2010). As highlighted in the introduction to this chapter, the study suggested that adaptation in developing countries may cost between US$70 billion and US$100 billion per year for the period between 2010 and 2050. The study covered the following sectors, albeit with only partial coverage within them: agriculture, forestry, fisheries, infrastructure, water resources, health, coastal areas, and extreme weather events. Furthermore, the study concluded that (i) the East Asia and Pacific region is likely to bear the highest overall costs, but the sub-Saharan Africa region would bear the highest costs per unit of gross domestic product (GDP); and (ii) the highest absolute costs would be borne by middle-income countries, but low-income countries would experience the highest costs per unit of GDP.

The sectoral coverage in these studies is partial, as is the coverage of risks within the targeted sectors. In addition, the studies use different approaches: some assess the optimal level of adaptation (trading-off adaptation against residual damages), while others quantify the costs associated with identified needs. The studies also represent adaptation in different ways and with varying levels of sectoral and technical detail. The following sections provide more detail on these and other aspects that explain why estimates of adaptation costs differ between studies.

Integrated assessment models take a different approach. They were developed to explore the costs of both mitigating greenhouse-gas emissions and adapting to future climate change impacts (Nordhaus and Boyer 1999, Plambeck *et al*. 1997). These models estimate the global and regional

impacts of climate change, and then extend the analysis to the costs and benefits of adaptation. They do this by connecting long-term economic development trajectories to a temperature pathway, the societal impacts of which are calculated through a mathematical function that is meant to characterise the average magnitude of those impacts.

Typically, integrated assessment models either aim to identify an optimal balance of mitigation, adaptation, and residual damages, or they seek to determine the most cost-effective way of adapting to a set mitigation target. A number of scientific reports and peer-reviewed publications have used integrated assessment models to estimate the future costs of adaptation. In 2009, the OECD used AD-RICE and AD-WITCH to examine the economics of adaptation to climate change. Specifically, this work sought to estimate total climate change costs, including mitigation, residual damages, and adaptation (de Bruin *et al*. 2009). A subsequent OECD study estimated adaptation costs in developed and developing countries (Agrawala *et al*. 2011a).

Studies of adaptation costs based on integrated assessment models typically find that adaptation is a highly effective response to climate change, with high benefits relative to costs. Furthermore, these studies provide insights into how adaptation costs may vary under different climate change scenarios. They indicate that even in the period between 2030 and 2050, adaptation costs could vary considerably between a 2°C warming scenario and higher warming scenarios.

However, these models currently provide a very wide range of estimates of adaptation costs. The outputs of two major models, AD-RICE and AD-WITCH, are presented in the Appendix available online, where the reasons for the wide divergence in model estimates are discussed.

In the future, one can expect these estimates to converge to some extent across the models, as parameter values become better determined empirically, and as the relationship between greenhouse-gas emissions, impacts and the effectiveness of adaptation become more firmly based on evidence. For the present, however, estimates of costs of adaptation have to rely mainly on bottom-up national studies and sectoral studies looking at specific types of impacts.

2.3 NATIONAL AND SECTOR ESTIMATES OF THE COSTS OF ADAPTATION IN DEVELOPING COUNTRIES

Most of the information base on the costs of adaptation at the national level has emerged from a small number of multi-country initiatives (Table 2.1).[3] A growing number of individual-country or sector studies complement this information base. Not least, several NDCs include estimates of the costs of adaptation (Chapter 1) (UNEP 2015).

The various initiatives – and even the studies within them – are highly heterogeneous, which makes direct comparison difficult, and precludes a simple aggregation of these country-level studies into a global estimate for developing countries. The Appendix provides additional background on, and details about, the findings presented in the remainder of this section.

3 The evidence presented in this section draws mostly on the ECON-ADAPT project and its review work, funded by the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration, under grant agreement nr. 603906.

Table 2.1: Multi-country studies on national adaptation costs in developing countries

Acronym	Name of the study	Commissioner and reference
IFF	Assessment of investment and financial flows to address climate change	United Nations Development Programme (UNDP 2011)
EACC	Economics of adaptation to climate change – country studies	World Bank (World Bank 2010)
NEEDS	National economic, environment and development study	United Nations Framework Convention on Climate Change (UNFCCC 2010)
RECCS	Regional economics of climate change	Multiple organisations and references

2.3.1 NATIONAL STUDIES

The IFF studies cover fifteen countries, and analyse one or two sectors in each country. The overall cost estimate is US$5.6 billion in 2020, US$6.3 billion in 2025, and US$7.1 billion in 2030. For the agriculture sector alone, the combined cost estimate for twelve countries is US$2.8 billion in 2020, US$3.5 billion in 2025, and US$6.0 billion in 2030.

The EACC national studies cover seven countries and use the general impact-assessment framework applied in the same project to obtain a global estimate for developing countries. Nonetheless, national cost estimates are higher than the global estimate. For some countries, national cost estimates were ten-to-twenty per cent higher, mostly due to the consideration of socially contingent impacts. For countries like Ethiopia and Ghana, national estimates were higher still. The national studies also demonstrated that cost estimates rise strongly when a global warming scenario above 2°C is considered (for example, in the study for Mozambique, much higher costs were reported when high sea-level rise scenarios were considered).

The NEEDS project covered eight countries and assessed the short- and mid-term costs of adaptation based on financing needs. Although the various studies used different methods and targets over different time periods, they all consistently reported high estimates of the costs of adaptation. This is mainly due to the use of the needs-assessment approach.

To date, a further twenty-five individual national assessments or studies have been conducted.[4] While most of these use impact-assessment approaches, comparing and synthesising estimates is challenging. What is interesting is that, for some countries, several independent studies have been conducted, which allows for cross-comparison. Examples of such countries are Bangladesh, Ethiopia, Ghana and India. In these countries, differences in adaptation costs between studies can vary by a factor of two-to-five.

2.3.2 SECTOR STUDIES

Previous reviews have assessed sector-specific studies of the costs of adaptation (IPCC 2014, OECD 2008). These reviews highlight that most studies focus on the coastal areas and agriculture sectors and, to a lesser extent, on the energy and infrastructure sectors. The recent European Union-funded ECONADAPT project has reviewed the state of this literature (ECONADAPT 2015). The ECONADAPT findings are summarised here, and presented in more detail in the Appendix.

4 Details about these are included in the Appendix.

COASTAL AREAS

The most comprehensive estimates of the costs of adaptation are for the coastal areas sector, primarily with respect to the risks of sea-level rise and storm surges on flooding and erosion. These estimates have been produced as part of global impact-assessment studies, often using the DIVA model.[5] Most of the global and national studies mentioned above also rely on this model.

The DIVA model has been used to estimate global annual investment and maintenance costs of protecting coasts up until 2100. The most recent estimates range from between US$12-31 billion to US$27-71 billion for low-and high-warming scenarios respectively (Hinkel *et al*. 2014). The additional adaptation costs associated with coastal erosion (beach and shore nourishment) are estimated at a further US$1.4-5.3 billion per year across low, mid and high scenarios (Hinkel *et al*. 2013). However, these results need to be considered in light of the discussion above: the studies assume modest protection levels, use an impact-assessment framework, and omit several risks related to the coastal and marine environment.

The case of coastal cities, which often require engineered protection, deserves particular attention. A global analysis of 136 coastal cities reported indicative annual adaptation costs of US$350 million per city, or approximately US$50 billion annually in total (Hallegatte *et al*. 2013). The coastal sector is also leading the application of new approaches based on iterative risk management and decision making under uncertainty (ECONADAPT 2015).

WATER MANAGEMENT

A growing number of studies analyse the risks of more frequent and/or intense floods, and changes to the water supply-demand balance, including potential water deficits, and the costs of adapting. Over recent years, there has been a focus towards national and even basin-level studies. These allow the use of more detailed hydrological models, which can be linked to probability-loss functions or depth-damage functions. More recent assessments also focus on low-regret adaptation options and non-technical options as complements to hard engineering, with early-warning systems and, increasingly, ecosystem-based approaches.

As with floods and changes in the water supply-demand balance, studies targeting water management and water demand are growing in number and tend to be national in scope. These often extend to risks that global studies typically omit, such as the costs of adapting wastewater and

5 The DIVA model is an integrated research model of coastal systems that assesses biophysical and socio-economic consequences of sea-level rise and socio-economic development, taking into account coastal erosion, coastal flooding, wetland change, and salinity intrusion into deltas and estuaries, as well as adaptation in terms of raising dikes and nourishing shores and beaches. A complete description is available online at: http://www.diva-model.net/

storm-water infrastructure, which can be high, or the costs associated with adaptation in hydro-electricity plants.

AGRICULTURE

The costs of adaptation in the agriculture sector, especially in developing countries, have been receiving increased attention. Both impact-assessment (crop modelling), and investment and financial flow studies are available, although these produce very different estimates, especially when the effects of trade are included. The most recent studies give greater consideration to early adaptation options, and focus on climate-smart agriculture (sustainable soil and water management practices).

HEAT IN THE CONTEXT OF THE BUILT ENVIRONMENT

A growing number of studies focus on heat, primarily in the urban environment. This risk cascades throughout multiple sectors: from the built environment (buildings), to energy use, and even human health. There are some studies of the potential increase in cooling demand and associated economic costs (increased air conditioning) under warmer climates (noting there are also other studies looking at the reduction in heating demand in cooler climates). Demand for cooling is expected to rise most strongly in South Asia, due to a combination of pre-existing high temperatures, increased warming and rising incomes. In India, for example, annual costs associated with additional demand for cooling could range between US$25 billion and US$100 billion by mid-century, for low- and high-warming scenarios, respectively (Mima *et al*. 2011). In addition, there are studies that look at the costs of alternatives to air conditioning, through passive systems, or building or spatial planning options. While these alternatives offer potential, they do require planned adaptation initiatives.

In OECD countries a recent focus has been on heat-alert health systems to address the potential risks of heat related mortality (especially from heat-waves). Such studies show that heat-alert systems are low-cost, high-benefit interventions; although with high warming, additional measures are needed to reduce residual risks.

SUMMING UP

In summary, the number of estimates of the costs (and benefits) of adaptation are growing. The literature reports increasing numbers of studies for coastal areas, water management, agriculture and the built environment, with additional studies in other areas. However, a concern is the lack of studies focused on the costs of adaptation in sectors such as ecosystems, or industry and services. Moreover, even in sectors where coverage is good, the full range of climate risks and adaptation options is partial, and the number of policy-orientated studies – which include practical application and implementation costs – is low.

Finally, more recent studies are considering the issue of uncertainty by using iterative climate risk management. This reflects a shift in the thinking around how to plan adaptation with uncertainty in mind, and such studies use a different analytical framework and provide a wider set of adaptation options, compared to early, technical and academic studies. What is clear from all these studies is that adaptation has the potential to be extremely beneficial and cost-effective when planned with uncertainty and implementation in mind (Section 2.4).

2.4 WHY COST ESTIMATES DIFFER

A number of factors influence the size of adaptation cost estimates. These factors are summarised below, to contextualise the estimates given in the previous section, and the reasons why they can differ substantially. Additional details are included in the Appendix.

2.4.1 COVERAGE

The costs of adaptation clearly depend on the coverage of sectors and risks. Studies with greater coverage will produce higher estimates, as they include a larger number of impacts. Comprehensive studies at the national level (for example, Ramsbottom *et al*. 2012) identify several hundred potential risks and opportunities from climate change. Nonetheless, most quantitative studies focus on a subset of the most important of these, mainly due to the complexity associated with quantifying and monetising impacts.

Existing estimates capture most of the key sectors, but not all. For example, biodiversity and ecosystem services are omitted and as a result, existing estimates understate the costs of adaptation.

The number and type of risks covered is a further issue. For example, studies focused on the agriculture sector tend to omit cash crops, horticulture and viniculture, and risks from changing pests and disease. Similarly, analyses of coastal zone risks typically cover coastal erosion and flooding, but neglect ocean acidification. The extent to which these omissions underestimate costs is difficult to ascertain. Previous critiques of the existing literature of global studies

have suggested a factor of two-to-three for the sectors considered (Parry *et al*. 2009):

> *We conclude that for coastal protection the factor of under-estimation could be 2 to 3. For infrastructure it may be several times higher, at the lower end of the cost range. For health the 'intervention sets' that were costed related to a disease burden that is approximately 30-50% of the anticipated total burden in low- and middle-income countries (and do not include interventions in high-income countries). Including ecosystems protection could add a further $65-$300 billion per year in costs. Furthermore, estimates are not made for sectors such as mining and manufacturing, energy, the retail and financial sectors and tourism.*

However, there are two additional issues. Firstly, direct climate change can often lead to indirect climate change impacts, which can amplify costs, especially when these lead to competition or constraints (such as with multiple demands for water). These may also include wider economic effects, although trade and market responses can often reduce cost increases.

The second issue relates to autonomous adaptation, as defined in Chapter 1. Most of the literature focuses on planned adaptation and omits autonomous adaptation. Examples of the latter include farm-level adaptation, the additional household energy costs associated with cooling, or adaptation action by the private sector. Including autonomous adaptation in the analysis of the costs of adaptation will increase cost estimates, potentially significantly.

2.4.2 OBJECTIVES AND QUANTIFICATION METHODS

Estimates of the costs of adaptation are influenced by the target, goal or objective chosen, as well as the degree of trade-off between the impacts of climate change, the costs of adaptation, and the residual costs after adaptation. Some studies may set objectives based on economic efficiency (that is, the optimal balance between costs, benefits and residual damages), while others may use levels of acceptable risk, which include a stronger consideration of equity (that is, setting a common protection level above which society considers risks unacceptable). These decisions entail careful consideration and interpretation of global equity concerns and international law provisions, especially when they apply to impacts in developing countries (due to their low responsibility for emissions, but high risks of impacts). These are contentious issues, on which views differ.

The available literature suggests that the choice of objective can lead to a factor of two-to-four difference in cost estimates. In terms of objectives, studies that adopt optimal frameworks produce lower cost estimates, compared to studies that use alternative methods (for example, using acceptable risks).

