UNEP

Federal Ministry
for Economic Cooperation
and Development

UNEP FINANCE INITIATIVE

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

DEMYSTIFYING ADAPTATION FINANCE FOR THE PRIVATE SECTOR

November 2016

JOINTLY IMPLEMENTED WITH:

Frankfurt School
FS-UNEP Collaborating Centre
for Climate & Sustainable Energy Finance

DISCLAIMER

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme concerning the legal status of any country, territory, city or area or of its authorities, or concerning delimitation of its frontiers or boundaries. Moreover, the views expressed do not necessarially represent the decsion or the stated policy of the United Nations Environmet Programme, The German Ministry of Economic Cooperation and Development (BMZ), the German Development Corporation (GIZ), The Frankfurt School UNEP Collaborating Centre for Climate & Sustainable Energy Finance, The German Development Centre (DIE), or Acclimatise, nor does citing of trade names or commercial processes.

The German Ministry of Economic Cooperation and Development
w www.bmz.de
e info@bmz.bund.de

UNEP Finance Initiative
w www.unepfi.org
e info@unepfi.org

The German Development Corporation
w www.giz.de
e info@giz.de

The Frankfurt School - UNEP Collaborating Centre
w fs-unep-centre.org
e fs_unep@fs.de

COPYRIGHT

DEMYSTIFYING ADAPTATION FINANCE FOR THE PRIVATE SECTOR

November 2016

What are the adaptation needs of private sector actors? How are those needs typically financed? What are the barriers that inhibit private adaptation finance flows? What is the appropriate role of public finance and policy to catalyse private financial flows towards adaptation?

Second of a series of UNEP Finance Initiative (UNEP FI) contributions to the multilateral negotiations on climate finance, the Green Climate Fund (GCF), and its Private Sector Facility (PSF).

A joint study between UNEP Finance Initiative (UNEP FI) and the German Federal Ministry for Economic Cooperation and Development (BMZ), implemented by the German Development Corporation (GIZ) and conducted by the Frankfurt School UNEP Collaborating Centre for Climate & Sustainable Energy Finance, The German Development Centre (DIE) and Acclimatise.

ACKNOWLEDGEMENTS

LEAD AUTHORS

Laura Druce
Frankfurt School
UNEP Collaborating Centre

Prof. Dr. Ulf Moslener
Frankfurt School
UNEP Collaborating Centre

Dr. Christine Gruening
Frankfurt School
UNEP Collaborating Centre

Pieter Pauw
The German Development Centre (DIE)

Dr. Richenda Connell
Acclimatise

PROJECT TEAM

Remco Fischer
UNEP FI

Angelika Frei-Oldenburg
GIZ

George Scott
UNEP FI

UNEP FI CLIMATE CHANGE ADVISORY GROUP

Karsten Löffler
Allianz

Abyd Karmali
Bank of America Merrill Lynch

Giorgio Capurri
Unicredit

Madeleine Ronquest
FirstRand

Bruce Duguid
Hermes

Frederic Samama
Amundi

David Bresch
SwissRe

Nick Robins, Co-Director
UNEP Inquiry

Merlyn VanVoore
UNEP Climate Change Coordinator

TABLE OF CONTENTS

List of Tables 1
List of Figures 1
Abbreviation List 2
Foreword 3
Executive Summary 4
1. Introduction 9
2. Adaptation Finance – Actors and Drivers for Private Adaptation 10
3. Climate Impacts, Risks, and Opportunities faced by Private Enterprise 14
4. Private Adaptation Measures 18
5. Financing Private Adaptation Measures 23
6. Barriers to Private Adaptation Finance 32
7. Implications for Public Policy and Finance 39
Annex 1: Private Sector Adaptation - Case study analysis 43
Annex 2: Case studies 56
Annex 3: Classifying SMEs 71
End Notes 72

LIST OF TABLES

Table 1. Adaptation Matrix – Populated with Examples from Case Study Analysis

Table 2. An Overview of (Private) Finance Instruments

Table 3. Typology of Adaptation Barriers in the Selected Literature

Table 4. Overview of Different Views on Barriers Relevant to Financing Adaptation-related Projects: The Economic Versus Demand of Financing Perspective

Table 5. Adaption Measure 1: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

Table 6. Adaption Measure 2: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

Table 7. Adaption Measure 3: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

Table 8. Adaption Measure 4: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

Table 9. Adaption Measure 5: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

Table 10. Adaption Measure 6: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

Table 11. Adaptation Measure: Case Study Analysis According to the Actors, Climate Change Impact, Instruments and Barriers

LIST OF FIGURES

Figure 1. Relevant economic actors involved in private sector adaptation and adaptation finance

Figure 2. Adaptation-Related Activities Finance – Towards an Actor-Based Perspective

Figure 3. Adverse Effects of Climate Change

Figure 4. Direct and Indirect Climate Risks to Businesses

Figure 5. Classification of Project and Activities According to Adaptation Intervention

Figure 6. Financing Instruments for Private Actors

Figure 7. The Debt Financing Options for Private Enterprises Varying by type and Scale

Figure 8. Infrastructure Finance

Figure 9. The Spectrum of Private Participation in Pnfrastructure

Figure 10. Steps for the Assessment of Investment/spending Criteria of Public Funds

ABBREVIATION LIST

AF	Adaptation Fund
ARC	African Risk Capacity
BMZ	German Federal Ministry for Economic Corporation and Development
CBO	Community-Based Organisation
CO2	Carbon Dioxide
CSR	Corporate Social Responsibility
EBA	Ecosystem-Based Adaptation
FAO	Food and Agriculture Organisation
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GSK	GlaxoSmithKline
HARITA	Horn of Africa Risk Transfer for Adaptation
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
KfW	Kreditanstalt für Wiederaufbau
km	Kilometre
MDB	Multilateral Development Bank
MEB	Terminal Maritimo Muelles El Bosque
MEbA	Microfinance for Ecosystem-based Adaptation
MFI	Microfinance Institution
mm	Millimetre
MMV	Medicines for Malaria Venture
MNC	Multinational Corporation
MSME	Micro, Small, and Medium Enterprise
MVI	Malaria Vaccine Initiative
NAPA	National Adaptation Programmes of Action
NGO	Non-Governmental Organisation
PES	Payment for Ecosystem Services
PPP	Public-Private Partnership
R&D	Research and Development
SME	Small and Medium Enterprise
TA	Technical Assistance
UHI	Urban Heat Island
USD	United States Dollar
XCF	Extreme Climate Facility

FOREWORD

The Paris Agreement in December last year was a landmark achievement with 197 countries speaking in unison to endorse ambitious action to combat climate change. While this undoubtedly represents a historic turning point in the global climate negotiations, it is important to remember that in pledging to limit global warming to two-degrees we are locking ourselves into a significant global warming trajectory. Even if greenhouse gas emissions were halted today, we would still experience decades of considerable and damaging climate impacts, that will put communities at risk and undermine economies around the globe.

In order to mitigate this impact, climate resilient development will require considerable additional investment compared to development paths in scenarios without climate change. While estimates of the level of investment are uncertain, it is clear that levels of public finance available for adaptation presently fall well below the volumes required. In order to achieve the required levels of adaptation it is therefore essential to understand and mobilise private sector financial flows.

To date, much of the discussion on adaptation finance has focused on integrating aspects of climate resilience into public sector budgeting and the allocation of international climate finance. It is however, through the integration of climate resilience aspects into the day-to-day decisions of private enterprises around the world, that the most significant adaptation potential in economic development can be achieved.

Understanding how these decisions are made and are ultimately financed is critical for establishing the policy frameworks capable to releasing that potential and, hence, scaling-up private sector investment, and financing, for adaptation to the transformational scale required.

Demystifying Adaptation Finance for the Private Sector is part of a series of studies, developed by the Finance Initiative of UN Environment (UNEP FI) that analyse the role of private finance in confronting the challenges of climate change. This report examines how private enterprises make investment decisions in adaptation and how those investments are ultimately financed. The report analyses the market barriers that inhibit investments in adaptation, both on the side of the private enterprise investing in adaptation, and on the side of the private financial institution financing such investment. Finally, the report provides practical policy solutions to remove the barriers and scale-up the volume of financial flows for adaptation. Understanding how private sector adaptation occurs and is financed is critical to making best use of the limited supply of available public finance and realise levels of adaptation at sufficient scale to ensure the long-term resilience of economies across the globe.

Philipp Knill
Head of Division - Climate Policy and Climate Financing, German Federal Ministry for Economic Cooperation and Development (BMZ)

Eric Usher
Head, UNEP Finance Initiative

EXECUTIVE SUMMARY

Climate change will alter the conditions that underlie economies. Slow onset changes such as shifting rainfall patterns, increasing temperatures, and coastal intrusion will affect both global as well as national and subnational markets, while rapid onset events such as high intensity storms and flooding will increase disruption and drive economic loss.

These impacts are changing the conditions under which economies deliver goods and services. The resulting structural shift in the economy has already started to drive investment in new business models, technologies, and infrastructure, as well as the upgrading/climate proofing and relocation of existing infrastructure. These investments are taking place against a background of unprecedented uncertainty accompanying climate change and its immediate physical impacts, as well as the more indirect consequences that might ensue. This uncertainty and lack of historical precedent, coupled with other market imperfections, inhibit private financial flows for adaptation from reaching the required volumes.

Much of the discussion on adaptation finance to date has focused on public spending. However, it is clear that a large share of the required adaptation measures, as well as the corresponding financing needs, will need to be provided by private sector actors.

This report finds that substantial investment in adaptation and resilience is already occurring in the private sector, financed by private capital. This investment is being undertaken within private enterprises of varying scales in response to the shifting market conditions driven by climate change. Understanding how this investment occurs, what drives it and how it is financed, is a low-cost entrance for governments and policy makers seeking to increase levels of adaptation.

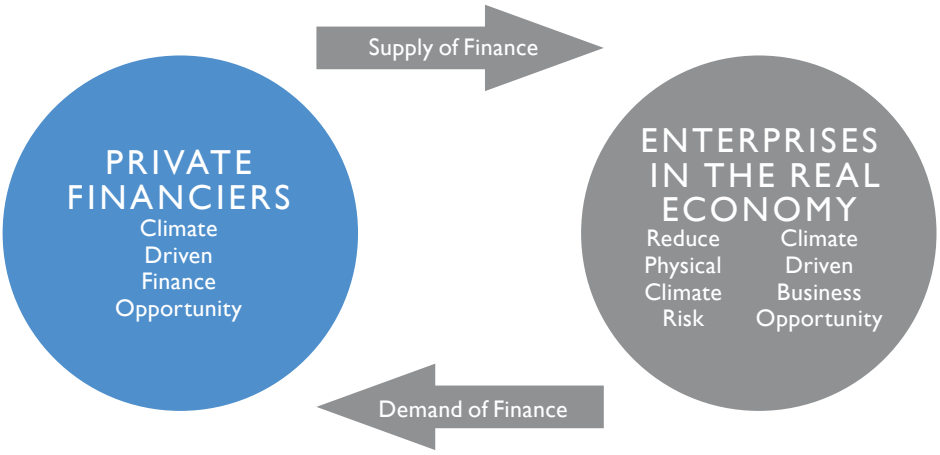
The ultimate aim of this report is to analyse the role of public actors in order to inform the way in which public finance and policy can be used to catalyse private investments in adaptation. The report focuses on the barriers inhibiting private financial flows for adaptation and how these barriers may be removed by public intervention.

Who are the relevant actors, and what is their motivation?

To understand better how private investments in adaptation occur and are financed, this report divides the relevant economic actors into four categories: (i) public policy makers, including legislators and regulators, both nationally and internationally; (ii) public finance providers, such as national, bilateral and multilateral banks and funds; (iii) private financiers, who constitute the supply side of private finance; and (iv) private enterprises in the real economy, who constitute the demand side. The flows of private adaptation finance occur between the two latter actors, while the role of the two former actors will be to provide the regulatory and legislative environments necessary to support these flows.

A private enterprise will typically choose to invest in adaptation measures to reduce physical climate risks directly, transfer the risk through insurance, or to capitalise on a new business opportunity that has arisen as a result of climate change.

The Two Dimensions of Investment in Private Adaptation Measures



Source: Authors

In order to analyse how these decisions are made, the report uses four climate impacts and provides examples of how they might typically affect private enterprises at different points of their business models. The study then identifies the measures with which businesses might respond with, so as to mitigate, or benefit from, the impact.