2.4.3 TIME-SCALES, AND FUTURE GREENHOUSE-GAS EMISSION PATHWAYS

The extent to which greenhouse-gas emissions will be mitigated in the future is unknown. The more emissions

Photo: *© Amir Jina*

are reduced, the less adaptation will be required. Therefore, estimates of the cost of adaptation differ with the assumptions made about future levels of greenhouse-gas emissions. Estimates are higher, even in early years, for higher scenarios of global warming. In addition, estimates of costs will differ with the assumptions made about future trends in socio-economic development. Socio-economic development can reduce future adaptation costs (for example, in situations where current vulnerabilities are reduced and/or adaptive capacities are increased), but it can also increase those costs (for example, as a result of poor planning, or as a consequence of rising asset prices). Similarly, adaptation costs vary strongly with expected economic growth.

2.4.4 UNCERTAINTY

Large uncertainties surround assumptions about the future emissions pathway the world is on – that is, a 2°C or 4°C world. Additional uncertainty arises due to the differences in the outputs of climate models. New approaches are being developed which allow decision-makers to factor these uncertainties into their planning, notably with iterative climate risk management, which encourages early, low-regret options, robustness, flexibility and learning. Instead of focusing on one (or a small number of) possible future projections, and suggesting adaptation strategies that are optimised for those conditions, newer approaches consider a range of plausible future conditions and propose adaptation strategies that can learn and evolve over time. Studies that include the consideration of uncertainty generally have higher costs when compared to studies that ignore it and implement optimal strategies, noting that in practice, the latter will lead to higher costs through maladaptation.

2.4.5 LIMITS OF ADAPTATION

Current estimates of the costs of adaptation assume that adaptation will be unconstrained. They further assume that, in terms of unit costs, adaptation will be similar for low and high global warming scenarios. In practice, however, there will be limits to adaptation (Klein *et al*. 2014), determined by physical and ecological constraints, technological limitations, information and cognitive barriers, and social and cultural barriers. Including these limits in estimates of the costs of adaptation will result in higher values. Not enough evidence is available to determine the extent of the increase, though it could be large.

2.4.6 AGGREGATION

Some studies analyse potential impacts and benefits from climate change, and aggregate the two (reading off residual damages against benefits). Such an approach is misleading, because it assumes that transfers will occur between those impacted by, and those benefiting from, climate change, which is very unlikely to take place in practice. For this reason, studies that allow aggregation are likely to report lower costs of adaptation.

2.4.7 ADAPTATION DEFICIT

The costs of adapting to climate change are determined by the size of the existing adaptation gap – that is, the difference between the costs of adaptation and the financing available to meet them at a given point in time. The costs of bridging this gap may not be considered adaptation, because they overlap to a great extent with developmental activities. However, unless this deficit is overcome first, adaptation will be less effective (Burton 2004). It follows that the estimates from studies that ignore the adaptation deficit are over-optimistic.

2.4.8 ADDITIONAL COST CATEGORIES AND SOFT VERSUS HARD ADAPTATION

Most current studies focus on the technical (engineering) costs of delivering adaptation and overlook opportunity and transaction costs. As a result, the estimates from technical studies are low. This mirrors a similar finding in the climate change mitigation domain, where ex-post cost outcomes were found to be higher than implied by technical (ex-ante) cost curves.

However, alternatives to more costly technical adaptation technologies are available. These include non-technological options that may offer wider co-benefits (Agrawala *et al*. 2011b). They can also include alternative strategies, such as insurance (risk pooling), which can reduce the costs of adaptation. While these alterative adaptation options are often low-cost, implementing them requires certain institutional capacity and mechanisms, which also have a cost.

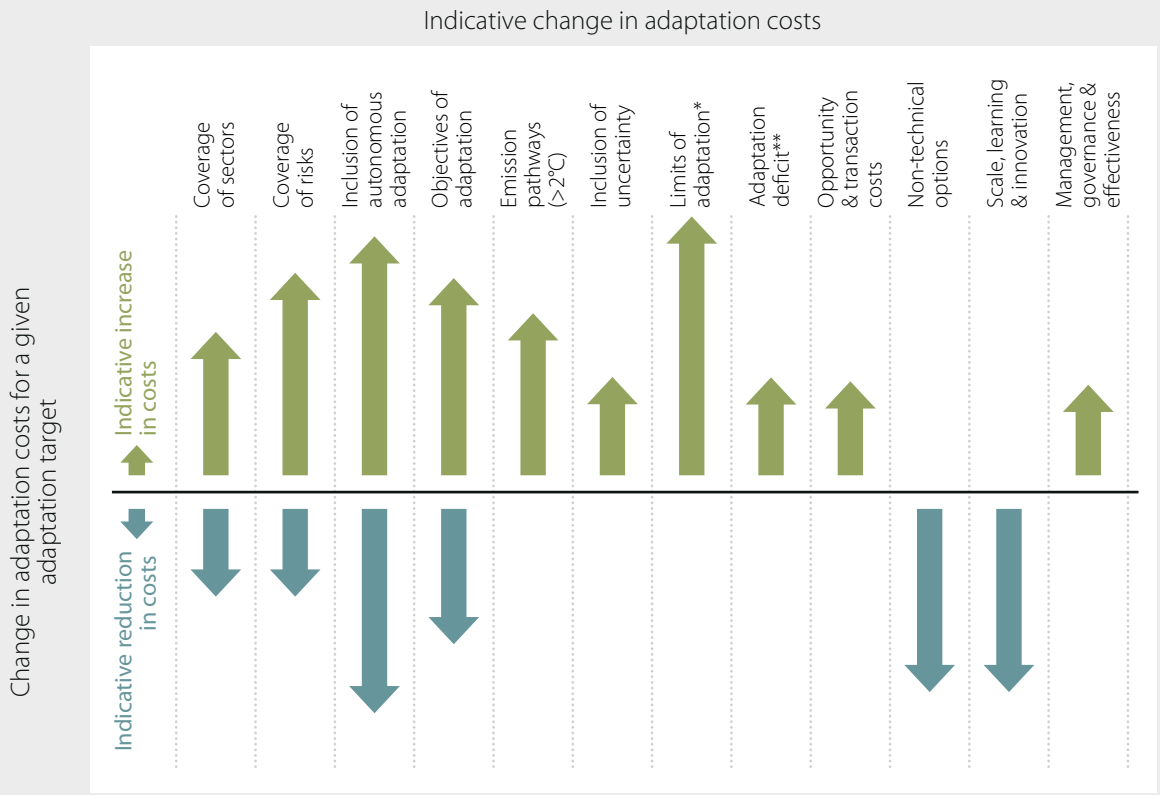
2.4.9 LEARNING, INNOVATION, SCALE AND THE PRIVATE SECTOR

Costs fall with learning and innovation, and with the scale of implementation. In many cases, existing costs can therefore be considered overestimates. However, in areas such as coastal protection and irrigation, adaptation relies on existing technological solutions and practices, where learning and efficiencies of scale have already taken place. Notwithstanding, more effective and innovative delivery of adaptation by the private sector would reduce adaptation costs.

2.4.10 IMPLEMENTATION COSTS AND EFFECTIVENESS

The actual implementation of adaptation (including design, management and execution), as well as the

Figure 2.2: Changes in adaptation costs and residual impacts



* Note that while costs will rise as limits of adaptation are considered, above the limit adaptation is not possible, hence the strong increase in residual costs.

** Costs will be higher if there is a greater adaptation deficit. Note that the costs of addressing the adaptation deficit itself will be much larger.

need for monitoring and reporting, all lead to additional costs that many technical studies ignore. For the least-developed countries, there are also additional governance challenges, which will affect the effectiveness of adaptation. These challenges reduce the benefits, and thus the cost effectiveness, of adaptation, or else require additional costs for management agents or intermediaries to ensure effective delivery.

The latter is important, as many current estimates tend to assume a high level of transferability (that is, options that will show similar effectiveness in very different countries and contexts). However, experience from development economics suggests that this is not the case: insufficient maintenance, lack of finance, and a range of behavioural barriers all reduce effectiveness. As a result, adaptation benefits are lower than anticipated (and residual damage levels are higher).

On the basis of the evidence summarised in the previous paragraphs, Figure 2.2 shows the indicative influence of each individual component on adaptation costs. In each case, a broad range is indicated, because the evidence on the scale of the effect is limited. In practice, the range will vary with each specific study, as a result of both the choices made and the approach adopted.

The combined effect of the various factors above has a large influence on estimates of the costs of adaptation. Indeed, even small or limited changes in only one component can change estimates significantly. For example, both the EACC and UNFCCC studies (Table 2.1) estimated the costs of adaptation in coastal areas and, to do so, both relied on the same model. However, changes in assumptions about unit costs and maintenance costs, and inclusion of port-upgrading costs, resulted in a five-fold difference in the final estimate. Furthermore, even when a conservative choice is used in one area (for example, a strong equity assumption), cost estimates can still be lower if other choices favour lower-cost outcomes.

Studies that include more practical-based assessments report higher adaptation costs. This arises because of the inclusion of implementation costs, but also because these studies tend to include higher warming scenarios, consider uncertainty, and set objectives based on existing standards. Further work to isolate the impact of each individual factor would allow for comparisons across studies. While in principle this is possible, it is challenging to do so in practice (Box 2.1).

Box 2.1: Improving estimates of the costs of adaptation

As outlined in the previous paragraphs, a wide range of factors influence estimates of the costs of adaptation. The following are examples of activities that, if undertaken, would help improve estimates:

- More empirical studies, covering sectors or risks that are currently poorly studied.
- Sensitivity testing and multi-model analyses, and other methods that can help determine how the choice of methods and assumptions affects estimates.
- Ex-post analyses of existing or early adaptation practices, to learn about opportunity, transaction and implementation costs.
- Analyses of the transferability of options, both between locations and in terms of aggregation of impacts.
- Sharing of available information and lessons learnt.

2.5 MOVING TOWARD PRACTICE

While the volume of climate finance, as illustrated in the next chapter, is increasing, it is likely to fall short of potential needs. For this reason, it will be important to ensure that available funds have the greatest possible impact. To this end, and in addition to other goals, such as maximising the number of beneficiaries, prioritising the most vulnerable, or delivering the highest value for money, prioritising adaptation will be of the utmost importance.

Prioritisation of adaptation involves some major challenges, not least due to the profile of cost and benefits over time, especially for planned adaptation. In addition, the high level of uncertainty surrounding adaptation makes choosing the exact form of intervention difficult, while potential benefits are highly site- and context-specific.

Reflecting these challenges, in recent years the framing of adaptation has shifted toward early-implementation practices (ECONADAPT 2015). Firstly, there has been a move toward a policy-orientated approach for assessing adaptation, in which the objectives are framed around key problems. This adaptation assessment approach contrasts with traditional science-first, impact-assessment approaches. Secondly, greater emphasis is being put on integrating adaptation into current policy and development, rather than treating adaptation as a stand-alone activity. This process is often referred to as mainstreaming (integration). Thirdly, there has been a move to consider the phasing and timing of adaptation, due to an increasing recognition of uncertainty. This has translated into different types of adaptation interventions, addressing current climate variability and future climate change, undertaken within the framework of iterative climate risk management and decision-making under uncertainty.[6]

As a result, greater emphasis is increasingly being put on early adaptation actions, low-regret options, capacity building, and options that build-in flexibility and robustness for long-term decisions, complemented with early planning for major future risks (with research, monitoring and learning). A key implication of this is that there is a need for studies of the costs of adaptation to focus on the above aspects, and to provide information that helps prioritise, and implement, adaptation actions.

6 For further details, the reader is referred to the Appendix.

Photo: © Anouk Delafortrie (EC-ECHO)


03

CHAPTER 3

ADAPTATION FINANCE

LEAD AUTHORS
CHIARA TRABACCHI (CLIMATE POLICY INITIATIVE), GISELA CAMPILLO (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT), STEPHANIE OCKENDEN (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT)

CONTRIBUTING AUTHORS (alphabetical)
ILARIA GALLO (UNITED NATIONS INSTITUTE FOR TRAINING AND RESEARCH), PRADEEP KURUKULASURIYA (UNITED NATIONS DEVELOPMENT PROGRAMME), JOANNE MANDA (UNITED NATIONS DEVELOPMENT PROGRAMME), ANGUS MACKAY (UNITED NATIONS INSTITUTE FOR TRAINING AND RESEARCH), MARIANA MIRABILE (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT), CHARLENE WATSON (OVERSEAS DEVELOPMENT INSTITUTE)

Photo: *© Vicki Francis (DFID)*

KEY FINDINGS

- In 2014, international public finance for climate change adaptation amounted to at least US$25 billion globally, of which US$22.5 billion were directed to developing countries. This represents a marginal increase compared to 2013, but a continued increase since 2010.
- A proper measurement, tracking, and reporting system of adaptation investments is indispensable to ensure that finance is used efficiently and targeted where it is most needed. Progress has been made with regard to harmonising concepts and accounting practices, as well as understanding the links between public and private finance. Nonetheless, further improvements are needed, including (i) increasing efforts to further enhance comparability across different financial flows; and (ii) evaluating the effect of development interventions that, while having a different primary goal, bring adaptation co-benefits.

3.1 INTRODUCTION

Adaptation finance is a central element to the international response to climate change, as recognised in many decisions by the CoP to the UNFCCC. Comprehensive and up-to-date information about finance flows, based on internationally agreed methodologies, is essential to inform national adaptation policy, and support investment decisions. However, at present this information is only partially available.

This chapter synthesises available information on financing flows for adaptation, while highlighting data gaps. The remainder of the chapter is structured around two sections: a description of the quantitative evidence available regarding adaptation finance, and an overview of opportunities for scaling-up adaptation finance and improving finance flow tracking systems.

Furthermore, it is worth recalling that the UNFCCC articulates its finance commitment (US$100 billion annually by 2020, to be increased after 2025) without specifying the share that public or private actors are expected to provide. For this reason, the estimates presented in this chapter should be interpreted in a broad sense, rather than simply compared against the UNFCCC finance commitment (Box 3.1).

Box 3.1: Progress toward meeting the US$100 billion finance commitment

The UNFCCC has called on its developed country parties to provide US$100 billion annually by 2020 for climate action in developing countries. However, there is no agreement as to the type of funding that shall be mobilised to meet this goal, and financing is expected to come from "…a wide variety of sources, public and private, bilateral and multilateral, including alternative sources" (UNFCCC 2010). This uncertainty has hampered efforts to monitor progress toward meeting the goal, despite recent efforts to improve tracking for climate finance.

A 2015 assessment entitled *Climate finance in 2013-14 and the US$100 billion goal* by the OECD reported that climate finance volumes flowing from developed to developing countries that might qualify to meet the US$100 billion goal amounted to an annual average of US$57 billion in the period between 2013 and 2014 (OECD 2015a). Of this, about US$9.3 billion was directed to adaptation, and a further US$3.7 billion was directed to dual adaptation-mitigation projects (OECD 2015a).

Public climate finance provided by donor governments accounts for the majority of the US$9.3 billion. However, it also incorporates public financial interventions from developed countries that have mobilised private funding for climate-related projects (OECD 2015a). Of the small fraction of private sector finance that can be tracked today, less than ten per cent is directed to climate change adaptation.

Adaptation Finance in the Paris Agreement

The Paris Agreement contains three provisions that are of particular relevance to adaptation finance. Firstly, the agreement urges developed countries to "significantly increase adaptation finance from current levels". Secondly, in an effort to advance toward an agreed definition of what qualifies as climate finance under the UNFCCC, the Agreement requested one of the convention's subsidiary bodies to develop modalities for the accounting of financial resources provided and mobilised through public interventions. Such an effort is expected to increase the accountability of financial pledges for climate change. Thirdly, the agreement renews, from the highest level, the political commitment for a (low-carbon and) climate-resilient economy. In doing so, it strengthens the position of first-mover investors and financiers, and represents a call to action for laggards.

3.2 AN OVERVIEW OF ADAPTATION FINANCE LEVELS AND TRENDS

This section presents the most up-to-date estimates of public financial flows directed to reducing vulnerability to climate change. This includes activities ranging from information and knowledge generation, to development of human and institutional capacities, to planning and implementation of climate change adaptation actions.[7]

Beyond certain commitments by national DFIs, no consistent figures are available documenting public sector budgets for domestic adaptation action. This is due to the lack of systematic tracking and difficulties associated with attributing adaptation functions to national or local budgets which, while performing those functions, may also serve other purposes and may have been approved on developmental grounds.

Similarly, no data are available on private sector financing for adaptation. This is because investment databases lack the contextual information needed to identify whether an investment has any relevance to adaptation. Not least, while households and corporations do engage in adaptation activities – most likely as a reaction to observed impacts, rather than as a forward-looking strategy aimed at anticipating projected changes – they do not typically label their actions as adaptation, because they tend to consider climate risk as part of their broader risk management processes (Averchenkova *et al*. 2015).

In short, the estimates presented in this chapter underestimate the volume of finance flowing to adaptation by an unknown amount, corresponding to the volumes of both public financing for domestic adaptation, and private sector financing for both domestic and international adaptation. The volumes of finance that are tracked, and presented in the chapter, correspond to commitments by the following providers of climate finance:

- Development finance institutions: multi-lateral, bilateral, national and sub-national development banks.
- Governments and their bilateral aid agencies, as recorded in the creditor reporting system, administered by the OECD's Development Assistance Committee (DAC).[8]
- Dedicated climate change funds.

3.2.1 PUBLIC ADAPTATION FINANCE FLOWS

Globally, public adaptation finance amounted to between US$23 billion and US$26 billion in 2014, or US$25 billion globally on average (Buchner *et al*. 2015). This accounts for 17 per cent of all public climate finance committed in 2014. About US$22.5 billion (90 per cent of the total US$25 billion) was directed to developing countries.

Adaptation finance volumes have been increasing since 2010, the first year for which data are available (Figure 3.1).[9] The amount is similar to that of 2013, but still represents an increase in adaptation-related bilateral development finance.

7 For details on definitions the reader is referred to the following sources: IDFC-MDBs (2015), IDFC (2014), UNFCCC (2014) and OECD (2011).

8 The creditor reporting system inventories adaptation finance flows from bilateral donors (irrespective of whether or not they are members of the OECD's DAC), multilateral organisations, and specialised climate change funds. The coverage of climate funds is not comprehensive. Additional details are available online at: http://www.oecd.org/development/stats/rioconventions.htm.

9 The OECD Rio marker for adaptation was introduced in 2010. Buchner *et al*. (2011) represents the first attempt at summarising climate finance flows. Data from multi-lateral development banks was first collated in 2012.

Methodology

The adaptation finance flows documented in this section refer to annual financial commitments made in the latest available year.[10] The estimates presented are drawn from the Climate Policy Initiative's Global Landscape of Climate Finance (Buchner *et al.* 2015), and the Organisation for Economic Co-operation and Development's (OECD) databases.[11]

In 2014, climate change-related ODA accounted for 19 per cent of overall ODA, increasing from five per cent in 2005. The share of adaptation-related ODA to overall ODA grew from 7 per cent in 2010 to 10 per cent in 2014.

10 We draw primarily on Buchner *et al.* (2015), which uses a mix of 2013 and 2014 data, depending on data availability at the time the report was prepared. However, for simplicity, we label the most recent estimates as 2014, even when some of the figures making up the aggregated estimate refer to 2013.

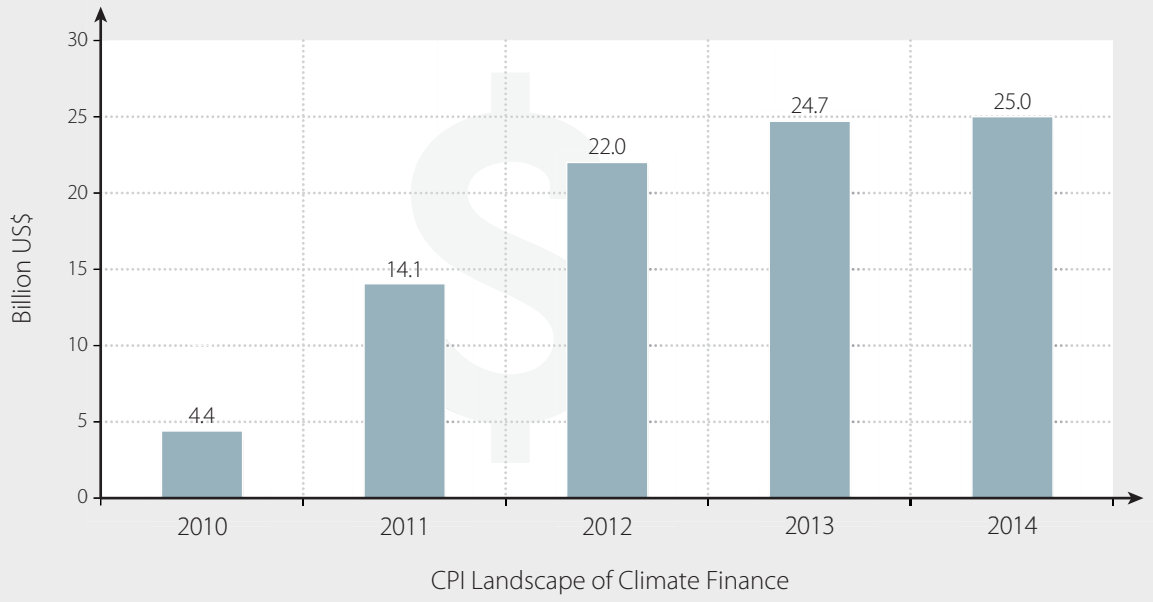
11 For additional details, the reader is referred to Buchner *et al.* (2015), which contains a full description of the methodology. The methodology relies on the tracking standards and reporting approaches used by the members of the OECD's DAC, the group of multi-lateral banks that report jointly on climate change finance volumes, the members of the International Development Finance Club, and the various funds dedicated to climate change.

3.2.2 KEY SOURCES OF INTERNATIONAL PUBLIC ADAPTATION FINANCE

Multilateral, bilateral, and domestic DFIs provided US$21 billion of the US$25 billion total of adaptation finance for both developed and developing countries. Direct public contributions from governments, ministries, and bilateral agencies made up an additional US$3 billion, whereas dedicated climate funds provided another US$1 billion (see Box 3.2) (Buchner *et al*. 2015). In 2014, adaptation-related bilateral ODA financing reached US$12.4 billion, with over two-thirds of this amount having adaptation as a significant objective (Figure 3.2).[12] Most of these sums are invested directly in projects, as opposed, for example, to sector-

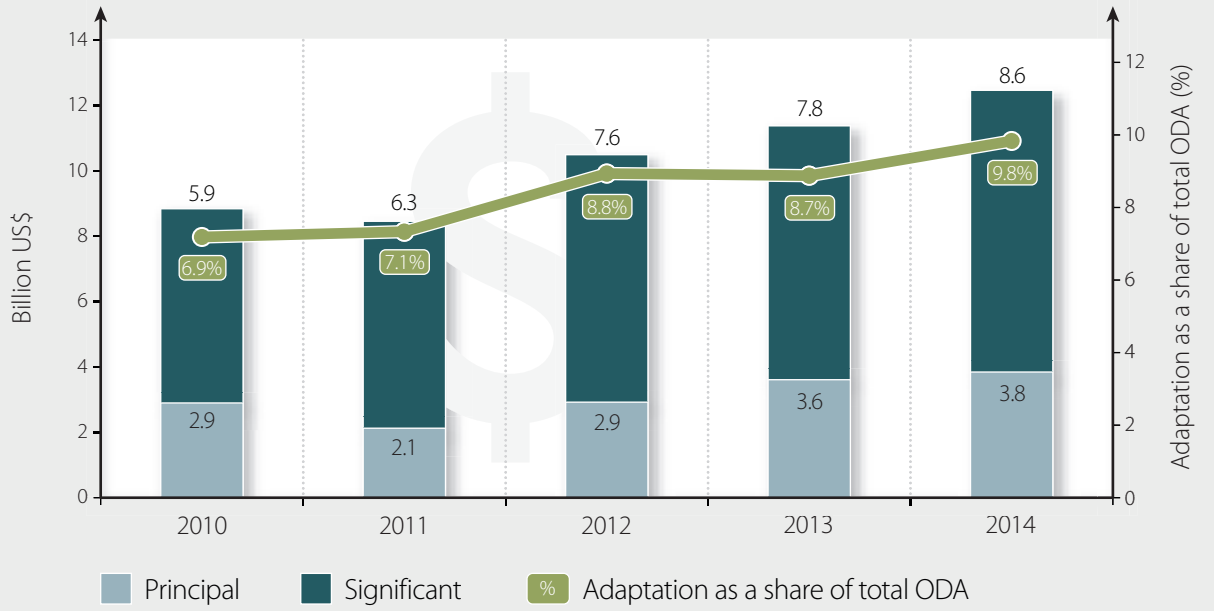
12 This figure includes commitments from bilateral DFIs such as France's AFD, Germany's KfW, and Japan's JICA. To avoid double counting, in CPI's estimates above these commitments are netted out as tracked under the DFIs category.

Figure 3.1: Global international adaptation-related public finance



Source: Buchner *et al.* (2015)

Figure 3.2: Adaptation-related bilateral ODA of DAC members



Source: based on OECD (2015b)

budget support. The European Union, France, Germany, Japan and the United States are the main providers of official development assistance for climate change adaptation.

It is worth noting that DFIs, bilateral donors and specialised climate change funds provide financing for activities that have adaptation co-benefits, even though this is not the primary goal of these activities. Examples of these are projects aimed at supporting climate change mitigation, disaster-risk reduction, or ecosystem-based services. The trade-offs and synergies between the adaptation objectives and the primary goal of these activities remain poorly understood (IPCC 2014), and adaptation co-benefits derived from financing other development activities remain unknown. This has implications for current estimations of international public finance flows for adaptation, as the inability to capture financing for co-benefits could lead to underestimation.

3.2.3 KEY INSTRUMENTS CHANNELLING INTERNATIONAL PUBLIC ADAPTATION FINANCE

In 2014, for both developed and developing countries, public actors extended US$18 billion out of a total of US$25 billion directed to climate change adaptation (in the form of low-cost loans, including concessional loans, and grants). Market-rate loans accounted for most of the rest. Table 3.1 gives a summary of key instruments, by source.

In addition to established instruments, such as loans and grants, new financing approaches are emerging to channel international public adaptation finance, as the following two illustrative examples show:

- In 2015, with financing from the Pilot Programme for Climate Resilience, the European Bank for Reconstruction

Table 3.1: Adaptation finance sources and instruments

Sources	Main instrument (share of total)
Official development assistance	Grants (66 per cent) and loans (32 per cent)
Bilateral development finance institutions	Low-cost loans (80 per cent)
Multi-lateral development finance institutions[13]	Market-rate loans (84 per cent)

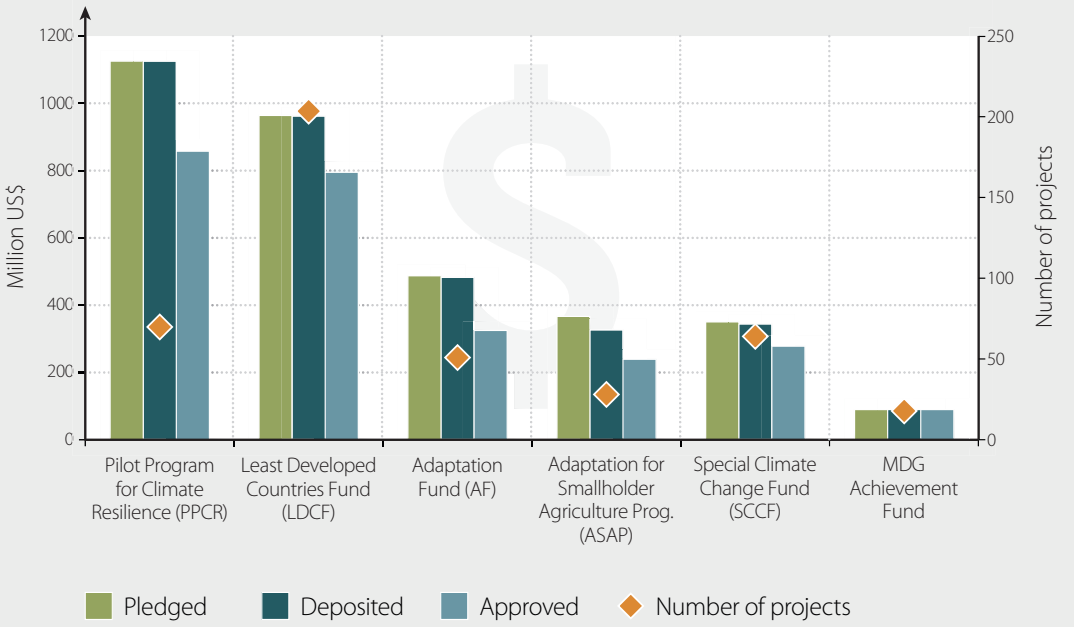
13 Multilateral DFIs often combine their loans with concessional financing, including from dedicated climate change funds.