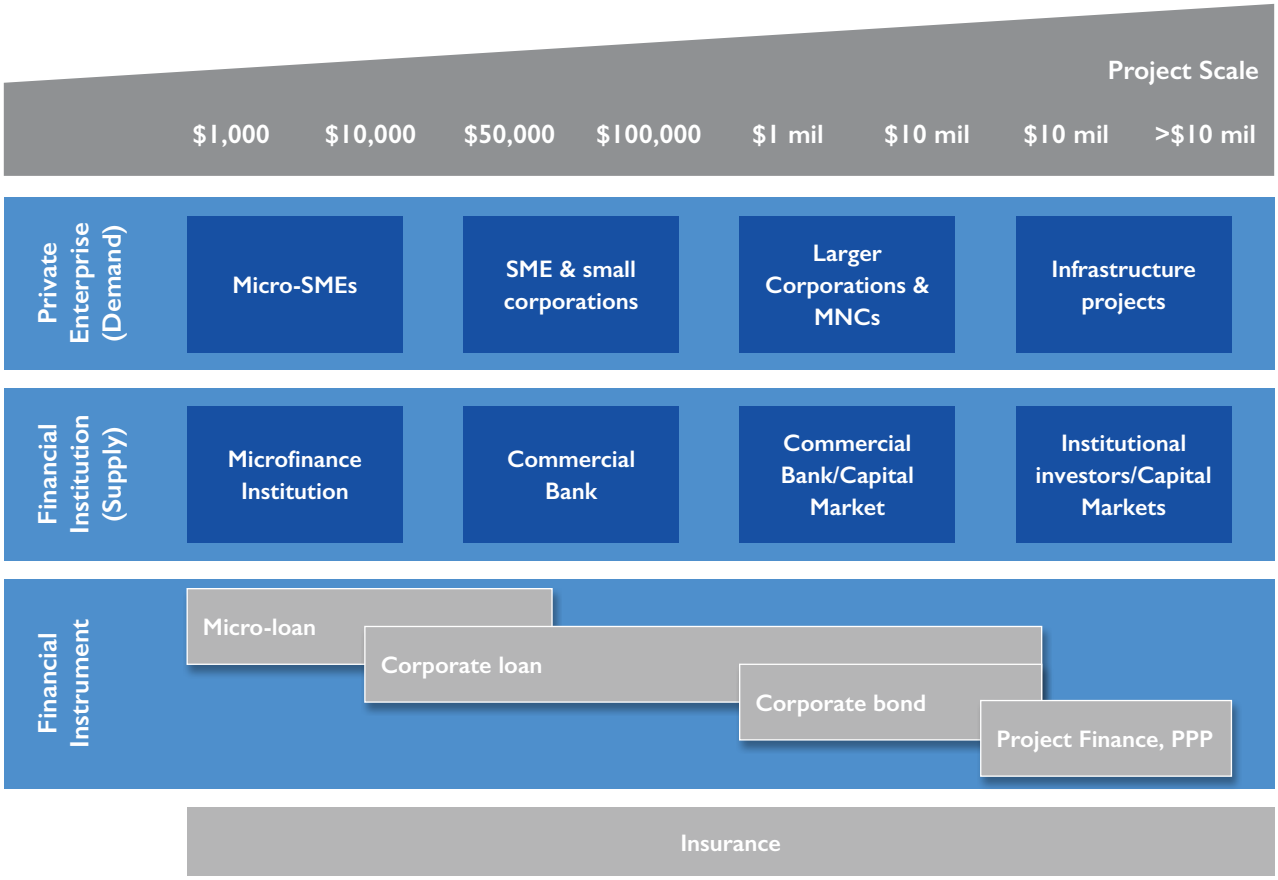
Using the resulting matrix of climate impact and counter-measures as a basis, the report describes how such adaptation measures by private actors would typically be financed, including the sources, financial instruments and actors that would typically be involved.

Broad Study Findings

The report applies this method to a sample of 28 case studies on adaptation to climate change by private sector actors. The analysis provides a number of broad insights:

- **Substantial investment is already being undertaken by private enterprises in adaptation and resilience.** Private enterprises have already started responding to climate change and many are mainstreaming adaptation and climate-related activities into their business planning, often without the explicit acknowledgement that what is being done contributes to their adaptation;
- **While climate change may adversely affect existing business activities, it will also lead to the creation of new opportunities.** Climate change is driving the emergence of new markets and creating business opportunities as emerging technologies are required to adjust to the changing conditions. Many private enterprises are responding by investing in the development and deployment of new products or technologies;
- **Private adaptation investments are typically financed using the same instruments as traditional business investments.** Adapting to structural change is an on-going component of strategic business management, addressing economic a range of social, political, and environmental factors. The physical impacts of climate change constitute one such example of structural change, albeit a significant one. If adapting to structural change is a core part of the normal course of business, then financing of adaption can be considered as part of normal business financing;

The Debt Financing Options for Private Enterprises Varying by Type and Scale



Source: Authors

- **Understanding both the supply of and demand for adaptation finance is critical to designing policies and public finance instruments to catalyse flows of private adaptation finance.** There is a shortfall between current volumes of adaptation finance and what is required to facilitate the transformational change of the economy as it adapts to climate change. When designing public policies or finance interventions to mobilise private finance, it is critical to understand the origins of this shortfall. Literature in the field of economics points to several barriers, in the form of market imperfections, which create distortions in the risk/return profile of an adaptation investment and suppress levels of adaptation below the ideal and required amount. These barriers manifest on either the demand side of private adaptation finance among the private enterprises challenged by physical climate change or on the supply side of finance, among private financiers;

- **Policy makers should focus on addressing market imperfections.** The report argues that addressing market imperfections and therefore enabling the market to perform its role of allocating capital efficiently, constitutes an effective approach to increasing financial flows for adaptation to socially optimal levels. In doing so, the report adopts a definition of barriers as, "a friction that prevents socially optimal (adaptation-related) investments from being commercially attractive".

Barriers to Adaptation Finance

These barriers, or market imperfections, can include:

- **Positive externalities,** when private investments generate benefits to society that do not generate additional cash flows and hence are not captured by the financial return. This, in turn, means that financial returns on the investment do not reflect the true value of undertaking the activity;
- **Imperfect capital markets,** when financial markets are unable to efficiently allocate capital or transfer risk. For instance, many financial markets are characterised by a shortage of longer-term credit, which inhibits the ability to finance investments required to cope with longer-term or distant climate impacts;
- **Incomplete or asymmetric information,** when critical information such as that pertaining to the expected impacts of climate change is unavailable, inaccessible, or distributed unevenly among different actors. Without accurate and reliable climate data actors are disempowered from making informed decisions and investing accordingly.

Describing barriers in this way can form the basis of remedial policy or public finance interventions that can either modify the **market environment in a way that the barrier is eliminated, or compensate the private actors for the effects on the risk/return profile.**

Tools for Addressing Barriers

Governments can use a range of known policy and financial instruments to mobilise private sector finance towards investments that build climate resilience and promote the adoption of adaptation technologies:

- **Addressing incomplete and asymmetric information:** Such as publically funded information campaigns to provide accurate information and knowledge on climate impacts, as well as to showcase promising adaptation strategies.

  For private enterprises, raising awareness of adaptation risks, costs and options will strengthen their capacities to identify and invest in appropriate adaption measures.

- **Addressing imperfect capital markets:** Such as ensuring adequate supply of finance for adaptation and resilience investments.

  Providing long-term public finance for on-lending can adjust for financial markets that fail to provide sufficient volumes of affordable, long-term debt. In addition, credit enhancement in the form of governmental guarantees can reduce the risk of adaptation-related lending to smaller enterprises for lenders. Public auctions of credit guarantees to commercial banks can further reduce the burden to public finance institutions and reduce the cost of borrowing to micro, small or medium enterprises (MSMEs) or corporations, which has a knock-on effect of freeing up capital for further investment in other activities.

- **Addressing Positive Externalities of Adaptation-Related Investments:** Such as using grants or subsidies to internalise the social benefit of a public good. Positive externalities can be internalised through financial instruments, such as taxes or subsidies that capture the value of the positive externality and provide reimbursement to the investor. This will improve the return from the investors' perspective and could bring it closer to the true value ("social rate of return") of the adaptation activity.

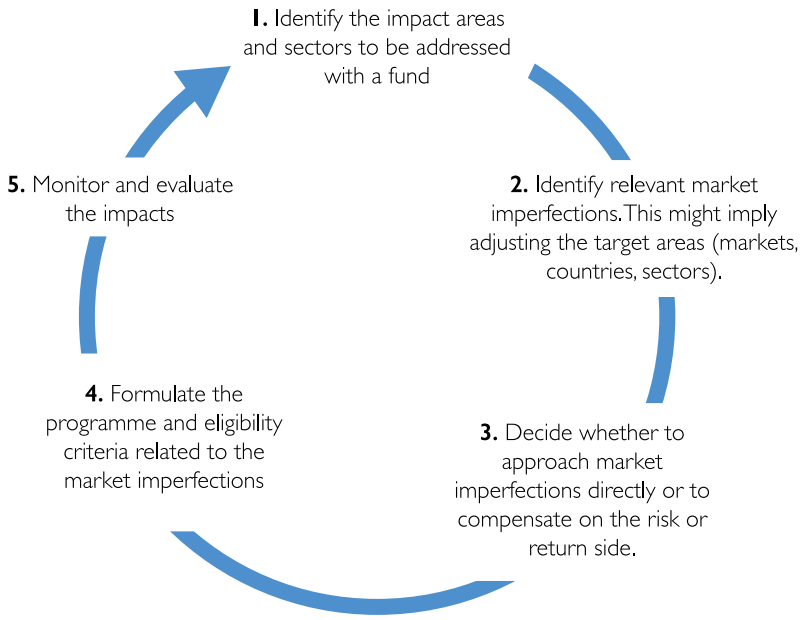
Recommendations for Policy Makers

Policy makers and other public actors can help facilitate or moderate the structural changes required in the private sector by:

- **Integrating a more granular, 'actor-based' perspective into national adaptation planning**, rather than limiting the process to high-level planning approaches at the macro level; considering the risk-return perspective of enterprises when making investment decisions; and identifying the positive impacts of private adaptation activities on other actors so as to incentivise corresponding activities;

- **Stimulating the creativity of the private sector.** This could be achieved by increasing the support for knowledge generation and innovation. This would be sector- and potentially actor-specific and should be aimed at contributing to a general climate of innovation where there is also room for new business models to emerge;
- **Adhering to clear processes for the determination and assessment of criteria for public spending**. As public funds are limited, the efficient use and allocation of this funding is important. Public authorities and financial institutions should set clear criteria for how funding decisions are made, and assess criteria over time.

Steps for the Assessment of Investment/Spending Criteria of Public Funds



Source: Authors

1. INTRODUCTION

In recent decades, climate change has impacted on both natural and human systems across the globe, affecting all continents and oceans.[1] Past and future emissions of greenhouse gases (GHGs) will continue to cause changes to the climate system, increasing the likelihood of severe and irreversible impacts on both ecosystems and economies.[2] The appropriate reaction of the global community must include both mitigation as well as adaptation efforts, and this report focuses on the latter.

Climate impacts will change how economies produce goods and services and generate welfare, or in other words, drive a structural change in the economy that involves using different technologies, shifting locations, and investing in resilience. Such change takes place against a background of uncertainty, since climate impacts are difficult to predict, making the cost of countermeasures and the levels of requisite investment and financing difficult to estimate.[3,4,5] Estimates indicate that global investment required for adaptation to climate change in developing countries ranges from USD 140 billion per year to USD 300 billion per year by 2030 under a two-degree warming scenario and that these costs will at least double by 2050. Under a three or four-degree warming scenario, these costs will be considerably higher.[6]

Some adaptation measures are likely to be financed by governments since they directly concern areas of government activities, such as public storm shelters, dams, or flood-resistant streets. However, in sectors where commercial or purely private activities are affected by climate change, most financing is expected to be commercially driven. Examples include: investments in agriculture, the real estate sector and larger commercial infrastructure[i]. Despite this, most of the research on adaptation to date has focused on public spending on adaptation rather than private adaptation.

This study seeks to explore and examine the motivation for private adaptation, **to identify private adaptation-related activities, and to explain how these activities are typically financed**. Introducing adaptation as a response to climate-induced structural change, the study differentiates between different relevant actors within the economy and examines the interactions between them. In doing so, it seeks **to provide insight on why finance is flowing towards adaptation in some cases and what may inhibit private adaptation finance flows in other cases**. The study also contributes to the discussion on **the appropriate role of governments and the way in which public finance or policy can catalyse private financial flows towards adaptation.**

In order to understand how the process of private adaptation occurs and is financed, an analysis was undertaken of 28 real-world case studies that demonstrate successful examples of private sector investment in adaptation. The case studies were analysed to better understand what typically is an 'adaptation component' in a broader investment and how that investment was ultimately financed, who the stakeholders were in the activity, and how any barriers that existed were overcome.

REPORT STRUCTURE:

Chapters 1 and 2 identify the key theoretical concepts of adaptation and describe the analytical approach of the study to in assessing the impacts and response measures to climate change in the private sector from the perspective of the individual economic actor. Chapters 3 and 4 display how private enterprises and the sponsors of infrastructure will be challenged by physical climate change. The starting point in chapter 3 is a sample of four potential climate change impacts, followed by an elaboration of how such climate impacts become business risks and opportunities. Chapter 4 discusses a cluster of six potential measures undertaken to respond to the four climate impacts. Examples are provided in a matrix of response measures, which becomes the basis for an examination in Chapter 5, of the financing requirements of those measures, as well as of the relevant financial channels, vehicles, institutions, and sources. Chapter 6 then elaborates on the barriers – market imperfections – currently keeping private financial flows for adaptation from reaching the required, socially-optimal level. Lastly, Chapter 7 highlights the types of intervention that public authorities, nationally and internationally, might put in place to remove the barriers previously identified.

i The taxonomy of 'Government financing' on the one hand and 'private financing' on the other, as alluded to here, is an approximation given the many areas where the two overlap. For instance, in their budgeting and expenditure Governments often rely heavily on the proceeds derived from the issuance of sovereign debt via capital markets. Furthermore, government-(co)sponsored projects are often financed with project loans from commercial banks. The inverse is also true; it is common practice for sovereign wealth funds, capitalised with retained tax revenue, to provide financing to commercial endeavours, including in the private sector.