Box 3.2: Dedicated adaptation funds

Dedicated climate change funds provide finance in the form of grants, loans or other instruments at more advantageous terms than those provided by commercial lenders or DFIs. This is one of the features that allow climate change funds to support multi-lateral development banks, as well as other implementing entities, with regard to breaking down financial and non-financial barriers that deter investment in climate change adaptation.

Adaptation is the focus of six climate change funds (Figure 3.3). At present, the US$1.2 billion Pilot Programme for Climate Resilience and the almost US$1 billion Least Developed Countries Fund are the largest among these adaptation-targeted climate funds.[14]

Figure 3.3: Adaptation-dedicated climate funds



Source: based on ODI (2016)

To date, a total of 76 per cent of the resources pledged to adaptation-dedicated funds have been approved for disbursement (ODI 2016). Disbursement rates vary depending on factors such as (i) time-lags associated with fund programming procedures, (ii) difficulties in developing project pipelines, and (iii) limited absorptive capacity in recipient country government agencies.[15] Overall, funds' financial commitments to projects have increased over the period between 2011 and 2014 (Buchner *et al*. 2015).

The Green Climate Fund (not pictured in Figure 3.3) entered into operation recently. Given its stated goal of seeking a balanced allocation of resources between adaptation- and mitigation-focused activities, this fund is expected to play a significant role in adaptation funding in coming years. In late 2015, the fund approved about US$109 million for four adaptation projects out of a total of US$168 million in funding—in other words, nearly 65 per cent of total funding from the Green Climate Fund (GCF) has been approved for adaptation. In February 2016, it set up the aspirational target of investing US$2.5 billion during 2016 (for both mitigation and/or adaptation projects).[16]

Concerns have been raised about the need for climate funds to improve the timeliness and completeness of their reporting. For example, a recent analysis of climate funds found that, of five adaptation-focused funds reviewed, two had not reported on whether or not they had achieved their expected results, whereas the other three reported underperformance against their expected results (ODI and HBS 2015).

14 Thus far the Pilot Programme for Climate Resilience has focused on integrating adaptation into national development planning, and supporting business models that promote private sector engagement in adaptation projects. The Least Developed Countries Fund has helped to fund the preparation of National Adaptation Programmes of Action, among other adaptation projects.

15 Data availability from each fund will also affect the apparent rate at which finance is approved, as funds report on different timescales.

16 Press release available online: http://www.greenclimate.fund/documents/20182/38417/Green_Climate_Fund_approves_first_8_investments.pdf/679227c6-c037-4b50-9636-fec1cd7e8588

and Development launched a climate resilience financing facility. The facility works with local financial institutions to provide adaptation financing worth US$10 million to Tajik households, businesses and farmers.

- In 2014, during its first cycle, the Global Lab for Climate Finance crowdsourced over thirty innovative adaptation finance concepts.[17] In 2015, three concepts were further developed. They concern the issuance of water bonds as a means of managing water infrastructure in water-stressed regions, and the provision of data and analysis for improving farmers' access to finance for climate-smart agriculture investments, and to increase climate resilience by facilitating the penetration of insurance.

17 For further details the reader is referred to the Global Lab for Climate Finance's website (climatefinancelab.org), and Trabacchi and Mazza (2015), which presents the Agricultural Supply Chain Adaptation Facility that the Lab endorsed.

3.2.4 SECTORAL USES AND GEOGRAPHICAL DISTRIBUTION OF INTERNATIONAL PUBLIC ADAPTATION FINANCE

In 2014, water and wastewater management projects attracted about half of the total volume of (tracked) international public adaptation finance provided that year. The agriculture and land-use sector followed with an average of US$3 billion. Water, wastewater and agriculture were among the most commonly prioritised sectors in the NDCs prepared by parties to the UNFCCC (UNEP 2015).

In 2014, about 90 per cent of all international public adaptation finance was allocated to non-OECD countries. The regions that benefitted the most were East Asia and the Pacific (46 per cent of the total), sub-Saharan Africa (14 per cent), Latin America and the Caribbean (12 per cent), and South Asia (9 per cent). In the same year, the top recipients of adaptation-related bilateral ODA were India, Myanmar, the Philippines, and Vietnam.

Photo: *© Johannes Carolus*

3.3 TRACKING ADAPTATION FINANCE

Over the past ten years, significant progress has been made in tracking international adaptation finance. Three achievements deserve particular attention: increased data comparability, improved data accessibility, and expanded knowledge on the linkages between public and private finance.

3.3.1 INCREASED DATA COMPARABILITY

Accounting and reporting methodologies are increasingly being harmonised, thereby ensuring greater comparability across data from different institutions. The common principles for tracking adaptation finance, agreed by a range of international, regional and national financial institutions, are central to this endeavour (IDFC-MDB 2015).[18] Not least, in April 2016, the OECD adopted an improved definition of the Rio Marker for tracking bilateral ODA targeting adaptation.[19] This updated version, included in the revised statistical reporting directives of the OECD DAC, is complemented by a guidance table, with examples of eligibility criteria for every sector and detailed guidance on how to use the marker.

3.3.2 IMPROVED DATA ACCESSIBILITY

The creditor reporting system, administered by the OECD's DAC, is contributing to improving the accessibility of data on international adaptation finance.[20] The system brings together data from 24 OECD countries (out of a total of 32 countries), a range of multi-lateral development banks, and most multi-lateral climate change funds, totalling 17 institutions. In addition, it currently gathers (mitigation and) adaptation financial flows, and data on official development flows (non-official development assistance) for eight countries and the European Union institutions.

3.3.3 EXPANDED KNOWLEDGE ON THE LINKAGES BETWEEN PUBLIC AND PRIVATE FINANCE

In an effort to better understand how public funds can help mobilise private financing for adaptation, a number of bilateral and multi-lateral DFIs have begun to collect and report estimates of the amounts of private finance raised through their operations.[21] Drawing on this information, the OECD and the Climate Policy Initiative are outlining a methodology for estimating private-sector finance flows mobilised by developed country, public sector-funded interventions in developing countries (Brown *et al*. 2015). The GCF also looks at private finance mobilised through their operations.

Notwithstanding the efforts described above, major impediments stand in the way of comprehensive tracking of adaptation finance. The close linkages between adaptation finance and development finance represent one such impediment: most adaptation actions rarely represent stand-alone interventions, as they are typically integrated into broader public or private sector operations. For this reason, identifying and classifying investments is challenging.[22]

As noted earlier, very little quantitative information is available regarding public sector funding for domestic adaptation, and private sector financing for adaptation. These data gaps prevent us from obtaining a fuller picture of adaptation finance flows.

The volume of public sector finance directed to domestic adaptation measures is unknown, both in developed and developing countries (see Box 3.3). A series of national studies highlight that, in developing countries, the share of the public sector's budget allocated to adaptation ranges between nil and 13 per cent (CPEIR 2015).[23] These and other studies show that domestic spending on climate change tends to be much higher for adaptation than for mitigation (World Bank 2012, Bird 2014).

Only indirect evidence is available concerning the volume of private sector financing for adaptation. For example, recent multi-lateral development-bank investments in support of private adaptation worth US$270 million made 26 private sector projects (with a total value of US$5.5 billion) more climate resilient (Vivid Economics 2015).

18 Complementing this effort, a larger number of financial institutions have adopted five voluntary principles, with the aim of further integrating climate change concerns into their project portfolios (World Bank 2015).

19 This definition is aligned with the joint tracking methodology used by multi-lateral development banks and the International Development Finance Club.

20 It is worth noting that, over the years, the system has improved in terms of data quality and coverage.

21 Private co-finance at the project level is the proxy used by most financial institutions to estimate the level of private sector finance mobilised with public sector financing. The reader is referred to, for example, Brown *et al*. (2015), IDFC-MDBs (2015), and Stumhofer *et al*. (2015).

22 This leads to under-reporting of the level of financing that influences adaptation. Nonetheless, over-reporting has also been observed (Terpstra *et al*. 2013).

23 The studies, dubbed climate public expenditure reviews, were conducted by the United Nations Development Programme. For each country, the studies provide three-year averages for the latest set of three contiguous data points available.

Box 3.3: Public sector funding for domestic adaptation in developed countries

Most developed countries take an integrated approach to adaptation and only a few earmark funds for adaptation-specific activities (Mullan *et al*. 2013). Earmarked budgets are primarily used for enhancing the enabling environment for adaptation, rather than implementing specific adaptation measures. For example, France has estimated that EUR 171 million (US$190 million) will be required to implement the national adaptation plan, whereas Canada has set aside CAD 149 million (US$114 million) for the period from 2011 to 2016 (OECD 2015c). Exceptions to this are, for instance, the European Union's financial instrument for the environment, which makes available co-financing worth EUR 190 million (US$215 million) for adaptation-specific activities in the period between 2014 and 2020, or the disaster-risk reduction funds operating in Japan and Mexico, among other countries.

Public sector budgets can be used to mobilise additional private sector financing for adaptation. Key mechanisms for doing so include:

- Adjusting regulatory frameworks, to create stronger incentives for private sector engagement.
- Giving businesses access to the information and tools they need to integrate adaptation into investment decisions.
- Integrating climate change considerations into the financial system.
- Demonstrating approaches, to create a track record that helps increase market confidence and, therefore, encourage investment.

04

CHAPTER 4

PRIVATE SECTOR FINANCE FOR ADAPTATION

LEAD AUTHORS
AARON ATTERIDGE (STOCKHOLM ENVIRONMENT INSTITUTE), PIETER PAUW (GERMAN DEVELOPMENT INSTITUTE), PIETER TERPSTRA (NETHERLANDS MINISTRY OF FOREIGN AFFAIRS)

CONTRIBUTING AUTHORS (alphabetical)
FABIO BEDINI (WORLD FOOD PROGRAMME), LORENZO BOSSI (WORLD FOOD PROGRAMME), CECILIA COSTELLA (WORLD FOOD PROGRAMME)

Photo: *© Stuart Price (AMISOM)*

KEY FINDINGS

- Assessing the extent to which private sector financing contributes to increasing resilience in developing countries is challenging because (i) data are scarce, (ii) the effectiveness of private sector investments is unclear, and (iii) the extent to which private sector finance incentivises maladaptation is unknown.
- There are indications that, perhaps with the exception of remittances, the international private sector is unlikely to be a major source of adaptation finance in the most vulnerable countries. In these countries the emphasis should be on strengthening the domestic private sector, as this sector is often dependent upon resources that are vulnerable to climate change.
- Remittances are an increasingly important source of external finance in many developing countries, and could play an important role in supporting household-level adaptation.
- International public finance can help mobilise domestic private investment in developing countries, provided that the right incentives and policies are introduced.

4.1 INTRODUCTION

An emphasis on private finance has emerged in climate finance discussions, particularly in the context of international climate change negotiations. This is partly because the overall volume of finance needed to support adaptation in developing countries (Chapter 2) is beyond what many expect public finance to be able to contribute.

Despite this emphasis, the depth of empirical analysis on the contribution of private finance to adaptation outcomes is limited (Surminsky 2013, Pauw *et al*. 2015). The growing body of literature on this issue covers four main areas:

- Assessments that seek to identify, and even quantify, private investment relevant to climate change (Buchner *et al*. 2015, Brown *et al*. 2015).[24]
- Reviews of experiences by multi-lateral development banks providing finance to the private sector for adaptation-related expenditure (Vivid Economics 2015, Eurodad 2015).
- Assessments of private financing for adaptation-relevant concepts, such as climate-proofing (UNEPFI 2014) or resilience (Trabacchi and Mazza 2015).[25]
- Descriptions of cases in which the private sector provides financing for adaptation, such as the UNFCCC Private Sector Initiative (Pauw *et al*. 2015).

The literature does not allow for a proper definition of the private sector's contribution to the financing of, and expenditure on, adaptation-related outcomes. In light of this, the goal of this chapter is to outline issues of relevance when considering the prospects of private sector financing for adaptation in developing countries (Box 4.1).

The chapter considers private sector financing for adaptation in general, as opposed to a narrower focus on the extent to which the private sector contributes to meeting international climate finance goals.[26] Not least, it is important to note from the outset the sensitivities that frame any discussion of the contribution of private sector finance to adaptation in developing countries:

- The emphasis on private sector finance is dominant in neoliberal (often Western) political economies. However, countries and communities with different political economies might have other perspectives as to what level and type of private investment is desirable and appropriate. Stated differently, the concept that mobilising private sector financing for adaptation is a goal may not be shared by all.
- Bridging the adaptation finance gap is not only a question of mobilising more resources: discussions about both public and private sector finance should be set against a background of effective delivery. In other words, it matters how finance connects with the priorities and

24 These studies underline the difficulties in defining what constitutes adaptation-relevant finance.

25 Notwithstanding the usefulness of these efforts, they represent narrow proxies for assessing the extent to which the private sector can help bridge the adaptation finance gap.

26 Specifically, the developed countries' pledge under the United Nations Framework Convention on Climate Change to mobilise US$100 billion in climate finance annually by 2020, to support developing countries with adaptation and mitigation.

Box 4.1: Key challenges in assessing private sector financing for adaptation

Unlike bilateral and multi-lateral donors, who have to report on their adaptation-related investments, the private sector has no obligation to do so. For this reason, data on financial transactions involving the private sector generally tend to be unavailable. Therefore, the scant data collected in commercial databases understates the actual level of private sector financing for adaptation (Agrawala *et al*. 2011, Pauw 2015).

Private investments in adaptation can create public benefits. However, the private sector is not accountable for creating them. As a result, the extent to which private sector financing for adaptation is delivered effectively, and how it affects regulatory efficiency and distributional equity, is unclear. Public sector expenditure for adaptation outcomes can help increase the accountability of private sector financing for adaptation, by creating enabling conditions that incentivise the right kind of private sector investment.

While some (private sector) finance flows may support adaptation priorities, other flows may erode community resilience and reduce adaptive capacity. Identifying the latter is particularly relevant in the case of private sector investments, due to the lack of accountability mentioned above, as well as for informing public responses and frameworks for private action.

needs of recipient countries and communities, and how lasting the outcomes are.

At present, the debate about private financing for adaptation focuses on climate-proofing in the infrastructure, water and agriculture sectors. Such a focus on responding to impacts is arguably too narrow, and neglects key pre-conditions for adaptation, notably those related to human health and ecosystem resilience. For this reason, further consideration of the private sector's potential to facilitate investment at scale in such public goods is warranted.

The remainder of the chapter is structured around two sections. The first section summarises the information available regarding private sector financing for adaptation in developing countries, with a focus on climate bonds, remittances and domestic private investment. The second section outlines financial and non-financial tools that can be used to mobilise private sector financing for adaptation in developing countries.

4.2 EVIDENCE ABOUT PRIVATE SECTOR FINANCING FOR ADAPTATION

In addition to ODA, foreign direct investment, portfolio equity, private debt, and remittances make up the largest components of financial inflows to developing countries.[27] Although there are no quantitative estimates of the adaptation-relevance of these flows (Chapter 3), there are some indications of their potential relevance as outlined in the following paragraphs.

4.2.1 CLIMATE BONDS

Over the last decade interest has grown in using bonds to raise capital specifically for climate change and environmental objectives – climate bonds, and green bonds, respectively. Bonds can raise capital for either private or public expenditure, depending on who issues the bonds in the market. It is estimated that 4.3 per cent of the US$65.9 billion outstanding green bonds are linked to climate adaptation projects (CBI 2015), while a

27 Least-developed countries generally receive very little foreign direct investment, equity, debt and remittances. In per-capita terms, upper-middle income countries receive substantially more foreign direct investment, and public and private debt, compared to all other countries.

larger percentage are in sectors that may be relevant for adaptation.[28]

At present, there are no international standards for delineating green bonds from other bonds, and questions have been raised as to whether the apparent rapid growth in green bond finance actually generates new capital for green investments, or instead reflects a re-labelling of traditional bonds and investments. Further analysis is therefore needed to properly explore the potential of the bond market to substantially contribute new capital to adaptation investment flows in developing countries.

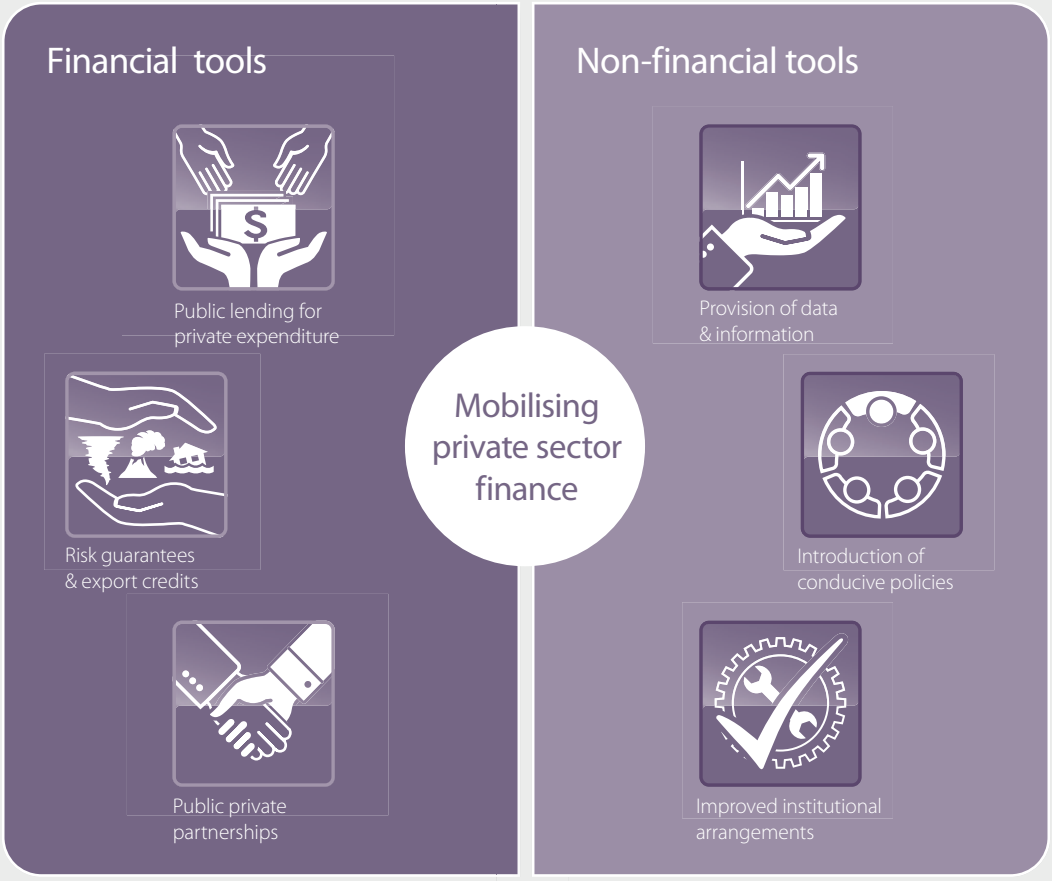
28 For example, local governments in the United States have issued green bonds for investment in water management. Among other interventions, these bonds finance the widening of storm water tunnels and more efficient waste-water treatment (CBI, 2015).

4.2.2 REMITTANCES

The value of remittances to developing countries is expected to increase to US$516 billion in 2016 (World Bank 2015). This is roughly 3.5 times the size of total ODA flowing to developing countries in 2015 (OECD 2016), illustrating the importance of remittances for developing countries' economy, for individual households, and for small businesses and entrepreneurs. Remittances may be valuable from an adaptation-perspective because they tend to increase, for instance, in the case of catastrophic weather events, natural disasters or economic crises in the migrants' country of origin. Furthermore, remittances reach households directly, including those in remote and vulnerable areas, more so than public finance flows (Bendandi and Pauw 2016).

Remittances can help fund adaptation-related investments ranging from short-term priorities, such as irrigation equipment, to longer-term goals related to health and education. For example, in water-stressed communities in the Himalayas, remittances can be an important source

Figure 4.1: Tools for mobilising private sector financing for adaptation



of finance for meeting basic household needs, including following disaster events (Banerjee 2011).

4.2.3 DOMESTIC PRIVATE INVESTMENT

There is little empirical evidence about the extent to which domestic private investment finances climate change adaptation. In developing countries, micro- and small-enterprises, and informal businesses provide the largest contribution to GDP (Dalberg 2011). Many of these enterprises are active in sectors that are sensitive to climate change, notably agriculture (World Bank 2012)[29]. Therefore, when engaging the private sector in adaptation, particular attention should be paid to micro- and small-enterprises. Investments in adaptation by these companies can directly contribute to strengthening community resilience (Dougherty-Choux *et al.* 2015).

4.3 MOBILISING PRIVATE SECTOR FINANCING FOR ADAPTATION

Interventions by donors, DFIs, bilateral agencies and governments can help to lower barriers (Box 4.2) to private sector financing for adaptation (Chapter 3). Broadly, these interventions can be classified as either non-financial or financial.

4.3.1 NON-FINANCIAL INTERVENTIONS

Non-financial interventions are policies and regulations that influence both investment conditions, and the specific kinds of

29 Micro- and small-enterprises are particularly affected by disasters, and many go bankrupt after a natural disaster, because they lack the financial means to face the costs of it (UNISDR 2013, UNDP 2013).

Box 4.2: Barriers to private sector financing for adaptation

Private sector financing for adaptation faces many of the same generic barriers to private sector investment in developing countries, which climate change could magnify. In addition, it faces barriers that are specific to adaptation to climate change:

- **Long-term planning needs.** The long time-scales and uncertainties inherent in climate change are at odds with the much shorter time horizons within which most businesses operate when making investment decisions (Danielson and Scott 2006).
- **Unclear costs and benefits.** While adaptation is often framed as a measure to reduce future costs, businesses tend to invest in actions that promote expansion and increase revenue, rather than in cost-saving measures (UNEPFI 2014).
- **Limited autonomous earning power.** Some kinds of adaptation, such as infrastructure projects, may offer limited autonomous earning power for the investor, which is a barrier particularly for attracting equity (UNEPFI 2014).
- **Social and cultural barriers.** Adaptation is essentially a social change process, and social and cultural factors may resist change, as evidenced, for instance, in the context of community adaptation to extreme weather events (IFRC 2014).

These kinds of barriers are especially challenging for small- and medium-sized enterprises, whose ability to understand the implications of climate change is limited, compared to that of larger businesses (Stenek *et al.* 2013, Ballard *et al.* 2013). In addition, small- and medium-sized enterprises have more limited access to finance, and even shorter planning horizons.

investments that are incentivised. Examples include (see also Stenek *et al.* 2013):

- **Provision of data and information.** The private sector is unlikely to invest in climate and hydrological data, or in decision-support tools for climate change-related risks, as these are often perceived as public goods.
- **Improved institutional arrangements.** Ensuring appropriate coordination among public agencies, and nurturing public-private partnerships that facilitate implementation can foster private sector engagement.
- **Introduction of conducive policies.** These include, for example, inducements such as technical standards or local zoning regulations that take into account changing climate risks, or financial incentives for adaptation-relevant technologies and practices.

Another important role for the public sector is to remove those policies that potentially create maladaptation. For instance, low water prices can lead to over-extraction and make investments in drip-irrigation unattractive (IFC and EBRD 2013).

4.3.2 FINANCIAL INTERVENTIONS

To shift private sector finance towards adaptation, public actors can rely on three main financial interventions: public lending, risk guarantees and export credits, and public-private partnerships (with a specific financial focus).[30] These are described in the following paragraphs, which complement the findings presented in Chapter 3.

PUBLIC LENDING FOR PRIVATE EXPENDITURE

Of all providers of international climate finance, only multi-lateral development banks report on the level of support provided directly to private sector recipients (IDFC-MDB 2015). These data reveal two interesting patterns. Firstly, while roughly one-third of the multi-lateral development banks' overall climate finance in 2014 was borrowed or received by private actors, less than 3 per cent of the US$5 billion spent in adaptation finance went to private recipients. Secondly, although approximately 30 per cent of all multi-lateral development bank adaptation finance went to LDCs and SIDS, only a tiny fraction of this (US$3 million) went directly to private recipients.

Directing public finance towards private recipients does not necessarily ensure good or diverse adaptation outcomes in all sectors, or with all types of private actors. For example, an analysis of development finance institutions and climate funds that provide private finance argues that (i) they tend to focus on large projects, often involving foreign corporations, and (ii) they deploy a wide array of tools to support private companies, but most do not reach the informal economy, and are frequently inadequate for supporting micro- and small-enterprises in developing countries (Pereira *et al*. 2013).[31] Moreover, reliance on financial intermediaries can result in weak monitoring and transparency, and limit accountability (Dzebo *et al*. 2015).

RISK GUARANTEES AND EXPORT CREDITS

Public finance can help reduce investment risks in projects through instruments such as credit guarantees, political risk insurance, hedging products such as currency and interest swaps, and public catastrophe and weather risk insurance. For example, insurance can spread and transfer the risks of coping with climate-related natural disasters, and may provide incentives for risk reduction and preventative behaviour (and thus private adaptation expenditure) (Box 4.3). However, insurance coverage is still much broader in developed countries than in developing countries (Naidoo *et al*. 2012). To mobilise more private investment in innovative insurance products in developing countries, public finance is often needed to fund research, pilot projects, and the data collection that underpins local index-based insurance (Pierro and Desai 2011, GIZ 2014).

Export credit agencies are another mechanism sometimes used to support private investment. In 2014, the OECD issued a revised sector understanding on export credits for renewable energy, climate change mitigation and adaptation, and water projects (OECD 2014). In an effort to make investments in adaptation more attractive, it sets favourable conditions for repayment of export credits to adaptation projects. It is too soon to determine the extent to which the revised sector understanding will contribute to making export credit agencies a more useful tool for private sector financing in adaptation. In the context of climate change mitigation, concerns have been raised about the small share of renewable energy projects financed through export credits, in spite of the more favourable terms that these projects receive, compared to projects that rely on fossil fuel-powered technologies (ECA-Watch 2010).

PUBLIC-PRIVATE PARTNERSHIPS

Public-private partnerships have been depicted as a useful vehicle for distributing risk, and thus drawing in private sector investment. Infrastructure projects, where private finance provides between 15 and 20 per cent of total investment in developing countries, are a case in point (Eurodad 2015).

In recent years, the financial value of public-private partnerships in developing countries has increased dramatically. Nonetheless, most partnerships are clustered in the energy and transport sectors in upper middle-income countries. For example, between 2009 and 2014,

30 Public institutions are also able to blend public finance with private finance in order, for instance, to lower the cost of capital (blending commercial debt with grants to provide concessional lending), to provide credit lines to local finance institutions for adaptation-related investments, or to provide risk-sharing instruments such as first-loss guarantees, and separate treatment of political risks (UNEP 2011).