2. ADAPTATION FINANCE – ACTORS AND DRIVERS FOR PRIVATE ADAPTATION

The Intergovernmental Panel on Climate Change (IPCC), in their Fifth Assessment Report,[7] defines adaptation as:

"The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects".

Three elements of this high-level definition are considered highly relevant for this study: (i) '*The process of adjustment*', as the focus of the study is on investment as part of a structural shift in the economy; (ii) '*actual or expected climate and its effects*', firstly, because it is not only the status-quo of climate impacts but the expected change, including corresponding uncertainty or knowledge gaps; and secondly, the inclusion of '*its effects*' makes reference to indirect consequences that are not directly related to primary climate variables, such as temperature or precipitation; and (iii) '*moderate harm or exploit beneficial opportunities*', as both strategies need to be part of an appropriate response of an economy to structural change and many adaptation measures carry elements of both in their implementation. After all, an emerging need of a farmer to buy a more efficient irrigation system also creates a new opportunity for those selling the systems.

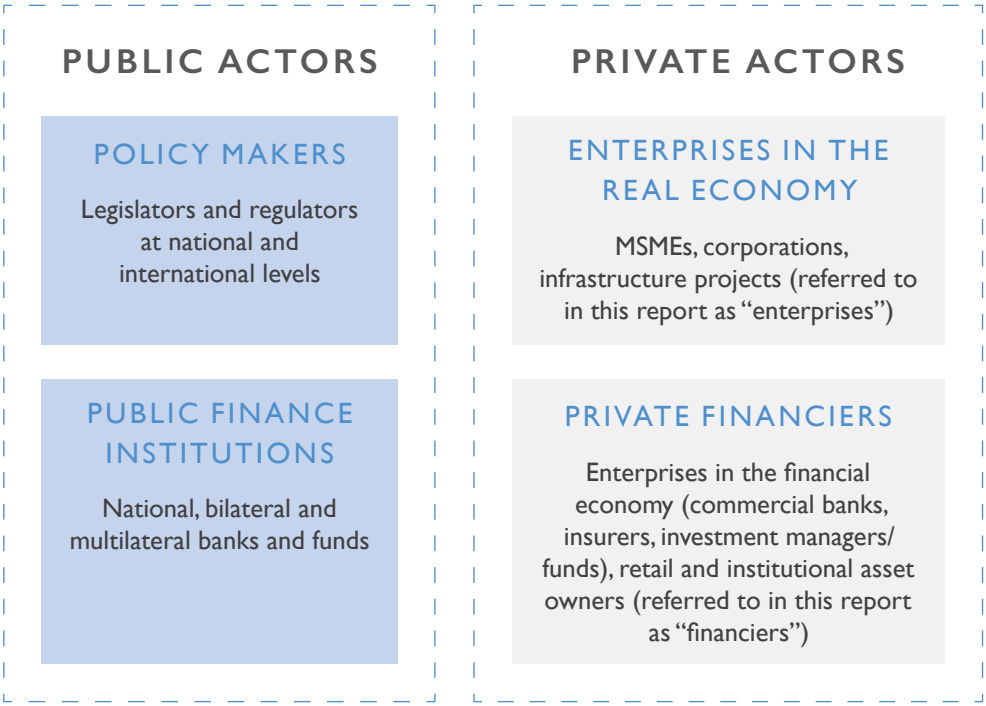
The 'high-level' IPCC definition describes adaptation as a process of adjustment, making reference to the causal relationship between GhG emissions and climatic impacts. Economic activity impacts the climate by generating emissions, while conversely a changing climate has an impact on economies, driving the necessity to adapt. Governments increasingly prioritise the identification and planning of measures to adapt, and as such the IPCC definition can be considered the adaptation-planning perspective.

The literature identifies a number of different dimensions by which to classify adaptation activities, including: (i) *reactive versus anticipatory*,[ii] (ii) *planned versus autonomous*,[iii] and (iii) *public versus private adaptation*.[iv]

The IPCC definition falls short of highlighting the roles of different actors in the economy in facilitating the required structural changes. An understanding of these roles is critical in the design and effective targeting public policy interventions. This report addresses that gap by identifying the different actors needed to facilitate the structural change and examining the drivers that underpin adaptation. More specifically it seeks to understand: (i) how they are impacted by climate change, (ii) what measures they need to take to mitigate or profit from that impact, (iii) what are the capital requirements to implement those measures and (iv) the interactions of different actors necessary to meet the financing requirements of investment in adaptation.

ii Reactive adaptation involves coping with the damages of climate change, while anticipatory adaptation increases resilience to potential climate change.
iii Planned adaptation is the result of deliberate policy decisions, while autonomous adaptation is action that takes place without direct public intervention.
iv This depends on whether the adaptation decision is motivated by private or public interests.

Figure 1. Relevant Economic Actors Involved in Private Sector Adaptation and Adaptation Finance



Source: Authors

In its assessment of private adaptation finance, this study considers the perspective of two different actors: the private enterprise investing in and implementing adaptation measures, and the private financiers who supply the required capital.

Actor 1 - Private Enterprises

For simplicity, private enterprises are considered along a spectrum from micro, small, and medium enterprises (MSMEs) to larger corporations and project sponsors implementing investment in large infrastructure projects. MSMEs[v] typically generate revenue by providing limited amounts of products and services, often within local markets. They are characterised by having great operational flexibility and swift decision-making processes, and rely on the competencies and entrepreneurial spirit of the owner(s). A high level of detailed knowledge about local circumstances and opportunities is also crucial for MSMEs.[8]

Corporations are legal entities that are separate from their owners, and like MSMEs they have the right to enter into contracts, lend and borrow money, hire employees, own assets, and pay taxes. The important distinction, however, is limited liability, as corporate shareholders can participate in profits through dividends and or stock, but are not personally liable for the company's debts.[9]

In order to implement adaptation-related activities, enterprises will typically invest own 'equity' capital (from retained earnings or an expansion of capital) or require external finance. The latter can be sought from different sources and channels, and the study, in Chapter 5, identifies which of these is best suited to meet the demand in adaptation-related contexts.

Adjusting to climate change may comprise a smaller component within a larger business model and may thus not be explicitly recognised as adaptation. While adjustments may lead to higher revenues or cost savings, they are likely to require upfront investment by enterprises and therefore require additional capital.

v A classification of MSMEs is provided in Annex 3.

Actor 2 - Private Financiers

The private financiers include a diverse set of institutions that are willing to provide financing, either as debt, equity or mezzanine, according to their individual tastes, determined by risk/return and investment horizon but also influenced by other characteristics such as sector, region, or more abstract statistical considerations such as risk correlation with other investments. These institutions may typically include but are not limited to: banks and other lenders, retail investors, institutional investors such as pension funds, and a wide range of specialized vehicles such as private equity and venture capital funds.

Actors 3 and 4 - Public Actors

The final group of relevant actors for this analysis are public actors, comprising of public policy makers (legislators and regulators) and public finance institutions. It is typically the role of the government to set rules according which private actors have to observe in order to pursue their commercial goals. Governments can also mandate public finance institutions to act on the financial market (as 'financier' rather than 'regulator') in order to pursue political objectives.

This study seeks to identify how legislation, regulation, and public financial interventions can be designed to facilitate the demand and the supply of adaptation finance, making it flow at the required scale.

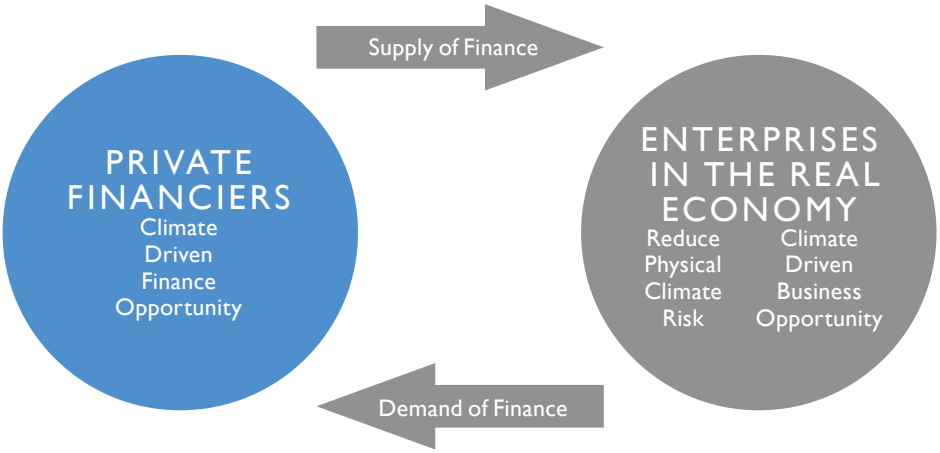
Towards an Actor-Based Perspective

In focusing on the implementation of adaptation, this study moves away from the traditional, 'high-level', adaptation-planning perspective to a more granular, 'actor-based' perspective of adaptation decisions. Since adaptation-related measures implemented by private actors are the focus of this study, it proposes an activity-level working definition of an adaptation-related activity:

'A private adaptation-related activity is any activity which a private actor pursues that is performed differently when compared to a counterfactual world without climate change'.

This frames climate change as one of many potential drivers that a private actor must consider in order to form expectations about the future on which to base their business/investment decisions. There are two main motivations that lead private actors to implement adaptation: (i) to hedge against or reduce risk, and (ii) to exploit new markets and business opportunities. These motivations drive the investment in adaptation activities, and thus add one more dimension to a range of considerations that are not specifically climate-related, such as more ordinary operational or regulatory risks.

Figure 2. Adaptation-Related Activities Finance – Towards an Actor-Based Perspective



Source: Authors

Figure 2 captures the implications of the physical effects of climate change to both enterprises and private financiers by adaptation. The activities pursued help the enterprises to reduce climate risk or realise new business opportunities, typically creating the demand for (private adaptation) finance. This simultaneously provides new financing opportunities for the private financiers.[vi]

vi Note that the government may also ask for funding from the private sector or provide finance to commercial businesses.

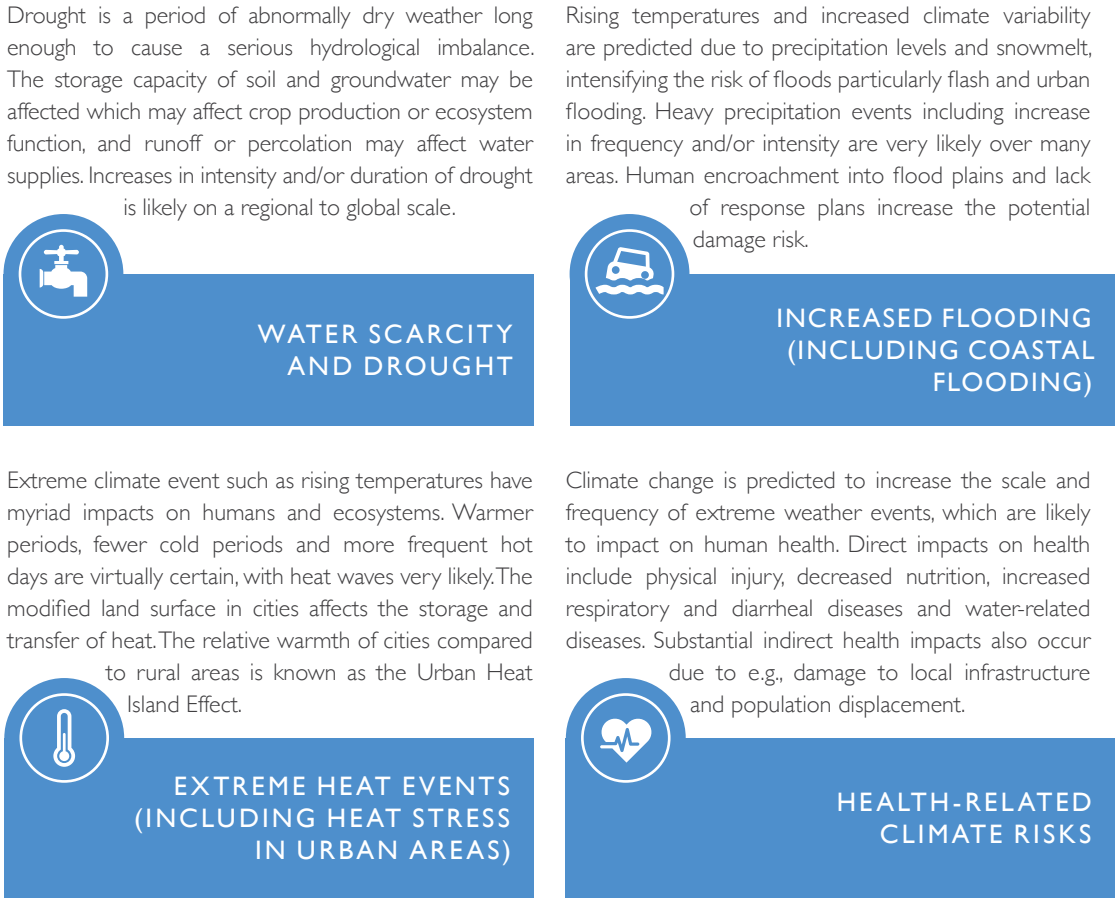
3. CLIMATE IMPACTS, RISKS, AND OPPORTUNITIES FACED BY PRIVATE ENTERPRISE

A 'Caring for Climate' survey found that among 72 companies, 83% believe that climate impacts pose a risk to their products or services, while 86% also expect business opportunities in response to climate risks or investing in adaptation solutions.[10] Whether reacting to increased risk or identifying upcoming business opportunities, it is worth noting that larger corporate entities, as those surveyed, are starting to acknowledge the risk that climate change poses to various parts of their business. This confirms that the physical climate change is considered of material importance to business planning and that its impacts are likely to manifest as risks and opportunities.