31 These tend to be important economic actors in developing countries, including from the point of view of employment.

Box 4.3: The R4 Rural Resilience Initiative

The R4 Rural Resilience Initiative (R4) is a joint effort by the World Food Programme and Oxfam America. It exemplifies how public finance can help reduce investment risks though the use of instruments such as weather-index insurance.

R4 promotes the use of four risk management strategies: risk reduction, risk transfer, prudent risk-taking, and risk reserves. It seeks to build resilience to weather-related shocks by fostering risk reduction in the form of communal and/or individual asset creation, and by promoting risk sharing and risk transfer. The initiative comes as a response to the lack of insurance mechanisms for addressing aggregate risk in developing countries, and minimal uptake of insurance when it is made available.

During the 2015 agricultural season, R4 provided weather-index insurance and supported the creation of disaster-risk reduction assets for more than 32,000 farmers in Ethiopia, Senegal, Malawi and Zambia. R4 works with local private insurance companies and microfinance institutions, as well as global reinsurers such as SwissRe.

only four partnerships out of 189 were finalised for water infrastructure across all low-income countries.[32] This pattern may change over time, as many countries are still developing institutional frameworks to support such partnerships (Kennedy and Corfee-Morlot 2012).

However, the benefits of public-private partnerships in supporting public goals, like adaptation, are sometimes contested. Based on an analysis of public-private partnerships for development purposes, it has been suggested that (i) resource mobilisation is the main rationale driving these partnerships, and (ii) there is little evidence of them delivering better quality outcomes in terms of either cost-effectiveness or environmental benefits (IOB 2013).

32 An inventory of public-private partnerships is available online at: http://ppi.worldbank.org/~/media/GIAWB/PPI/Documents/Data-Notes/PPI-Note-IDA-Countries-to-2009-2014.pdf

05

CHAPTER 5

THE ADAPTATION FINANCE GAP AND PROSPECTS FOR BRIDGING IT

LEAD AUTHOR
ANNE OLHOFF (UNEP DTU PARTNERSHIP)

Photo: *© Skylar Bee (UNEP DTU Partnership)*

5.1 INTRODUCTION

The previous chapters of the report signal that developing countries face an adaptation finance gap. Firstly, adaptation costs are significant and likely to increase sharply in the future. Secondly, although recent years have shown good progress in terms of increasing international public finance flows to adaptation, total finance for adaptation would have to increase significantly to meet the estimated costs of adaptation, and avoid an adaptation finance gap.

In this chapter, central findings of the previous chapters of the report are synthesised to shed light on the following key questions:

- What do we know about the adaptation finance gap?
- What is required to bridge it?
- What is the relevance of the report's findings in the context of strengthening adaptation under the Paris Agreement?

5.2 THE ADAPTATION FINANCE GAP – NOW AND IN THE FUTURE

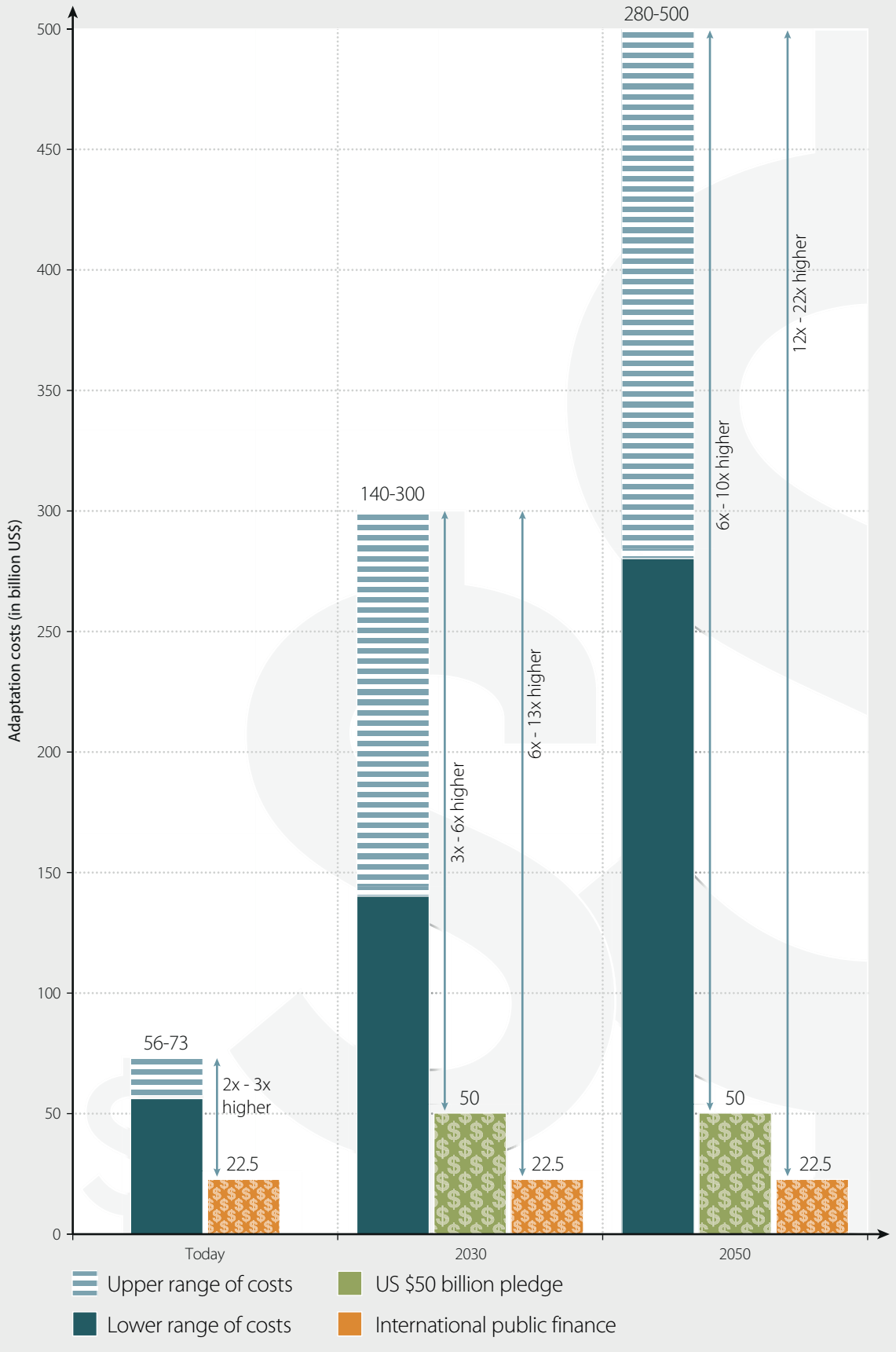
Today, developing countries already face an adaptation finance gap – a gap that is likely to increase significantly over the period 2030 to 2050, unless new and additional finance for adaptation is mobilised through public and private sources, nationally as well as internationally. This is the key message emerging from the previous chapters of the report. While uncertainties and data limitations prevent firm conclusions regarding the exact size of the adaptation finance gap now and in the future, overcoming these shortcomings is unlikely to change this key message.

Figure 5.1 shows how the adaptation finance gap could develop for the time period until 2050. As Chapters 3 and 4 illustrate, currently it is only possible to include data on international public adaptation finance flows. The figure consequently shows how international public finance for adaptation compares to the estimated costs of adaptation for three different points in time: now, 2030 and 2050. For 2030 and 2050 the figure further illustrates how the estimated costs of adaptation compare to the commitment by developed country parties of mobilizing US$100 billion per year for mitigation and adaptation from 2020 (assuming that this amount will be split equally between mitigation and adaptation). Figure 5.1 thus gives an indication of how much greater total finance for adaptation would have to be to avoid an adaptation finance gap at these three points in time.

Figure 5.1 shows that adaptation costs today are likely to be at least two-to-three times higher than international public finance for adaptation. Estimates of current adaptation costs (US$56-73 billion per annum for the period 2010-2019) are taken from the World Bank (2010), which is the key source for the global adaptation cost estimate of US$70-100 billion for developing countries for the period 2010-2050, referenced by the IPCC and cited in Chapter 2. This range of current adaptation costs is comparable to the indicative adaptation cost estimates included in the adaptation components of developing country NDCs. The estimate of current international public adaptation finance flowing to developing countries of US$22.5 billion in 2014 is taken from Chapter 3.

Turning to 2030, the assessment of national- and sector-based studies in Chapter 2 concluded that, by 2030, adaptation costs are likely to be in the range of US$140-300 billion per annum, that is, two-to-three times higher than the World Bank estimates of US$70-100 billion. Total finance for adaptation would thus have to be six-to-thirteen times higher than current levels of international public adaptation finance to avoid an adaptation finance gap in 2030. International public adaptation finance is, however, unlikely to remain at current levels until 2030. As noted earlier in the report, the Paris Agreement restated the 2020 commitment by developed country parties of mobilizing US$100 billion per year for adaptation and mitigation until 2025, and requires parties to increase that commitment after 2025. For this reason it may be more relevant to compare the estimated adaptation costs in 2030 to this international climate finance commitment. Assuming that the commitment of mobilizing US$100 billion per year from 2020 is fully met (and potentially increased after 2025), and assuming that this amount is distributed equally between mitigation and adaptation, international adaptation finance flows from developed to developing countries for adaptation would reach at least US$50 billion by 2030. Under these assumptions, total finance for adaptation would have to

Figure 5.1: Conceptualising the adaptation finance gap



be roughly three-to-six times higher to meet likely finance needs in 2030.

It should be noted that, as specified in Chapter 3, the current figure of US$22.5 billion for international public finance flowing to developing countries includes all tracked international public financial flows for adaptation. This figure combines ODA and non-ODA finance originating from developed and developing country governments, adaptation-dedicated multilateral climate funds and development finance institutions. These flows are much broader than the amount that counts towards developed countries' commitment of mobilizing US$100 billion per year from 2020. It follows that part of the international public finance for adaptation by 2030 would not be included in the US$50 billion figure outlined above.

In 2050, adaptation costs could be in the range of US$280-500 billion (four-to-five times US$70-100 billion, see Chapter 2). The potential adaptation finance gap would consequently be much larger – in the order of between twelve-to-twenty-two times current flows of international public adaptation finance, or six-to-ten times the US$50 billion commitment (assuming an equal split between adaptation and mitigation).

As noted previously in the report, adaptation costs, and thus finance needs, are emissions dependent. Adaptation costs in 2030, and particularly 2050, could be even higher than indicated in this section if mitigation ambition is insufficient to keep the world on a 2°C track.

Finally, although the report finds that adaptation costs are likely to be much higher than previous estimates, they still only represent a fraction of current and projected GDP.

5.3 BRIDGING THE ADAPTATION FINANCE GAP

To address the adaptation finance gap effectively, action targeted both at (i) reducing adaptation needs, and thereby the costs of adaptation, and (ii) scaling up the level of finance flowing to adaptation, is required. Efficiency is a main issue for both types of action. The following section highlights key options for bridging the adaptation finance gap effectively and efficiently within these two areas, drawing on the findings of the previous chapters of the report.

5.3.1 ENHANCING MITIGATION AMBITION

Mitigation ambition has direct implications for adaptation needs and costs. The assessment undertaken in this report and in the preliminary UNEP Adaptation Gap Report (UNEP 2014) confirms that adaptation costs are emission-dependent. This is expected for longer timeframes, looking beyond 2050, since there is a time lag between the point in time when greenhouse gases are emitted and the point in time when climate change impacts materialise. However, indicative results from integrated assessment models show that adaptation costs may vary with different emission trajectories as early as 2030 (see the Appendix to this report). This underlines the urgency of enhancing mitigation ambition, and of boosting pre-2020 mitigation action, to limit climate change and its impacts and keep adaptation costs and challenges at manageable levels. Furthermore, it highlights the relevance of directly linking adaptation to the 2°C temperature target as part of the global goal on adaptation under the Paris Agreement.

5.3.2 MAKING DEVELOPMENT CLIMATE RESILIENT

The trend in international public finance for adaptation over recent years reflects increasing attention to mainstreaming adaptation into development co-operation practices (UNEP 2014), and a growing focus on climate resilient development. As the discussion in Chapter 2 highlights, it is imperative to address existing adaptation and development gaps, as they have important implications for countries' ability to address adaptation needs, and reduce vulnerability in the future, as well as for the associated costs.

5.3.3 SCALING UP FINANCE FOR ADAPTATION

Section 5.2 of this chapter illustrates the urgency of scaling up all sources of finance. The Paris Agreement urges

developed countries to "significantly increase adaptation finance from current levels" (UNFCCC 2015) and the UNFCCC process is likely to be critical for increasing international finance for adaptation. While it is widely acknowledged that there is a need to bring all types of finance into play, it is also clear that adaptation in developing countries will continue to require grants. Tracking domestic funding is a priority, as this source of financing is believed to be important in the near- and longer-term, and data about its size and destinations are currently lacking.

Similarly, a more systematic and explicit approach is required to both understand the extent to which private sector financing complements public sector budgets, and the ways in which private sector engagement can be bolstered. One of the emerging lessons is the need to establish policy frameworks and legislation that creates the incentives for private sector investment in adaptation. This is an area where experience and best practice from numerous other areas, notably mitigation and environment, is available to inform the process.

While quantitative estimates of private finance flows for adaptation are lacking, private domestic investment and remittances are good examples of adaptation-relevant investment. Private domestic investment levels are rising in developing countries and, if this trend holds true for micro- and small-sized enterprises, a portion of those funds can be expected to be spent on adaptation-relevant activities, particularly for those enterprises active in agriculture, a sector that is especially sensitive to climate change.

Remittances may be valuable from an adaptation perspective because they tend to increase in cases of catastrophic weather events and natural disasters in migrants' countries of origin. Furthermore, remittances reach households directly, including those in remote and vulnerable areas, more so than public finance flows.