3.1 Impacts

The observable impacts of climate change on business activities are widespread, with diverse type, frequency, intensity, and consequences. Without claiming to include all major climate impacts, this study categorises several major adverse effects of climate change into four overarching impacts: water scarcity and drought, increased flooding (including coastal flooding), extreme heat events (including heat stress in urban areas), and health-related climate risks (see Figure 3).

Figure 3. The Four Climate Change Impacts Assessed In the Study

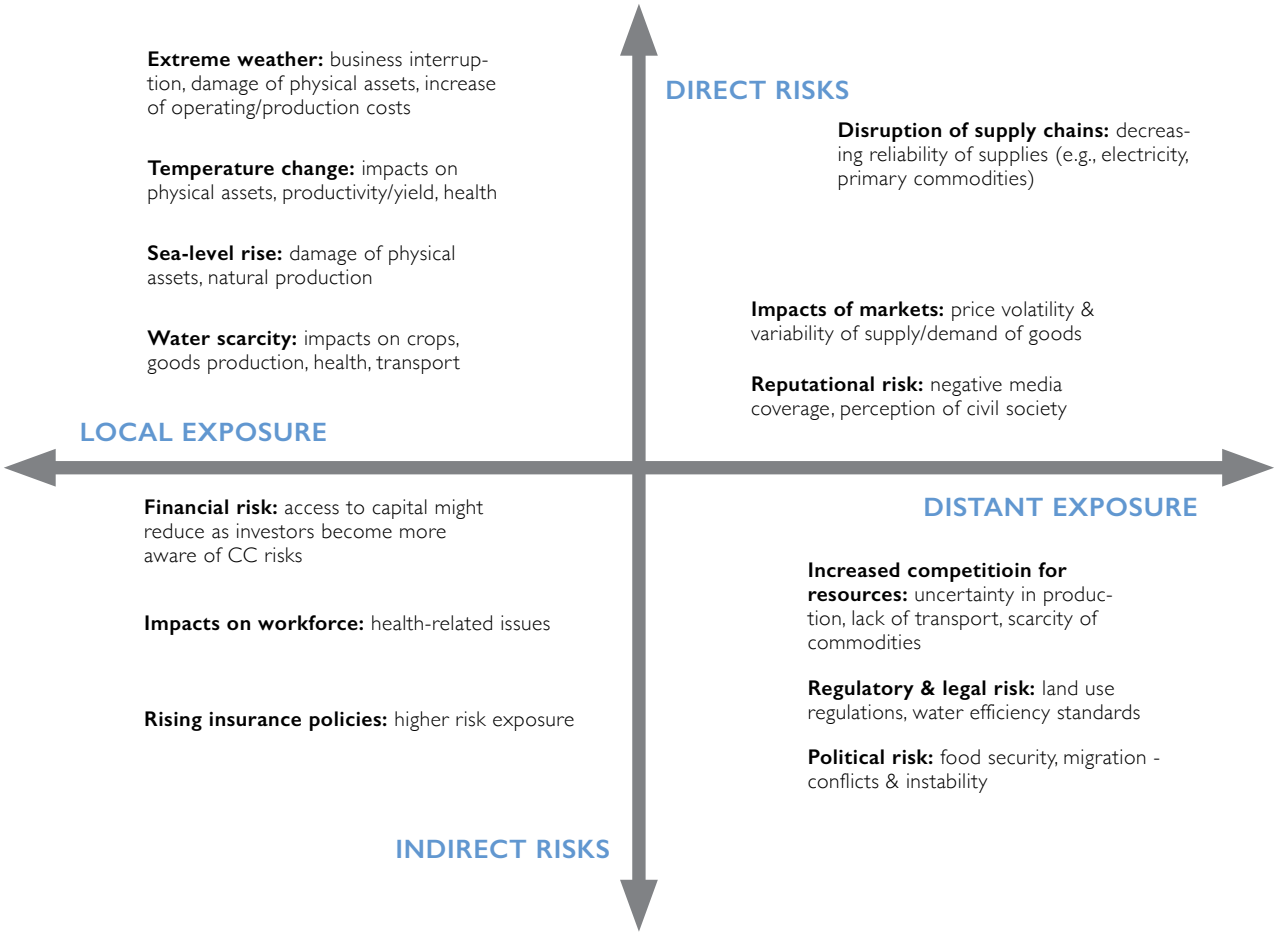


Source: IPCC (2014), Climate Change 2014 Synthesis Report Summary for Policymakers,[11] adapted by FS-UNEP Collaborating Centre

3.2 Risks

Climate change poses direct and indirect risks to business performance with both local and distant exposure.[12] For example, sea level rise poses a direct risk with local exposure, as physical assets may be damaged.

Figure 4. Direct and Indirect Climate Risks to Businesses



Source: Authors, adapted from Pauw (2014)

Direct risks with local exposure, such as extreme weather or temperature change, directly impact enterprises and cause them to adjust business models in order to integrate adaptation considerations. As interconnectivity increases between industries, direct risks with distant exposure, such as the disruption of supply chains, have greater potential to disrupt trade and distribution channels. This may encourage larger businesses to enforce requirements on smaller enterprises in the supply chain, such as increasing energy efficiency or adopting different farming practices.

One indirect risk could be a shift of consumer behaviour due to changing weather patterns; new products and services may result in price adjustments in the market. The impact of the changing climate on human systems may, for example, affect the health of the workforce, which in turn could lead to increased costs of healthcare or higher unemployment due to sick leave (healthcare and health-related climate risks are analysed in Chapter 4).

3.3 Opportunities

Climate change not only presents risks to business activities but is also expected to give rise to new and profitable commercial activities. Broadly speaking, two types of opportunity arise. Firstly, changing weather patterns may alter the demand for goods and services across sectors, including agriculture, (e.g., different kinds of seeds, water-efficient irrigation systems), communication (e.g., technology and information services), and water management (e.g., water saving and purification). Secondly, publicly, or even privately, funded adaptation projects such as climate-resilient roads and flood protection barriers frequently require implementation and co-financing by the private sector.[13] However, it is beyond the scope of this study to attempt to draw a comprehensive picture of new business opportunities. As a rule of thumb, it can be helpful to consider the risk avoidance-side of adaptation and take a closer look at how the money of those who want to react to the increased risk will be spent.

3.4 Risks and Opportunities Across Management Domains

For analysis this study has divided MSMEs and larger corporations into three main areas of structural and operational concern in which adaptation-related activities could be mainstreamed: supply chain, internal production, and downstream market.

- **Supply chain risk for MSMEs and corporations:** Climate change may impact businesses' operation and production at different stages along the supply chain,[14] but may also present new opportunities through supply diversification or new products and services becoming available. Agricultural supply chains are particularly exposed to direct risks such as drought, flooding, or coastal intrusion. Indirect risks such as increased competition, reduced availability of material inputs, or price volatility could also present a challenge to businesses. Also, additionally imposed regulation could further serve to increase input costs.

  Supply chain management is a major component of competitive strategy to enhanced productivity,[15] and MSMEs in particular are more aware of their supply chains, as their management[16] affects overall business operations.[17]

- **Internal production processes:** Business operations face substantial risk of interruption from direct impacts such as flooding and extreme heat. In addition, operations may face other indirect impacts such as higher incidence of disease that affects employees, or higher insurance costs or refused coverage for business interruption, in reflection of the greater risk.

  Typical investments for MSMEs and corporations to address risk on internal production processes may include modernised or adapted technology, equipment, and machinery. These investments generally help to reduce operating expenses. For example, water saving measures can significantly reduce operational costs while at the same time help businesses to address water scarcity. Building insulation can help MSMEs gain a cost advantage as energy consumption can account for 25-50% of the total business costs for MSMEs.[18]

- **Downstream Market:** Climate change can both positively and negatively affect the downstream market of an enterprise, if demand for goods and services change. Some examples from a wide array of new or emerging business opportunities being created are early warning systems through mobile technology, development of water-efficient equipment, and weather index insurance. But as the markets change, demand for existing products may also wane as they become obsolete or irrelevant. For example, enterprises that operate in tourism are particularly exposed to loss of revenue as demand for their products are supressed by physical climate change.

Table 1 shows the various management domains of an enterprise that may be exposed to the above-mentioned impacts of climate change, across corporations and infrastructure. It also starts to provide examples of different adaptation measures to address the resulting climate risks or opportunities. The table is populated with real-world examples from the case studies that are analysed in Annex 1.

Table 1. Adaptation Measures Matrix – Populated with Examples from Case Study Analysis

ACTIVITY TYPE	Climate Impacts	Water Scarcity and Drought	Increased Flooding (including coastal flooding)	Extreme Heat Events (including UHI Effect)	Health-related climate risks
	SME/Corporate				
	Upstream supply chain	Supply chain management, e.g., provide organic pesticides or new pest resistant crop varieties (COOPAC, Rwanda)	Index weather based insurance, e.g., agribusiness firms covering farmers' insurance premiums (Guy Carpenter LLC, Olam and SANAM, Mozambique)	Coordinating the underlying supply chains, e.g., fostering PPPs to the design of infrastructure (Rotterdam Climate Initiative: Water Square)	Supply chain assessment, e.g., identify role of SMEs as part of a larger supply chain (ABBAS Products, India)
	Internal production (including employees)	Water management measures, e.g., investing in water efficient technologies (Coconut Bay Beach Resort and Spa, Saint Lucia)	Strengthening the adaptive capacity of the business, e.g., new MFI loan products for technologies to increase income generating opportunities	Optimising the energy performance of buildings and equipment, e.g., energy efficient equipment (Tokyo)	Manufacturing and distribution, e.g., delivering vector-disease control products (A to Z Textiles Mills)
	Downstream market	New product or service, e.g., sale of new drought resistant agriculture inputs (DBL Group, Bangladesh)	New early warning system technologies, e.g., providing mobile phone weather forecasts through seasonal subscriptions (Farmerline, Ghana)	Products and service innovation, e.g., landscape and urban design (Toronto Climate Change, Clean Air and Sustainable Energy Action Plan, 2007)	Improved access to medical information, e.g., telecommunications for trained doctors to share knowledge to health officers (Tele Medicine)
	Infrastructure				
	Public Infrastructure	Ecosystem-based adaptation options, e.g., Fog Catchers intercepting fog and collecting water droplets for irrigation (Microfinance for Ecosystems-based Adaptation)	Coastal development, e.g., developing new metropolitan coastal area with flood protection (NCICD, Jakarta, Indonesia)	Improve spatial pplanning, e.g., greenification of streets, bike lanes; create parks and open water areas (Ratterdam Climate Initiative)	Drug develoopment based on socio-economic and public health benefits, e.g., research facility (GSK Tres Cantos Medicines Development Campus)
	Private Infrastructure	Constructing/strengthening infrastructure, e.g., construction of large water storage tank with rainwater harvesting (Coconut Bay Beach Resort and Spa, Saint Lucia)	Climate0proofing private infrastructure, e.g., investing in facilities to protect against future flood risk (Terminal Martitimo Muelles El Bosque, Colombia)	Incorporate resilience in building design and construction, e.g., green roofs (Toronto Climate Change, Clean Air and Sustainable Energy plan, 2007)	Affordable health treatment facilities, e.g., running a viable mobile clinic as a standalone enterprise (Siemens Mobile Clinics; Telvent; Nokia; Ericsson)

4. PRIVATE ADAPTATION MEASURES

For protection against the increasing threat of direct or indirect risks to daily business activities, private actors can either take *measures to reduce* or *manage the risk*. This study considers a risk reduction measure to be an activity that reduces either the impact or the likelihood of an impact on a private enterprise.

There are many ways to characterise and analyse adaptation-related measures. Climate change will impact **almost all sectors** either directly or indirectly, and due to its diversity it is impossible to capture all measures in a comprehensive manner within the scope of this report. Instead of analysing all potential measures, for analysis this study has selected four climate impacts and six possible adaptation measures that respond to those impacts; four direct measures that directly respond to a particular impact and two general measures. In this way the study is able to analyse private sector adaptation by exemplifying a specific range of climate change impacts, and the adaptive measures they may implement to reduce those impact on different temporal and spatial scales.