The above points are well aligned with the information provided in the adaptation components of the NDCs, where it is apparent that countries perceive a current finance gap, and that they realise the need for domestic budgets as a key part of the solution for bridging that gap. They are also aware of the need for greater mobilisation of private finance (both domestic and international). Nonetheless, international public finance is still perceived as a key source of finance for adaptation.

5.3.4 ENSURING EFFECTIVENESS AND EFFICIENCY OF RESOURCE USE

Effectiveness and efficiency implies that available funds are targeted where they are most needed and used optimally to ensure they have the greatest possible impact. To this end, and in addition to other goals, such as maximising the number of beneficiaries, prioritising the most vulnerable, or delivering the highest value for money, prioritising adaptation will be of the utmost importance (Chapter 2). There is growing evidence that adaptation has the potential to be extremely beneficial and cost-effective when planned with uncertainty and implementation in mind. Against this background, the importance of the phasing and timing of adaptation practices is increasingly being recognised: more and more, adaptation actions are differentiated depending on whether they target current climate variability or future climate change. Overall, there is a shift toward early adaptation actions, low-regret options, capacity building, and options that build-in flexibility and robustness for long-term decisions, complemented with early planning for major future risks – all of it increasingly integrated in regular development projects and actions, as highlighted above.

Total finance flows to adaptation are not known, which hampers attempts to both evaluate the effectiveness of current spending levels, and determine future financing requirements. As highlighted in Chapter 3, a proper measurement, tracking, and reporting system of adaptation investments is indispensable to ensure that finance is used efficiently and targeted where it is most needed. To date, resources disbursed through adaptation-focused climate funds have had some of the poorest countries in sub-Saharan African and South Asia as main recipients, and small-island developing states are among the main recipients of adaptation finance for disaster-risk reduction. Increasing the transparency of reporting by finance providers in general, and particularly for dedicated adaptation funds, is central to document and enhance the effectiveness and efficiency of climate finance.

There is evidence that dedicated climate funds are helping break down barriers to investment in adaptation projects in developing countries and play an important role in catalysing a wide range of adaptation-related investments. They do this by strengthening the capacities of local stakeholders, creating incentives for institutions and investors (for example, by offering concessional terms) and, ultimately, by taking on risks from which commercial financiers would typically shy away.

To summarize, bridging the adaptation finance gap is not only a question of mobilising more resources. As highlighted in Chapter 4, both public and private sector finance have to be placed in the context of effective delivery, to ensure that finance corresponds to the priorities and needs of recipient countries and communities, and results in lasting outcomes.

5.4 THE PARIS AGREEMENT AND THE WAY FORWARD

The Paris Agreement contains a number of provisions that are central to discussions on adaptation costs, needs and finance. This section highlights some of these provisions, while suggesting options for bolstering adaptation finance and, more generally, for making progress toward adaptation.

As noted above, clear goals and targets are indispensable to identify adaptation needs and options, steer investments, enable progress-tracking, and strengthen policy awareness and action. Indeed, that is a key premise behind the UNEP gap reports. Experience from other global processes, such as the Millennium Development Goals and the Sustainable Development Goals, corroborates the importance of setting targets to enhance policy commitment and action.

The Paris Agreement establishes a global adaptation goal "of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2" (UNFCCC 2015). The goal can be seen as recognition that adaptation is both a global and a local challenge, or as reflecting an implicit principle of common, but differentiated, adaptation needs. However, since it is a highly generic and qualitative goal, a central question remains: how to operationalise it at different scales (local to global), as part of the implementation of the Agreement.

More specific goals, targets and indicators for adaptation that build on an in-depth understanding of local and national vulnerabilities, priorities and needs, seem critical from an operational perspective. The NDCs highlight current and short-term expected adaptation needs and priorities, and several of the adaptation components include information that can be used as a first step toward cementing adaptation goals and targets at sectoral and national levels. The NDCs made clear that knowledge of adaptation costs and financing flows is fundamental for developing countries to manage medium to long-term adaptation. The need for consistent methodologies and metrics around adaptation costs and finance became apparent from the NDCs, and is echoed in the Paris Agreement.

The assessment of the evidence on adaptation needs and costs, and adaptation finance flows provided in this report highlights that flexible, but clear and comprehensive, frameworks are needed to guide national assessments and underpin global stocktaking efforts. Methodology development is emphasised and will be required to implement the provisions of the Paris Agreement – both those that entail action on the part of parties to the climate convention, and those that mandate the secretariat to the convention to conduct a global stocktaking.

In regards to estimating the costs of adaptation, three key messages emerge. Firstly, as demonstrated in Chapter 2, there is an urgent need for more empirical studies to address key coverage gaps for those sectors or risks which are currently poorly or partially covered. Moreover, to ensure the success of such empirical studies, there is a need for testing how the choice of methods and assumptions affect the cost estimates, for example, with sensitivity testing and multi-model analyses. Secondly, there are important potential lessons to be learnt from assessing cost out-turns (ex post costs) from existing or early adaptation practice, to better take account of opportunity, transaction and implementation costs. Thirdly, it is important to better understand the transferability of options (by aggregation scale and between locations).

In regards to estimating adaptation finance, three provisions under the Paris Agreement are of particular relevance. The Paris Agreement urges developed countries to "significantly increase adaptation finance from current levels" and one of the convention's subsidiary bodies is requested to develop modalities for the accounting of financial resources provided and mobilised through public interventions. Such an effort is expected to increase the accountability of financial pledges for climate change. Additionally, the political commitment for a (low-carbon and) climate-resilient economy is renewed, which strengthens the position of first-mover investors and financiers, and represents a call for action to laggards. This is particularly relevant in relation to the findings of this assessment, as Chapter 3 demonstrated that increasing adaptation finance flows remains an urgent priority.

Photo: *© Trust for Africas Orphans*

REFERENCES

CHAPTER 1

Burton, I. (2004). Climate change and the adaptation deficit. Adaptation and Impacts Research Group Occasional Paper 1. *Environment Canada*. Quebec.

Chambwera, M., Heal, G., Dubeux, C., Hallegatte, S., Leclerc, L., Markandya, A., McCarl, B.A., Mechler, R. & Neumann, J.E. (2014). *Economics of adaptation*. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R. & White, L.L. (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 945-977.

IPCC (2014) *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, Pachauri, R.K., and Meyer, L.A., (eds). Geneva: IPCC. Available at: http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf

UNEP (2014). *The Adaptation Gap Report: a Preliminary Assessment*. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available at: http://www.unep.org/climatechange/adaptation/gapreport2014/portals/50270/pdf/AGR_FULL_REPORT.pdf

UNEP (2015). *The adaptation finance gap update: with insights from the INDCs*. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available at: http://web.unep.org/sites/default/files/gapreport/UNEP_Adaptation_Finance_Gap_Update.pdf

UNFCCC (2015). *Draft Decision -/CP21 – Adoption of the Paris Agreement (FCCC/CP/2015/L.9/Rev.1)*. United Nations Framework Convention on Climate Change. Bonn, Germany.

World Bank. (2010). The economics of adaptation to climate change: A Synthesis Report. The World Bank Group. Washington, DC., United States.

CHAPTER 2

Agrawala, S., Bosello, F., Carraro, C., De Bruin, K., De Cian, E., Dellink, R., & Lanzi, E. (2011a). Plan or react? Analysis of adaptation costs and benefits using integrated assessment models. *Climate Change Economics*, 2(03), 175-208.

Agrawala, S., Bosello, F., Carraro, C., De Cian, E., & Lanzi, E. (2011b). Adapting to climate change: costs, benefits, and modelling approaches. *International Review of Environmental and Resource Economics, 5*(3), 245-284.

Burton, I. (2004). Climate change and the adaptation deficit. Adaptation and Impacts Research Group Occasional Paper 3. *Environment Canada*. Quebec.

De Bruin, K., R. Dellink and S. Agrawala (2009). *Economic Aspects of Adaptation to Climate Change: Integrated Assessment Modelling of Adaptation Costs and Benefits*. OECD Environment Working Papers, No. 6, OECD Publishing. Available at: http://www.oecd-ilibrary.org/content/workingpaper/225282538105

ECONADAPT (2015). *The Costs and Benefits of Adaptation: Results from the ECONADAPT Project*. Watkiss, P. (ed.). Published by the ECONADAPT consortium.

Hallegatte, S., Green, C., Nicholls, R. J., & Corfee-Morlot, J. (2013). Future flood losses in major coastal cities. *Nature climate change*, 3(9), 802-806.

Hinkel, J., Lincke, D., Vafeidis, A. T., Perrette, M., Nicholls, R. J., Tol, R. S., & Levermann, A. (2014). Coastal flood damage and adaptation costs under 21st century sea-level rise. *Proceedings of the National Academy of Sciences*, 111(9), 3292-3297.

Hinkel, J., Nicholls, R. J., Tol, R. S., Wang, Z. B., Hamilton, J. M., Boot, G., & Klein, R. J. (2013). A global analysis of erosion of sandy beaches and sea-level rise: An application of DIVA. *Global and Planetary Change*, 111, 150-158.

IPCC (2014). *Summary for policymakers*. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R. & White, L.L. (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

Klein, R.J.T., G.F. Midgley, B.L. Preston, M. Alam, F.G.H. Berkhout, K. Dow, and M.R. Shaw, 2014: Adaptation opportunities, constraints, and limits. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R. & White, L.L. (eds.). Cambridge University

Press, Cambridge, United Kingdom and New York, NY, USA, pp. 899-943.

Mima S., Criqui P., & Watkiss P. (2011). The Impacts and Economic Costs of Climate Change on Enery in Europe. Summary of Results from the EC RTD Climate Cost Project. In: *The Climate Cost Project*. Final Report. Watkiss, P. (ed.). Volume 1: Europe. Published by the Stockholm Environment Institute Stockholm, Sweden.

Nordhaus, W. D., and Boyer, J. (1999). Roll the DICE again: the economics of global warming. *Draft Version*, 28, 1999. Available at: http://www.econ.yale.edu/~nordhaus/homepage/web chap 4 102599.pdf

OECD (2008). *Economic aspects of adaptation to climate change costs, benefits and policy instruments: costs, benefits and policy instruments*. OECD Publishing. Organisation for Economic Cooperation and Development. Paris, France.

Parry, M., Arnell, N., Berry, P., Dodman, D., Fankhauser, S., Hope, C., & Kovats, S. (2009). *Assessing the costs of adaptation to climate change: a review of the UNFCCC and other recent estimates*. Iied.

Plambeck, E. L., Hope, C., & Anderson, J. (1997). The Page95 model: Integrating the science and economics of global warming. *Energy Economics*, 19(1), 77-101.

Ramsbottom, D., Sayers, P., & Panzeri, M. (2012). *Climate change risk assessment for the floods and coastal erosion sector*. DEFRA Project Code GA0204. Report to DEFRA. London, United Kingdom.

Stern, N. (2016). Economics: Current climate models are grossly misleading. *Nature*, 530(7591), pp.407-409.

UNDP (2011). *Assessment of Investment and Financial Flows to Address Climate Change (Capacity Development for Policy Makers to Address Climate Change)*. Country summaries. Available at: http://www.undpcc.org/en/financial-analysis/results.

UNEP (2015). *The adaptation finance gap update: with insights from the INDCs*. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available at: http://web.unep.org/sites/default/files/gapreport/UNEP_Adaptation_Finance_Gap_Update.pdf

UNFCCC. (2007). *Climate change: impacts, vulnerabilities and adaptation in developing countries*. UNFCCC Secretariat. Bonn, Germany. Available at: https://unfccc.int/resource/docs/publications/impacts.pdf

UNFCCC (2010). *Synthesis report on the National Economic, Environment and Development Study (NEEDS) for Climate Change Project*. UNFCCC Secretariat. Bonn, Germany. Available at: http://unfccc.int/resource/docs/2010/sbi/eng/inf07.pdf

World Bank. (2010). *The economics of adaptation to climate change: A Synthesis Report*. The World Bank Group. Washington, DC., United States

CHAPTER 3

Averchenkova, A., Crick, F., Kocornik-Mina, A., Leck, H., & Surminski, S. (2015). *Multinational corporations and climate adaptation–Are we asking the right questions? A review of current knowledge and a new research perspective* (No. 183). Grantham Research Institute on Climate Change and the Environment. Available at: http://www.lse.ac.uk/GranthamInstitute/publication/multinational-corporations-and-climate-adaptation-are-we-asking-the-right-questions-a-review-of-current-knowledge-and-a-new-research-perspective

Bird, N. (2014). *Fair share: climate finance to vulnerable countries*. Overseas Development Institute. London, United Kingdom.

Brown, J., Stadelmann, M., Wang, D., Boni, L., CPI, C. P. I., Jachnik, R., & Kato, T. (2015). *Estimating mobilized private finance for adaptation: exploring data and methods*. Climate Policy Initiative. Available at: http://climatepolicyinitiative.org/publication/estimating-mobilized-private-finance-for-adaptation-exploring-data-and-methods/Climate Policy Initiative (2011)

Buchner, B., Falconer, A., Hervé-Mignucci, M., Trabacchi, C., and Brinkman, M. (2011). *The Global Landscape of Climate Finance: A CPI Report*. Climate Policy Initiative. Venice, Italy. Available at: http://climatepolicyinitiative.org/wp-content/uploads/2011/10/The-Landscape-of-Climate-Finance-120120.pdf

Buchner B., Trabacchi C., Mazza F., Abramskiehn A. and Wang D. (2015). *Global Landscape of Climate Finance 2015: A CPI Report*. Climate Policy Initiative. Venice, Italy. Available at: http://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2015/

CPEIR (2015). CPEIR Country Database [Internet]. The Climate Public Expenditures and Institutional Review. Available from: <http://climatefinance-developmenteffectiveness.org/CPEIR-Database.> [Accessed February 2016]

GCF (2014). *6th Board Meeting*, Agenda item 11: Policies and procedures for the initial allocation of Fund resources, Decision B.06/06. Green Climate Fund. Available at: https://www.greenclimate.fund/documents/20182/46529/3.4_-_Allocation_of_Fund_Resources.pdf/e717fcd0-3f85-4a5d-81aa-9199c5df4c3d

OECD (2011). *Handbook on the OECD-DAC Climate markers*. OECD DAC. Paris, France. Available at: http://www.oecd.org/dac/stats/48785310.pdf

IDFC (2014). *Mapping of Green Finance Delivered by IDFC Members in 2013*. International Development Finance Club. Frankfurt, Germany.