Figure 5. Classification of Project and Activities According to Adaptation Measures

Adaptation Measures	
	Water saving measures to reduce risk of water scarcity and drought
	Protection against flood risk
	Role of pharmaceuticals in health-related climate risks
	Spatial planning to address risks associated with heat stress in urban areas
General Adaptation Measures	
	Climate related insurance Early warning systems for extreme weather events

Source: Authors

4.1 Adaptation Measure 1: Water Saving Measures to Reduce the Risk of Water Scarcity and Drought

Climate change will alter hydrological systems in many regions, changing rainfall patterns, melting snow and ice, causing more intense and frequent extreme rainfall events, and affecting water resource quantity and quality. Climate change will also put additional pressure on water resources that are often already stressed by a number of socio-economic factors, including economic growth and population shifts. **These factors have the potential to create or intensify water supply and demand imbalances, and water stress creates challenges for businesses operating in vulnerable locations.** Given the innumerable current or medium-term risks facing businesses due to water scarcity, many are beginning to take action to build resilience, reduce costs, and gain competitive advantage at various points along their supply chains.

4.2 Adaptation Measure 2: Measures to Reduce Risk of Increased Flooding

Many regions worldwide are experiencing changing rainfall patterns, along with melting snow and ice, shrinking glaciers, and thawing permafrost, which greatly increases risks of flooding at the regional level. The IPCC also found that it is likely that extreme sea levels (for example as experienced in storm surges) have increased since 1970, resulting in the mean sea-level rise.[19]

Low-lying areas already depend on flood risk management measures for their safety, including nature-based solutions, artificial flood defences, and enhanced drainage systems. Sea-level rise is a serious and unidirectional global threat multiplier to coastal ecosystems and socio-economic development,[20] and poses a risk to private enterprisese in low-lying zones. The rate of sea-level rise increased over the course of the twentieth century to around 3.2 mm/year.[21] In developing countries, the costs of protection schemes are often beyond the financial capacity of (local) governments, and may exceed the capabilities of some small island nations.[22] Economic cost-benefit analyses show that investments in coastal protection measures generally pay off in well-populated areas with high value property and strategic infrastructure,[23,24] but not in moderately-populated areas, for agricultural land, or ecosystem areas that must maintain interactions with the sea to retain their function.[25]

To date, the involvement of private sector actors in coastal defence infrastructure has largely been confined to its design and implementation. Typically, private actors have not been involved in the financing of large-scale national schemes due to the lack of a profitable business model. In developing countries, it is frequently multilateral development banks (MDBs) that extend third-party financing.[26]

4.3 Adaptation Measure 3: Role of Pharmaceuticals to Reduce Health-Related Climate Risks

Access to healthcare varies across countries, groups, and individuals, and is largely influenced by social and economic conditions and health policies in countries. Healthcare planning usually occurs centrally among public authorities, but it can also be distributed among market participants. Although the projected climate change impacts were previously **predicted to exacerbate existing health problems**, the IPCC is now predicting that climate change will lead to increased ill-health, particularly in low-income developing countries.[27] In addition to the risk of immediate death as the result of fires, climate impacts such as intense heat waves can also result in reduced food production (leading to the likelihood of under-nutrition), reduced labour productivity or higher unemployment for vulnerable populations, and food, water, and vector-borne diseases. The report goes on to argue **that climate change will increase demand for healthcare services**. The most effective vulnerability reduction measures for health in the near term are programmes that implement and improve basic public health measures, such as ensuring the provision of clean water and sanitation, securing essential healthcare measures including vaccination and child health services, increasing the capacity for disaster preparedness and response, and alleviating poverty.[28]

It is important to acknowledge that the complex nature of health impacts, with multiple causes and interconnections, means that disentangling the climate change signal and motivator for business action is difficult. A number of the larger pharmaceutical companies are

recognising the impacts climate change will have on disease distribution and prevalence, including some 'neglected diseases'[vii,29] such as malaria and dengue. Those multinationals also recognise the market opportunities arising from climate change in relation to the demand for healthcare products. **While it is typically large multinationals that have the technical and financial capabilities to invest in the necessary Research and Development (R&D), a growing number of SMEs are also entering the market.**

Businesses were traditionally dependent on collaboration with government schemes, other social enterprises, NGOs, and Community-Based Organisations (CBOs) to realign research incentives[30] and to make medicines available to the poor at affordable rates, or by offering drugs in conjunction with other affordable treatment facilities.[31] **However, the most common types of health service providers are individuals and SMEs, including medical professionals, clinics, and diagnostic facilities.[32] There are also an increasing number of SMEs joining the pharmaceutical supply chain, producing specialised products for larger pharmaceuticals in the healthcare industry.**

4.4 Adaptation Measure 4: Spatial Planning for Reducing Risks Associated with Heat Stress in Urban Areas

According to the IPCC, many global risks of climate change are concentrated in urban areas, for example heat waves,[33] which are also linked to the risk of mortality and morbidity, particularly for vulnerable urban populations and those working outdoors.[34] Urban Heat Islands (UHI) occur when cities replace natural land with concentrations of infrastructure, which absorb and retain heat. The UHI effect is a prime example of the 'high-level' adaptation planning perspective introduced in Chapter 2. Adaptation planning typically occurs at the macro-level and the public sector plays a key role in coordinating efforts to include the mitigation of UHI effects within the overall framework of urban planning. The challenge that remains in the adaptation-planning perspective is how best to unlock the creativity and investment potential of private actors.

Cities play an important role in coordination efforts. Although individual companies can contribute to reducing the UHI effect, collective action and an integrated approach are required for changes on a city scale. **National and local governments need to shape their own operations and mandate or provide incentives for private actors to adapt. Awareness-raising is a crucial first step to mobilising private action in order to address the UHI effect,[35] and the public sector should elucidate the mechanisms of the UHI effect and its mitigation measures.** At the same time, public actors need to curb or prevent maladaptation, for example when urban development exacerbates the UHI effect.

Many mechanisms and measures to address the UHI effect can be implemented and financed publicly, privately, or in a partnership:[36]

- Reducing anthropogenic heat releases (increasing energy efficiency by: improving the operation of air-conditioning systems, heat insulation, thermo shields and reflectivity of buildings; greening buildings and adopting water-retentive materials; or introducing traffic-control measures, etc.);
- Improving artificial surface covers (for example, reflectivity and water-retention capacity of paving materials; greening of streets and buildings; creating open water spaces);
- Improving urban structures (for example, the orientation of buildings and roads (including wind- and water paths); improving land use (creating large parks and reorienting industrial and commercial activities); and creating a recycling-based society.

A private investment in UHI mitigation might offer private goods and benefits, but will often only have a negligible effect on the local climate, and create public goods. In order to identify the type and scale of private investments in adaptation in urban areas, a number of issues should be taken into consideration. Firstly, most of the market-based value is found in real estate. The value of property assets is a direct function of the performance of the location, which depends on the attractiveness and reliability of the location for residential, retail, and other commercial activities and the revenue streams they produce.[37] Therefore,

vii A diverse group of diseases with distinct characteristics that thrive mainly among the poorest populations.

attractiveness and real estate prices can reinforce each other, which could create more interest in certain measures that mitigate the UHI effect, such as 'greenification'.

Secondly, basic utilities such as water and energy services offer additional revenue streams that can attract private investment for upgrading activities. Yet basic infrastructure (e.g., drainage, road systems, and retention walls) underpin local value but do not generally provide direct investment opportunities.

Although the UHI effect is studied in cities all over the world, most studies focus on technical aspects of causes, effects, and potential solutions. Academic literature mentions private benefits, such as first-mover advantages and a new adaptation market generated by upcoming changes in regulations.[38]

4.5 Adaptation Measures in Response to General Climate Risks

4.5.1 Adaptation Measures 5: Climate-Related Insurance

Policies for financial support of adaptation are often reactive in character, taking the form of relief aid and rehabilitation and reconstruction loans, with insurance being a notable exception.[39] In the adaptation finance debate, (climate) insurance is often considered to be the best and most advanced example of private adaptation financing. The IPCC discusses both the potential for climate insurance to contribute to adaptation, as well as the challenges faced by public institutions to make sure that (climate) insurance does not provide disincentives, cause market failure, and decrease equity. Governments thus play a key role as regulators, providers, or insurers of last resort.[40] Widespread (climate) insurance cover has generally been confined to developed countries so far. In developing countries, innovative climate insurance products could help to spread and transfer risks, where the costs of coping with climate-related natural disasters could outstrip current levels of humanitarian aid. Climate insurance does not necessarily mobilise additional international private climate finance: the insurance programme is generally financed by those insured, and they invest in risk transferring rather than risk reduction behaviour. However, climate insurance may provide incentives for risk reduction and preventative behaviour by reducing the price of insurance policies.[41] Furthermore, climate insurance can improve adaptive capacity by providing beneficiaries with a buffer against climate impacts and therefore secure or ensure private investments.[42]

For private insurance actors, climate change is not only a business opportunity but also a potential risk as it might lead to high claim ratios and lower uptake of insurance cover.[43] As a result, insurers use 'defensive underwriting' through re-pricing insurance policies, applying high deductibles, and withdrawing from high-risk areas.[44]

At the same time, climate insurance presents a new business opportunity, including through weather-index insurance.

The implementation of weather-index insurance also faces obstacles, causing high up-front costs. For example, farmers and insurance sales representatives need to be trained and made aware of longer-term climate change and insurance.[50] Furthermore, significant investment in research (including reliable weather data) and start-up phases (identify, design, and piloting) are necessary to develop weather-index insurance.[51,52] Also, the new understanding of pay-out triggers of index insurance in comparison with indemnity-based insurance needs to be understood: not the factual damage, but a certain threshold. As a result, there can be damage but no pay-out, or no damage but a pay-out. This requires a careful calibration of parametric triggers. Finally, in order for the insurance scheme to work, the climate risk should be spread among a large number of individuals in order to transfer individual risk to a homogenous collective of individuals.[53] This too can be particularly difficult in developing countries.

WEATHER-INDEXED INSURANCE:

Few traditional crop insurance schemes have managed to break-even.[45] For example, loss values are hard to estimate and administrative costs can grow rapidly when a large number of small businesses are insured and loss claims need to be verified. Furthermore, a large deductible is necessary to avoid problems of moral hazard,[46] which could occur, for example, when insurance incentivises farmers to neglect their crops in order to gain a higher pay-out, since compensation is based on the estimated value of what was lost. Finally, adverse selection may arise when the insurer lacks relevant information withheld by the insured.[47] Weather-index insurance reduces such risks because it pre-defines a correlation between crop yields and rainfall. Automatic pay-outs to insured farmers are triggered, for example, when there is a shortage of rain during a crucial period of a crop's growth.[48] Costly in-field assessments of individual farms are not needed to verify damage, which makes insurance more affordable. Furthermore, the pay-out can be set up to occur as soon as the loss-causing event is detected, which helps smallholder farmers to stabilise their incomes and recover more quickly from climate-related shocks.[49]

4.5.2 Adaptation Measures 6: Early Warning Systems Against Extreme Weather Events

Early warning is identified as a priority area for adaptation and disaster risk reduction, as it is a low-regret measure with robust benefits that already help to reduce vulnerability to current weather and climate variability.[54,55]

As 'public goods', early warning systems are often considered a public task.[56] Indeed, in the National Adaptation Programmes of Actions (NAPAs) of least developed countries, early warning systems are often developed by the public sector. However, as governments face funding constraints when developing early warning systems, it is suggested that major parts should be delegated to private agencies or NGOs.[57]

There are both business- and risk-reduction opportunities for private actors through the collection of data, and the development, deployment, and improvement of early warning systems.[58,59] The Information and Communication Technology sector in particular can inform the actions of the government, media, and other private actors in the following ways:[60,61]

- Deployment of systems to collect and model climate information, including satellite imagery, geographic information systems' risk modelling, and post disaster evaluation;
- Early warning measures, e.g. development of integrated (multi-hazard) early warning systems;
- Real-time risk communications on weather and disasters, e.g. tailored for smartphone and mobile phone markets.