IDFC-MDB (2015). Common Principles for Climate Change Adaptation Finance Tracking. African Development Bank (AfDB), the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Inter-American Development Bank (IDB) and the World Bank Group. Available at: http://www.eib.org/attachments/documents/mdb_idfc_adaptation_common_principles_en.pdf

IPCC (2014) *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Pachauri, R.K., & Meyer, L.A. (eds.). Geneva: IPCC. Available at: http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf

Mullan, M., Kingsmill, N., Agrawala, S., & Matus Kramer, A. (2015). *National adaptation planning: lessons from OECD countries*. In: Handbook of Climate Change Adaptation. Filho, W.L. (ed.). Springer. Berlin, Heidelberg.

ODI (2016). Climate Funds Update Database [Internet]. London; Washington DC. Available from: <http:// www.climatefundsupdate.org> [Accessed April 2016].

ODI and HBS (2015). Ten things to know about climate finance in 2015. ODI and H. London, United Kingdom. Available at:https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10093.pdf

OECD (2011). *Handbook on the OECD-DAC Climate markers*. OECD DAC. Paris, France. Available at: http://www.oecd.org/dac/stats/48785310.pdf

OECD (2015a). *Climate finance in 2013-14 and the USD 100 billion goal*. OECD & Climate Policy Initiative. Available at: http://www.oecd.org/environment/cc/OECD-CPI-Climate-Finance-Report.htm

OECD (2015b). Climate Change: OECD DAC External Development Finance Statistics [Internet]. Paris. Available from:< http://www.oecd.org/dac/stats/climate-change.htm> [Accessed January 2016].

OECD (2015c). *Climate Change Risks and Adaptation: Linking Policy and Economics*. OECD Publishing. Paris, France.

Stumhofer, T., Detken, A., Harnisch, J., & Lueg, B. (2015). *Proposal of a methodology for tracking publicly mobilized private climate finance*. KfW Development Bank. Frankfurt, Germany. Available at: https://www. kfw-entwicklungsbank.de/PDF/Download-Center/ Materialien/Nr.-9_Proposal-of-a-methodology-for-tracking-publicly-mobilized-private-climate-finance.pdf.

Terpstra, P., Peterson, C.A., and Wilkinson, E. (2013). *The Plumbing of Adaptation Finance: Accountability, Transparency, and Accessibility at the Local Level*. WRI. Washington, DC. Available at: http://www.wri.org/publication/the-plumbing-of-adaptation-finance

Trabacchi, C. and Mazza, F. (2015). *Emerging solutions to drive private investment in climate resilience: a CPI Working Paper*. Climate Policy Initiative. Venice, Italy. Available at: http://climatepolicyinitiative.org/wp-content/uploads/2015/06/Finance-for-Climate-Resilience.pdf

UNEP (2015). *The adaptation finance gap update: with insights from the INDCs*. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available at: http://web.unep.org/sites/default/files/gapreport/UNEP_Adaptation_Finance_Gap_Update.pdf

UNFCCC (2010). The Cancun Agreements: outcome of the work of the ad-hoc working group on long-term cooperative action under the convention (Decision 1/CP.16). United Nations Framework Convention on Climate Change. Bonn, Germany. Available at: http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf

UNFCCC (2014). Standing Committee on Finance: Biennial Assessment and Overview of Climate Finance Flows [Internet]. Bonn. Available from: <http://unfccc.int/cooperation_and_support/financial_mechanism/standing_committee/items/8034.php> [Accessed April 2016].

Vivid Economics (2015). *Building an Evidence Base on Private Sector Engagement in Financing Climate Change Adaptation*. Report prepared for EBRD. Available at: http://www.ebrd.com/documents/climate-finance/building-an-evidence-base-on-private-sector-engagement-in-financing-climate-change-adaptation.pdf

World Bank (2012). *World Development Report 2013: Jobs*. Washington, DC., United States

World Bank (2015). Mainstreaming Climate Action Within Financial Institutions Five Voluntary Principles [Internet]. Washington, DC. Available from: <http://www.worldbank.org/content/dam/Worldbank/document/Climate/5Principles.pdf.> [Accessed April 2016].

CHAPTER 4

Agrawala, S., Carraro, M., Kingsmill, N., Lanzi, E., Mullan, M., & Prudent-Richard, G. (2011). *Private sector engagement in adaptation to climate change: approaches to managing climate risks.* OECD Environment working paper no. 39. Organisation for Economic Cooperation and Development. Paris, France.

Ballard, D., C. Bond, N. Pyatt, K. Lonsdale, G.P. Whitman, S. Dessai, M. Evans, & Tweed, J.H. (2013). *PREPARE – Barriers and*

enablers to organisational and sectoral adaptive capacity – qualitative study. Part of the PREPARE Programme of research on preparedness, adaptation and risk. Final Report for project ERG1211 by Ricardo-AEA for Defra. Reference Ricardo-AEA/R/ED58163/PREPARE R1a/Issue 1.0.

Banerjee, S. (2011). *Remittances: A key to adaptation? Perspectives from communities exposed to water stress in the Himalayan Region.* Information Sheet #1/11. International Centre for Integrated Mountain Development. Kathmandu. Nepal.

Bendandi, B. and Pauw, W.P. (2016). *Remittances for adaptation: an 'alternative source' of international climate finance.* In: Migration, Risk Management and Climate Change: Evidence and Policy Responses. Warner, K., Cascone, N., Schraven, B. & Milan, A. (eds.). Springer.

Brown, J., Stadelmann, M., Wang, D., Boni, L., CPI, C. P. I., Jachnik, R., & Kato, T. (2015). *Estimating mobilized private finance for adaptation: exploring data and methods.* Climate Policy Initiative.
Available at: http://climatepolicyinitiative.org/publication/estimating-mobilized-private-finance-for-adaptation-exploring-data-and-methods/

Buchner B., Trabacchi C., Mazza F., Abramskiehn A. and Wang D. (2015). *Global Landscape of Climate Finance 2015: A CPI Report*. Climate Policy Initiative. Venice, Italy. Available at: http://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2015/

CBI (2015). *Bonds and Climate Change: The State of the Market in 2015.* Climate Bonds Initiative. London, United Kingdom. Available at: http://www.climatebonds.net/files/files/CBI-HSBC%20report%207July%20JG01.pdf

Dalberg (2011). Report on Support to SMEs in Developing Countries Through Financial Intermediaries. *SME Briefing Paper, EIB Draft version.* European Investment Bank. Luxembourg, Luxembourg

Danielson, M. G., and Scott, J. A. (2006). The capital budgeting decisions of small businesses. *Journal of Applied Finance, 16*(2), 45.

Dougherty-Choux, L., Terpstra, P.Q., Kurukulasuriya, P., & Kammila, S. (2015). *Adapting from the Ground Up.* World Resources Institute. Washington, DC., United States.

Dzebo, A., Atteridge, A. & Davis, M. (2015). *The SEI Initiative on Climate Finance.* SEI Fact Sheet. Stockholm Environment Institute. Stockholm, Sweden. Available at http://www.sei-international.org/publications?pid=2866.

ECA-Watch (2010). *Export Credit Agencies and Climate Change – a briefing for Cancun.* FERN. Gloucestershire, UK & Brussels, Belgium.

EIB (2014). *Joint Report on MDB climate finance 2014.* European Investment Bank. Luxembourg, Luxembourg.
Available at: http://www.eib.org/attachments/documents/flyer_joint_report_on_mdb_climate_finance_2013_en.pdf

Eurodad (2015). What lies Beneath? A Critical Assessment of PPPs and their Impact on Sustainable Development. Eurodad. Brussels, Belgium. Available at: http://www.eurodad.org/files/pdf/55cb59060d9d4.pdf

GIZ (2014). *Final Evaluation: Adaptation to Climate Change and Insurance (ACCI): Kenya*. Deutsche Gesellschaft für Internationale Zusammenarbeit. Eschborn and Bonn, Germany.

IFC and EBRD (2013). *Climate Risk Case Study: Pilot Climate Change Adaptation Market Study: Turkey.* International Finance Corporation (IFC) and European Bank for Reconstruction and Development (EBRD).

IFRC (2014). *World Disasters Report: Focus on Culture and Risk*. International Federation of Red Cross and Red Crescent Societies. Geneva, Switzerland.
Available at: http://www.ifrc.org/Global/Documents/Secretariat/201410/WDR%202014.pdf

IOB (2013). *Public-Private Partnerships in developing countries: A systematic literature review.* IOB Study No 378. Ministry of Foreign Affairs. The Netherlands.

Kennedy, C. and Corfee-Morlot, J. (2012). *Mobilising Investment in Low Carbon, Climate Resilient Infrastructure.* OECD Environment Working Papers, No. 46. OECD Publishing. Available at: http://dx.doi.org/10.1787/5k8zm3gxxmnq-en

MDB Joint Report (2015). *2014 Joint Report on Multilateral Development Banks' Climate Finance.* African Development Bank (AfDB), the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Inter-American Development Bank (IDB) and the World Bank Group. Available at: www.worldbank.org/climate/MDBclimatefinance2014

Naidoo, T., Vaz, K., & Byaba, L., (2012). *Background paper on adaptation: An introduction to adaptation in view of developing a private financing approach for adaptation related projects using the CTI PFAN model.* Verde Azul, and PPL International. Available at: www.cti-pfan.net/upload/event/file/CTIPFANAdaptationPaper_Final_270212.pdf

OECD (2014). *Revised Sector Understanding on Export Credits For Renewable Energy, Climate Change Mitigation and Adaptation, and Water Projects.* OECD TAD/PG(2014)4. Paris, France.

OECD (2016). Net ODA (indicator) [Internet]. Paris. Available from:<https://data.oecd.org/oda/net-oda.htm> [Accessed on 25 April 2016].

Pauw, W. P. (2015). Not a panacea: private-sector engagement in adaptation and adaptation finance in developing countries. *Climate Policy, 15*(5), 583-603.

Pauw, W. P., Klein, R. J. T., Vellinga, P., & Biermann, F. (2015). Private finance for adaptation: do private realities meet public ambitions? *Climatic Change,* 1-15.

Pereira, J., Orenstein, K., and Chan, M. (2013). Pro-poor climate finance: is there a role for private finance in the Green Climate Fund? *Friends of the Earth and PanAfrican Climate Justice Alliance*. Washington, DC., United States. Available at: http://www.foe.org/news/archives/2013-04-pro-poor-climate-finance-is-there-a-role-for-private

Pierro, R., and Desai, B. (2011). *The potential role of Disaster Insurance for disaster risk reduction and climate change adaptation.* Climate and Disaster Governance, and Christian Aid. Available at: http://www.preventionweb.net/english/professional/publications/v.php?id=18210

Stenek, V., Amado, J.C. & Greenall, D. (2013). *Enabling Environment for Private Sector Adaptation: An Index Assessment Framework*. International Finance Corporation. Washington, DC., United States.

Surminsky, S. (2013). Private-sector Adaptation to Climate Risk. *Nature Climate Change*, 3, 943-945.

Trabacchi, C. and Mazza, F. (2015). *Emerging solutions to drive private investment in climate resilience: a CPI Working Paper.* Climate Policy Initiative. Venice, Italy. Available at: http://climatepolicyinitiative.org/wp-content/uploads/2015/06/Finance-for-Climate-Resilience.pdf

UNDP (2013). *Small Businesses: Impact of Disasters and Building Resilience.* Background Paper prepared for the 2013 Global Assessment Report on Disaster Risk Reduction. UNISDR. Geneva, Switzerland.

UNEP (2011). Innovative Climate Finance: Examples from the UNEP Bilateral Finance Institutions Climate Change Working Group. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available at: http://www.unep.org/pdf/UNEP_Innovative_climate_finance_final.pdf

UNEPFI (2014). *Demystifying Private Climate Finance.* UNEP Finance Initiative. Geneva, Switzerland. Available at: http://www.unep.org/pdf/DemystifyingPrivateClimateFinance.pdf

UNISDR (2013). *From Shared Risk to Shared Value: The Business Case for Disaster Risk Reduction.* Global Assessment Report on Disaster Risk Reduction. UNISDR. Geneva, Switzerland. Available at: http://www.preventionweb.net/english/hyogo/gar/2013/en/gar-pdf/GAR2013_EN.pdf

Vivid Economics (2015). *Building an Evidence Base on Private Sector Engagement in Financing Climate Change Adaptation.* Report prepared for EBRD. London, United Kingdom.

World Bank (2012). *World Development Report 2013: Jobs.* Washington, DC., United States.

World Bank (2015). *Migration and Remittances Factbook 2016.* Washington, DC, United States.

CHAPTER 5

UNEP (2014). *The Adaptation Gap Report-a Preliminary Assessment*. United Nations Environment Programme (UNEP). Nairobi, Kenya. Available at: http://www.unep.org/climatechange/adaptation/gapreport2014/portals/50270/pdf/AGR_FULL_REPORT.pdf

UNFCCC (2015). *Draft Decision -/CP21 – Adoption of the Paris Agreement* (FCCC/CP/2015/L.9/Rev.1). United Nations Framework Convention on Climate Change. Bonn, Germany.

World Bank (2010). *The Costs to Developing Countries of Adapting to Climate Change: New Methods and Estimates*. The Global Report of the Economics of Adaptation to Climate Change Study. Consultation Draft. Washington DC: The World Bank. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2016/03/30/090224b084246b88/2_0/Rendered/PDF/The0costs0to0d0climate0change0study.pdf

www.unep.org

United Nations Environment Programme
P.O. Box 30552 – 00100 Nairobi, Kenya
Tel.: +254 20 762 1234
Fax: +254 20 762 3927
e-mail: uneppub@unep.org
www.unep.org

ISBN: 978-92-807-3498-0
Job Number: DEP/1912/NA