5. FINANCING PRIVATE ADAPTATION MEASURES

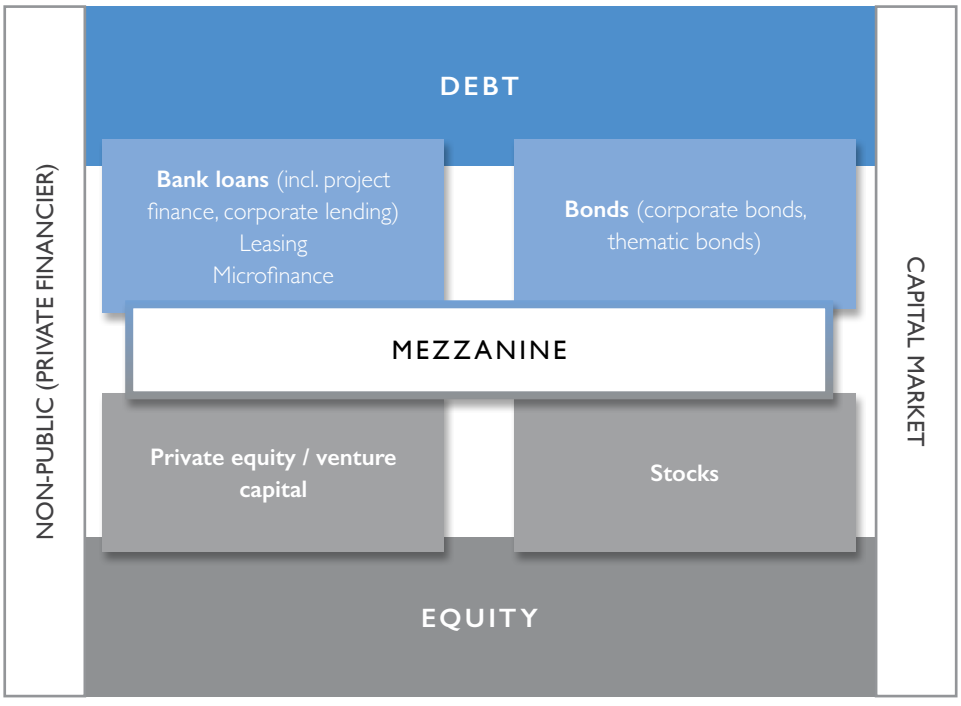
In financing their business activities, private actors have two general options: (1) sharing risks and rewards of their business with additional stakeholders - equity or (2) borrowing capital, referred to as debt. Equity is permanent capital and often influences the business activity, whereas debt financing is an obligation and needs to be repaid with interest.

When businesses aim to raise firm equity, they can approach individuals or institutions for direct investment in return for a portion of the business, or they issue shares on the capital markets, depending on the scale of the company. Alternatively, firms can borrow privately from banks or individual investors, or raise debt on the capital market by, for example, issuing tradable bonds. This is only accessible to large corporations with a sufficient credit rating.

For MSMEs in developing countries, micro/corporate loans directly from banks and other lending institutions provide a source of funding without the need for a formal credit rating or reporting requirements. This source can be used, for example, when an enterprise has no access to capital markets, or tailored debt instrument. However, bank loans typically come at a higher rate of interest, reflecting the credit risk posed by the borrower and the cost of lending.

Figure 6 provides a broad overview of both the debt and equity instruments available to private actors for financing their adaptation-related activities against the source of funding. This illustrates to what extent the source of funding is from private capital provides, or whether the funds are raised on capital markets, typically through securities that can be traded among investors. These are bonds in the case of debt, and stocks in the case of equity.

Figure 6. Financing Instruments For Private Actors



Source: Authors

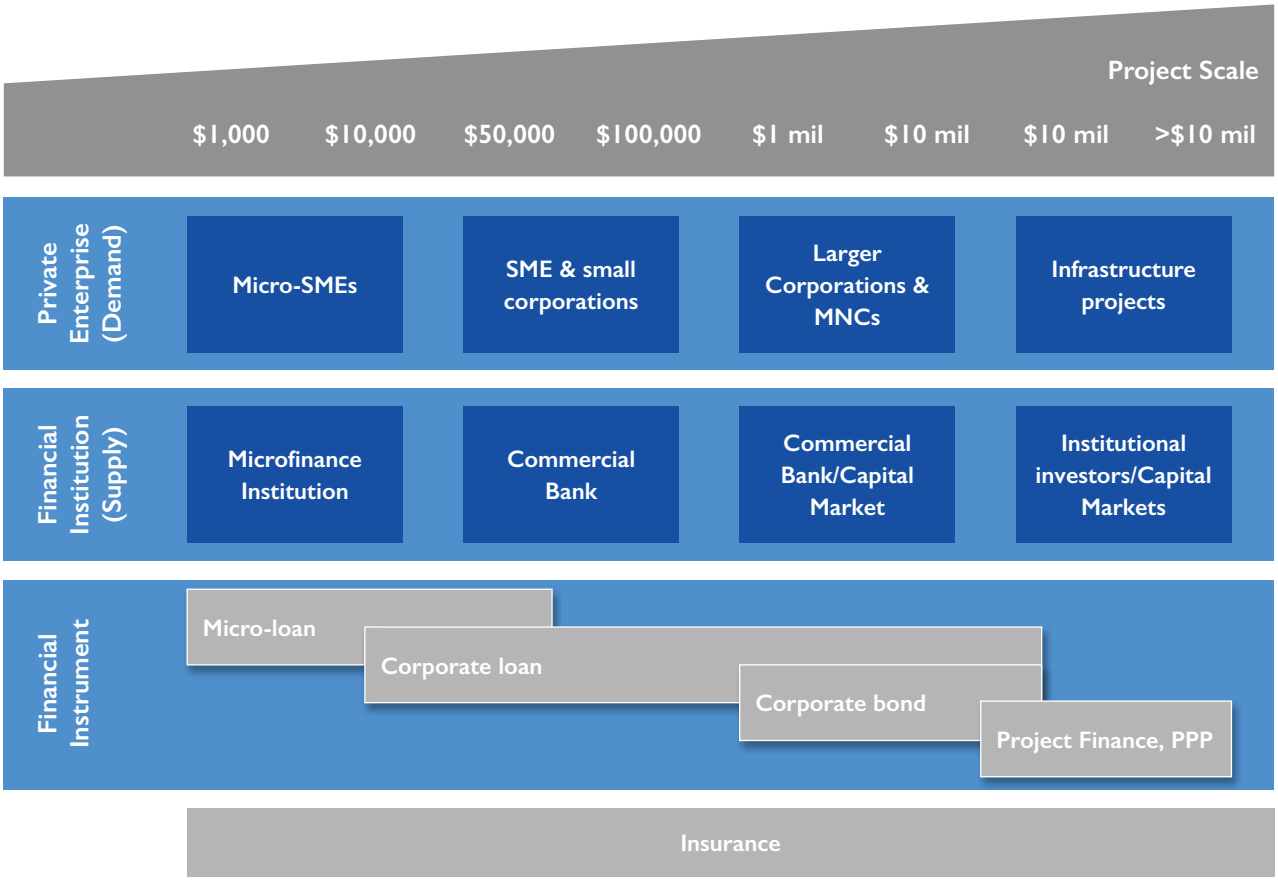
To a large extent, the scale or volume of the capital required determines the choice of the appropriate financing instrument. All flows and transfers of capital carry transaction costs, including contracts and monitoring, etc. These costs also determine the appropriate instrument for a given financing need. Highly standardised and easy-to-handle procedures, for example, loans from MFIs or banks) carry lower transaction costs and are often used for

smaller scale financing. Larger loans to corporations require individual loan contracts and will therefore be less standardised and more expensive to implement, and so require higher volumes in order to be attractive.

The longer-term capital needs of larger corporations may be served by directly by issuing bonds or shares to the capital market. Companies will typically enlist the services of an investment bank to mediate between themselves and the market, increasing the transaction cost compared to an individual loan contract. However large, credit worthy companies tend to have to pay less interest if they borrow direct from capital markets rather than banks, making this option attractive for high-volume, long-term financing.

Large infrastructure projects, such as power plants, toll-roads or telecommunication networks, are mostly funded through project financing. In this case, the project itself is designed as a dedicated company (special purpose vehicle) into which a sponsor injects equity and has a strong influence over how the project is run. At the same time the project company borrows from banks, or issues a 'project bond' directly to investors; this form of financing requires the project, as a stand-alone legal entity separate from its corporate 'sponsor', to be bankable. In other words, the single purpose vehicle needs to be able to generate the cash flows required for debt service and dividends.[62]

Figure 7. The Debt Financing Options for Private Enterprises Varying by Type and Scale



Source: Authors

As shown in Chapter 3, private actors can react to climate change either by launching a new business or complementing existing operations through new measures. Thus, if an adaptation measure is added to the underlying core business activity as a component, the appropriate financing decision and instrument will be determined as it would otherwise be without the adaptation component. As for any adaptation measure that is discrete and 'stand-alone', the financing decision and instrument is also likely to be arranged accordingly. This is in line with the observation that private actors are frequently unaware that what they are already doing is adaption. This premise is demonstrated by a large variety of instruments as illustrated in Table 2 and also tested through the analysis of 28 case studies in Chapter 7.

Table 2. An Overview of (Private) Finance Instruments

Finance Instrument	Actors financing innovation (demand)	Actors providing finance (supply)	Description	Examples for adaptation related activities (see Annex 1 for more information)
Debt Instruments				
Debt financing is contractually fixed, for a specified period of time, and is often secured by collateral. Collateral is a security to the financier that the loan will be repaid, and may include guarantors, assets or savings.				
Microfinance	MSMEs, individual clients	Microfinance institutions (MFIs), commercial banks with micro-finance functions	Microfinance is a form of financial services for small businesses, entrepreneurs and households to access finance and related services. The main role for microfinance is to enhance financial inclusion at affordable costs to disadvantaged and low-income communities; mainly members of poorer sections of the population. Loans must typically be fully repaid before follow-up loans are provided	The Microfinance for Ecosystem based Adaptation project (MEbA) works with MFIs in Colombia and Peru to enhance access of vulnerable populations to financial products and services aimed at increasing resilience to climate change. MFIs are supported to develop dedicated loan products for ecosystem-based adaptation (EbA) measures, including diversification of agricultural production. Climate-smart lending enhances the MFIs outreach in rural areas while decreasing their operational and financial risk. Strategic investments also improve their clients' resilience to climate threats and ensure the sustainability of ecosystem services on which they depend
Balance sheet based lending	Utilities, corporations, SMEs	Commercial banks with corporate functions	Borrowing on-balance sheet is a main form of financing existing business and assets. Here, companies realise a new investment through additional debt on the balance sheet. The company as a whole becomes liable for the debt. In an event of default, the lenders would have access to all of the company's assets used in existing operations, as well as a claim on the new investment	The findings of an IFC feasibility study identified a number of potential adaptation measures for the Terminal Maritimo Muelles El Bosque Port in Colombia (MEB) to prevent loss and damage threatened by climate change. A financial analysis demonstrated that an initial investment in a number of adaptation measures would realise reduced operating and maintenance costs. MEB took out a commercial loan to finance such measures. The relationship between health and climate change is complex; however, IPCC reports that changes in infectious disease transmission patterns are likely to be a major consequence of climate change and research and development (R&D) efforts are required to understand the underlying complex causal relationships.[63] A to Z Textiles Mills, a small textile manufacturer in East Africa, formed a consortium with a number of partners to manufacture and distribute, among others, long-lasting insecticidal bed nets. Acumen Fund provided USD 325,000 corporate debt financing for A to Z to buy capital equipment and modify their factory
Concessional lending	A range of different actors	MDBs, government agencies	Concessional loans, or soft loans, are provided with terms more generous than market loans. For example, an interest rate below market rate, or a longer grace period	An industrial estate in Thailand suffered a period of closure following Thailand's largest ever flood in 2011. The Government proposed flood prevention measures, but the Estate decided to build a new 11km long dike, an adaptation measure to protect against future flooding. The dike was financed, in part, by a 15 year concessional loan provided by the government at 0,01% interest for 7 years. The Estate is now lobbying for a favourable interest rate for the remaining 8 years

Finance Instrument	Actors financing innovation (demand)	Actors providing finance (supply)	Description	Examples for adaptation related activities (see Annex 1 for more information)
Leasing	A range of different actors	Commercial banks, non-bank financial institutions	A lease is a contractual arrangement whereby a user of an asset can pay the owner for use of that asset. Leasing commonly includes property, building and vehicles or business equipment	The changing climate is predicted to significantly impact businesses through damage to infrastructure and assets, disrupting supply chains, threatening employee health, and changing consumer demand for products and services. Pharmaceutical companies play an important role in public health and healthcare systems which are increasingly affected by extreme weather events such as flooding, as well as increasing incidence and intensify of food, water and vector borne diseases. SMEs are playing an increasingly important role in the pharmaceuticals industry, forming part of the supply chain offering diverse services and products, or components, necessary to respond to the predicted climate driven increase in infectious diseases. SMEs in this industry typically have high finance needs, particularly for specialised equipment. In India, Intec Capital Ltd offer financial products and services to these SMEs; for example the option to acquire specialised machinery through lease. Intec buys and owns the machinery, and at the end of the lease term the SME can purchase, retain or return it[64]
Project finance	Project developers, Governments, infrastructure investors	Commercial banks, infrastructure funds	Project finance is a way of financing large-scale and long-term infrastructure projects. The income to be generated by the project can typically be isolated from the other income of the business ('ring-fenced'). This usually required the formation of a 'special purpose vehicle'; a company which owns the assets and becomes the counterparty of lenders and other project stakeholders. The basic idea of project finance is that lenders advance money for the development and/or realisation of a project solely based on projected cash flows to be generated by the project	
Bonds (including asset-backed and 'thematic' bonds)	Different actors ranging from corporations (in the case of corporate bonds), project sponsors (in the case of project bonds), banks (in the case of bonds backed by loan pools), and Governments (in the case of sovereign bonds)	Retail and institutional investors (pension funds, insurers), including via specialized infrastructure funds	Bonds are an instrument of debt from the bond issuer to the bond holder. The bond issuer is usually obliged to pay interest and pay back the principal at the bond maturity date. The bond issuer can use the funds to finance longer term investments. Climate thematic bonds are debt securities linked to climate change mitigation or adaptation solutions	In 2014, Unilever issued a USD 411m sustainability bond for water improvements in manufacturing plants. The bond had a 4-year maturity with a 2% fixed interest rate. It is linked to projects that improve the energy and water efficiency in internal operations; each project must reduce CO2 emissions or water use by 50% (new project) or 30% (retrofit), against a 2008 baseline, in order to be included.[65] Despite being a general corporate obligation, an auditing firm analysed the bond to provide assurances that the funds are being tracked and directed to the stated sustainability projects[66]

Finance Instrument	Actors financing innovation (demand)	Actors providing finance (supply)	Description	Examples for adaptation related activities (see Annex 1 for more information)
Equity Instruments				
Equity financing involves the sale of an ownership interest to raise funds for business purposes.				
Venture capital	Entrepreneurs, start-up companies	Venture capital investors	Venture capital investors provide early stage capital to typically new and small technology companies or project developers. They take significant risk but expect equally high returns	Farmerline, an SME in Ghana, utilises mobile phone technology to support farmers' activities by providing reliable daily information on weather forecast and climate information. Farmerline's business model was developed based on a new business opportunity identified within a unique place in the adaptation value chain. Following the receipt of an upfront grant, which was used to develop and expand activities, Farmerline received an equity investment from seed capital firm Village Capital and is now seeking further equity investments
Stock	Corporations	A range of from private investors to institutional investors	Common stock gives holders ownership of a corporation as well as voting rights. In the event of company liquidation however, common stock owners are only entitled to the remaining assets after all creditors' liabilities are satisfied. For the company, issuing common stock is a source of permanent, long-term capital	GlaxoSmithKline (GSK) is a pharmaceutical company with publicly listed common stock. Most recently there were about 2.5 billion of shares outstanding, which at the current stock price values the company at close to USD 100 billion in market capitalisation. Similar to other large Multinational Corporations (MNCs), the company's shares are listed on multiple stock exchanges (London, New York).[67] GSK is one of the largest pharmaceutical companies in the world. In 2005 it established a Foundation to research diseases such as malaria and tuberculosis. Such R&D activities are increasingly important as that changes in infectious disease transmission patterns are likely to be a major consequence of climate change and R&D efforts are required to understand the underlying complex causal relationships[68]
Mezzanine Instruments				
Mezzanine instruments provide a hybrid of debt and equity and may include subordinated debt, preferred stock, project-specific arrangements, risk-oriented yield, or conversion options. Typically mezzanine finance is provided as debt capital which can be converted into equity if the loan is not repaid. For example, 5% of the SME investment volume from KfW Development Bank in 2014 was financed from 'other sources' including mezzanine capital.[69] The Africa Agriculture and Trade Investment Fund, initiated by KfW on behalf of the German Federal Ministry for Economic Corporation and Development (BMZ), is managed by Deutsche Asset and Wealth Management. It provides mezzanine instruments and senior debt to support on-lending by local financial institutions or select intermediary agribusinesses.[70] The Fund supports climate adaptation through the development of agricultural production, manufacturing, services and trade in Africa				
Risk Mitigation Instruments				
Public-private partnerships	Cooperation between public authorities and private actors		The public sector can incentivise projects undertaken or invested in by private sector actors through different instruments. Public-private partnerships (PPPs) enable the public sector to transfer the provision, or a part of the provision, of services to private providers. These private partners receive remuneration only for exactly specified services and take over some of the risks for the creation and/or operation of that asset	GE Healthcare works with local organisations globally to meet the healthcare needs of growing populations. The provision of healthcare services and infrastructure to improve basic public health measures is reported by IPCC to be important to reduce the increasing climate impacts on health. GE Healthcare work with governments, health systems, financiers, contractors and other stakeholders to develop Managed Equipment Services (see Annex 1) through PPPs. PPPs help to share risks, provide access to capital funding, ensure facilities are completed on-time and budget, help cost savings and ensure efficiency gains in health services delivery, among others[71]

Finance Instrument	Actors financing innovation (demand)	Actors providing finance (supply)	Description	Examples for adaptation related activities (see Annex 1 for more information)
Insurance	A range of actors from individual clients to countries	Insurance companies	Insurance provides an important instrument for reducing the extent of possible losses of those who invest and hold assets	Guy Carpenter LLC, Mozambique launched weather index insurance for farmers, focusing on drought, low temperature and excess rainfall risks. Agribusiness firms within the value chain covered their farmers' insurance premiums, using a 'portfolio pricing' model (see Annex 1)

Source: Authors if not mentioned differently; Note: Case studies are explained and analysed in Annex 1

The capital requirement of an investment, and the nature of the entity requiring capital, determines the most appropriate financing partner and financial instrument to be used. On the demand side, the actor-based perspective concentrates on the spectrum of private enterprises; MSMEs to large corporate adaption projects, which, as illustrated in Figure 7, have a corresponding spectrum of private financiers on the supply side.

Private Enterprises

All private enterprises must manage capital and operating expenses. Capital expense is incurred during the establishment of a business and any subsequent scaling-up, while operating expenses are incurred in all business operations, including payment of salaries, rent, utilities, and raw materials.

In response to the business and financial needs of MSMEs, financial institutions have developed a range of financial products, in particular loans for working capital and business expansion, business protection, and profit enhancement. Business expansion requires capital investments that are usually mid- to long-term and that can be financed by retained business profits, new capital from business owners, but more likely loans from financial institutions.[72]

Well-designed adaptation-related activities may show positive cash flows that allow the projects to pay back investments through cost savings such as water saving technology investments. However, MSMEs first need to realise the investments that require protection, or to raise finance for new business opportunities.

However, many MSMEs struggle to obtain finance from the formal financial system, and these factors come together as a 'financing gap'. Without working capital, MSMEs cannot expand or take advantage of market opportunities. Without a fixed asset loan, MSMEs may lack the liquidity to make a larger investment in, for example, a more efficient technology, even though it may produce favourable returns in the long run.

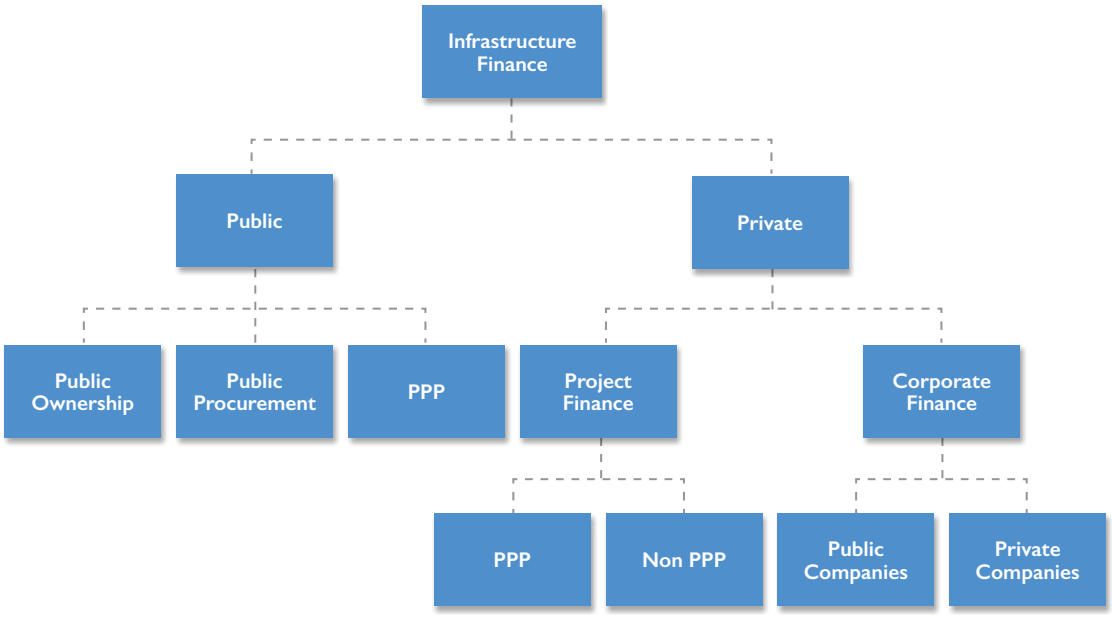
Climate change impacts are a growing concern and MSMEs are reported to be disproportionately vulnerable. For example, direct effects may include damage to assets and infrastructure, interruption of operations, or damage to products.[73] Indirect effects may include raw material availability, incidence of diseases affecting employees, increased cost of transport, and/or decreased demand for existing products. Therefore, climate change has the potential to increase costs faced by MSMEs, and this may further increase the 'financing gap'.

Infrastructure

Infrastructure assets such as transportation networks, health and education facilities, communications networks, and water and energy distribution systems are essential for the productivity of an economy, and most are impacted by climate change. At the same time, maintaining robust and resilient infrastructure systems will help economies adapt to climate change.

Existing assets may require retrofitting, as ageing assets may be replaced or adjusted, for example, to increase the capacity of sewer systems in cities or to protect railway networks against flooding. These retrofitting investments may incorporate adaptation components that increase resilience to future climate impacts. New infrastructure assets may directly include an adaptation component, such as making roads resilient against intense rainwater runoff or to protect new coastal infrastructure against sea-level rise. Infrastructure projects, typically being large and long term**, have substantially different financing from MSMEs and corporations**. Figure 8 outlines the many actors involved in infrastructure finance, while the role of public policy is addressed in Chapter 8.

Figure 8. Infrastructure Finance

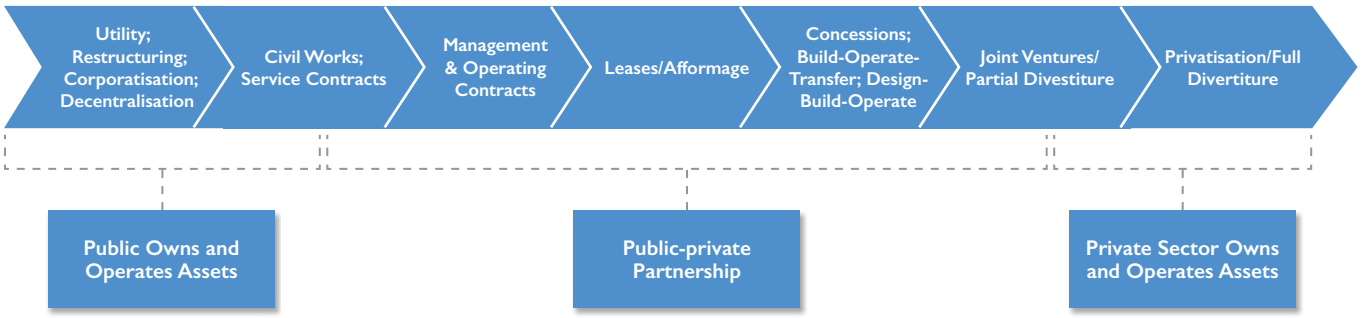


Source: Klein, M., Frankfurt School of Finance and Management

It is generally expected that public infrastructure is provided by public institutions, mandated by the government. In these cases, the infrastructure provides primarily a public good. Governments, MDBs, and export credit agencies, along with state-owned infrastructure banks, play an important role in financing publically-owned infrastructure projects; however, private financing will also continue to grow in importance.[74]

Where the role of the government ends and the role of private actors start differs depending on country, sector, and project. Recent years have seen an increased role of public-private partnerships (PPPs). While private investors have traditionally been involved in financing public investments (e.g., through government bonds bought by private investors), they are increasingly explicitly involved, for example through build-operate-transfer schemes, a form of project financing where the private actor receives a concession from public or private sources to finance, design, construct, and operate a facility.[75]

Figure 9: The Spectrum of Private Participation in Infrastructure



Source: World Bank (2010)[76]

The relatively long time between construction and the generation of positive cash flows requires long-term capital, which can make private finance difficult and costly. In the present climate, the key challenge for debt markets remains attracting institutional pension fund money with a long-term investment horizon corresponding to long-term climate-related activities. Long-term investors such as insurers and pension funds are eager to invest in infrastructure, as are endowments and sovereign-wealth funds.[78] However, market participants try to create multi-investor institutional debt funds or find structured products that mitigate the risk of senior debt.[viii], [79] The impacts of Basel III regulations are still being established in the markets, but are likely to reduce the supply of long-term debt still further.

The **long-term nature** of these investments also determines the role of the government. In cases considered as public infrastructure this is obvious, as it is in the direct interest of the government to realise the project. Correspondingly, the government has available a range of options in order to take specific risks or inject public funds into a project either to make less private funds necessary or to make the financing from private sources more attractive (e.g., through public guarantees for specific risks).

The typical approach to financing large-scale infrastructure projects is project finance. Here, a new legal entity will be established: a special purpose vehicle that needs to be equipped – typically through equity – in order to be capable of undertaking the project. The equity enables the project company to develop the business plan sufficiently and ensure contracts are in place, for example for the provision of specific services, so that the project company is an attractive borrower from the perspective of other investors, such as banks or even capital market participants buying bonds. Typical actors on the supply side of financing are large commercial banks and institutional investors such as pension funds.

The government could also decide to intervene more actively based on a spectrum of options. These can include taking specific risks, such as providing export credit insurance or more directly buying the services offered by the project, via broader guarantees. Or, a more facilitative role assisting in the appropriate risk quantification efforts or appropriate structuring of such projects in an environment characterised by climate change.

Bank loans often supply a large share of financing in the initial phases of infrastructure projects, since they are flexible enough to provide a gradual disbursement of funds.[77] In extending a loan, a bank takes on a considerable risk, particularly during the initial phase, until the project is generating revenue and is cash-positive.

viii Senior debt is debt the company must repay first if it goes out of business. Ranking junior to senior debt serves as a risk buffer for senior debt tranches, making it more attractive for private investors.

6. BARRIERS TO PRIVATE ADAPTATION FINANCE

There are already many private and commercially financed adaptation-related activities where demand matches supply of finance. However, concerns remain that progress is insufficient,[80] and a 'shortfall' exists between the expected adaptation investments required and the current flows of finance towards adaptation-related projects.[81] This is especially true for MSMEs. This raises the question of what "barriers" keep adaptation-related projects from materialising, or whether they generate situations where the demand and supply of adaptation-related finance do not match.[82] In order to identify, design and implement public policy or public financial interventions to move adaptation forward, it is important to understand why markets sometimes fail to provide the necessary supply of finance. This chapter focuses on understanding barriers to private adaptation finance as a starting point to designing potential public interventions.

There is a considerable body of literature about so-called barriers to adaptation investment, and the research has demonstrated that many adaptation-related activities face obstacles to their implementation and appear to have adopted versions of a broad and descriptive understanding:

"Obstacles can be overcome with concerted effort, creative management, change of thinking, prioritisation, and related shifts in resources, land uses, institutions, etc."[83]

Although there are overlaps, the six most frequently discussed typological groupings of barriers to investing in adaptation are: financial barriers, information barriers, institutional barriers, political and regulatory barriers, technological barriers, and socio-cultural barriers, as summarised in Table 3.

Table 3 indicates that barriers mentioned in the literature mainly refer to the demand side of financing. Technological barriers, like limitations in modeling accurate weather forecasts, reduce the chances of identifying climate risks and assess their implications on adaptation activities. This impacts the demand for financing of adaptation-related activities. Financial and informational barriers, in contrast, often refer to both the demand-side and supply-side of financing. Examples include lack of long-term debt, limited access to formal credit, and information and knowledge gaps either at the project level or within financial institutions, which reflect shortcomings on the demand and supply side of financing.

Table 3. Typology of Adaptation Barriers in the Selected Literature

Adaptation Barriers	Description	CPI 2015[84]	Islam 2014[85]	Antwi-Agyei[86]	Barnett[87]	Jones[88]	Vivid Economics[89]	PCIR 2012[90]	Stenek 2013[91]
Financial	Lack of financial resource, budget constraints or lack of access to credit	Funding, revenue and risk coverage gap	Budget constraints; limited access to formal credit	Lack of resources; limited availability of formal, market-rate loans to smallholders and micro-SMEs			Lack of donor co-financing; lack of long-term debt	Provision of public goods, split incentives	Lack of economic incentives
Information	Informational and knowledge gaps pertaining to future climate developments; lack of, or limited access to, tools to assess risks and opportunities related to the implementation of adaptation projects	Knowledge gaps		Lack of climate data; lack of awareness of climate change and climate risks		Human and informational barriers	Lack of aware-ness and capacity; asymmetric information	Imperfect information	Lack of data and information
Institutional	General shortcomings in institutional arrangements and governance, in the public and/ or private space		Lack of access to markets	Lack of institu-tional capacity	Path dependency and inertia (lack of willingness to change)		Shortcomings in institutional and regulatory environment, e.g. institutional competition, layered bureaucracy and entrenched rules	Shortcomings in governance and institutional arrangements, e.g. accountability and transparency, coordination and community involvement	Path dependency in/for institutional arrangements
Political & Regulatory	Adverse effects of policy & regulation on the business motivations for adaptation investing	Policy gap; policy distorting price signals	Lack of legal and regulatory enforcement	Top-down government approach not effective locally				Lack policy and regulatory barriers	lack of policies (standards, codes, zoning, permits)
Technological	Lacking availability of, or access to, advanced technologies, tools and structures		Technological limitations in modelling accurate weather and climate forecasts	Top-down government approach not effective locally					Lack of policies (standards, codes, zoning, permits)
Social & Cultural	Social and cultural processes that govern how people and other stakeholders react to climate variability and change		Lack of educa-tion/ skills; ethics and coercion	Technology not applicable to local context		Cognitive; normative; institutional[92]		Behavioural barriers	

Table 3 illustrates that the term 'barrier' is typically used in a descriptive way in the adaptation literature, and refers to obstacles. This is different in the broader economic literature, e.g., on trade or capital markets, where the term carries normative aspects in the sense that barriers keep markets from functioning efficiently. Since overcoming barriers is frequently used to guide policy design, a descriptive understanding of the term is not sufficient in that it implies simply realising more investments in adaptation. Further, it does not appropriately allow for a reflection of the real costs, economy-wide of overcoming the barrier, nor does it capture varying degrees of efficiency associated with different pathways towards the intended structural change. As such, it ignores alternative options to improve market and financial market functioning.[93]

A reference to efficiency is key if a narrative on the removal of barriers is to be used to inform public policies (and other public interventions) on how to facilitate the structural change. This is because in this case, overcoming a barrier tends to increase efficiency and improves the quality of the investment decision from a societal perspective.

Since the focus of the study is enabling the market to perform its role in financing adaptation, it therefore adopts a narrower definition that is inspired by the traditional understanding of barriers in the literature on trade or capital markets.[94,95] For this study, barriers to investment in adaptation-related activities are defined as:

"A friction that prevents socially optimal (adaptation-related) investments from being commercially attractive".

The major difference between this narrower definition and the earlier, rather broad definition is the reference to the 'social optimum', which describes the ideal distribution of resources in a society. As stated by Ekholm et al. (2013), "In an ideal environment in which markets are complete and competitive [and there exist no market imperfections] investments will be at a socially optimal level".[96] From this it may be concluded that market imperfections are the main reason why the real world is currently not conducive towards levels of private adaptation finance flowing at socially-optimal levels. For this study, market imperfections in adaptation-related activities are classified into:

- positive externalities;
- an imperfect capital market;
- asymmetric information;
- and other potentially unjustified market imperfections.

These market imperfections lead to an 'unjustified' reduction of the commercial attractiveness of an adaptation investment relative to the hypothetical case of a functioning markets. From the perspective of an investor, this will appear in the form of reduced return or increased risk of the adaptation-related activity.

The market imperfections have been identified based on the case studies and a literature review. This approach is explained and exemplified based on adaptation cases in order to demonstrate the practical use of the concept. The barriers are characterised with respect to two dimensions:

1. **Economic classification of the market imperfection:** Grouping of the market imperfections according to the underlying economic mechanism;
2. **Demand of the financing perspective:** From the perspective of an investor, it is not the market imperfection that is primarily relevant but rather its consequences on risk and return on investment.

The separation of impacts on return, risk, or both allows for a differentiation between the types of risk that are particularly relevant for targeted government intervention. We differentiate between output risk, input risk, labour-force risk, liquidity risk, and regulatory and policy risk.

6.1 Positive Externalities of Adaptation-Related Investments

Frequently, adaptation-related activities that would naturally be undertaken by commercial actors provide more than just private goods that can be sold and generate revenues, but also so-called public goods, which benefit others but do not generate direct revenues. Prominent examples are approaches to reduce the UHI effect (cases 22 - Toronto, 23 - Rotterdam, and 24 - Tokyo), for example by applying more efficient air conditioning systems.[ix] Here, the private benefit, such as more efficient air conditioning, appears in the form of a decreased energy bill, whereas the public benefit, such as the resulting reduction of urban heat, does not increase the attractiveness of the investment.

In addition there is also an on-going debate about negative externalities where an activity has a negative impact on others (maladaptation), for example dikes protecting an industrial area from flooding (commercial, private good), but also increasing other flood risks ("public bad", a negative impact on others) (case 7).

Positive externalities can also appear in the form of so-called technology-spillovers, which can mean that a project generates lessons learnt that will be helpful for other actors in the future but do not add to the revenues of the investor now. As a consequence, the return on investment is below what it should be, impeding the commercial viability of the activity. One prominent area where technology spillovers may be identified is improved access to drugs within the theme of health-related climate risks (cases 19 – GSK's research facility in Tres Cantos, Spain, 20 – The Medicines for Malaria Venture (MMV), or 21 – GSK's development of a malaria vaccine (RTS,S) in PPP with MVI and the Bill and Melinda Gates Foundation).

6.2 Incomplete or Asymmetric Information

Many barriers to activities related to adaptation are rooted in incomplete or asymmetric information, the simplest form being that a small enterprise is not aware of what can be expected from climate change or of existing technologies to cope with the consequences. This would obviously keep this enterprise from making optimal investment decisions. Examples include MEbA (case 3), where one component of the project was to make farmers and financier aware of low-cost options to adapt to climate change. Ericsson's Mobile Weather Alert project (case 28) targeted at fishermen may serve as another example of tackling this barrier.

A more subtle problem for MSMEs related to asymmetric information is more common and can be considered a traditional challenge, regardless of any adaptation context: relative to the (small) financial volume, the efforts of the bank to understand and evaluate the business model, business environment, supply chain specific, and other related risks are high. **This reduces the attractiveness of MSME-lending for a bank, leading to a financing challenge for MSMEs in general. Adaptation efforts will exacerbate that challenge, as climate change might affect the business in a more complex way, and one that is even more difficult to estimate.**

A third way in which asymmetric information can become relevant to investment returns is **if one party is responsible, for example, for an infrastructure investment, while another makes decisions on using this infrastructure.** As an example, if a real estate developer is planning and constructing water, sanitation, and irrigation, they might look to minimise the investment cost as this is the main dimension along which they compete with other offers. This might, however, fail to take into account potential water savings for the whole lifetime of the infrastructure. Thus the developer has a reduced incentive to suggest a water-efficient infrastructure. This effect would be amplified by the presence of a subsidised water price.

A last channel to flag in this context is the lack of information – not just at the company level as discussed above but more generally, in the form of scientific uncertainty about climate change. This uncertainty may of course appear in financing decisions. The consequences will be discussed later, in the context of the capital market and its abilities to provide insurance.

ix The case numbers refer to the in-depth cases described and analysed in Chapter 5 and Annex 1.

6.3 Imperfect Capital Markets

There are some examples of imperfections on capital markets[x] holding back adaptation-related financing. One common challenge, relevant even beyond adaptation finance, is **the lack of a liquid, long-term capital market.**

As climate impacts often materialise on longer time-scales, increased demand for long-term debt will emphasise the general problem of illiquid long-term credit markets and is at odds with the preference of regulatory interventions for shorter maturity. In principle, those investments are looking out for institutional investors such as pension funds and life insurers as they have increasing assets under management driven by a number of factors, amongst which longevity plays a role. The result is to divert an increasing portion of investor capital, from the more typical asset classes such as listed equities and bonds, into long-tenor investments – such as infrastructure – to match their long-tenor liabilities.

More frequently, financing is held back by **different levels of information** on the financing demand versus the financing supply side. This is strongly related to the issue of asymmetric information as discussed above. Practical examples would be the awareness of MFIs or banks about climate impacts and adaptation options (case 3 – MEbA or case 4 – coffee processing in Rwanda).

A final channel through which imperfect capital markets hold back private adaptation investments relates to **uncertainty about climate change** itself (as already discussed related to asymmetric information): some uncertain climate parameters or their direct consequences may be key revenue drivers for projects. As businesses will want to hedge those risks that they are unable to influence themselves, they depend on the provision of insurances if they ask for debt. However, especially in the field of climate-related risks, insurances are not always available. This is a prominent example for an incomplete financial market.

These barriers and solutions can be practically observed in weather insurance schemes (case 11 – Thailand, where weather-index insurance is provided) but also timely and targeted information can help reduce climate-related risk and potentially make access to financing easier (case 26 on weather and climate information provided to farmers in Ghana via mobile networks).

6.4 Lacking Markets & Other imperfections

There may be more barriers that keep adaptation investment below the optimal level. Depending on the specific circumstances, they might be traced back to the market imperfections, as discussed above. In some cases, the barriers might stem from policy interventions that are explicitly designed to avoid markets for some goods. As will be discussed below, it seems implausible to aim for the introduction of 'perfect' markets, but there is a need to be aware that market absence has consequences that must be resolved.

Perhaps the most prominent adaptation-related example for the lack of a market is the water sector, when water prices are kept at fixed levels below what would reflect the true scarcity of water in a given region. As an immediate consequence, any investment in water saving becomes less attractive than it should be, based on the true scarcity (i.e. a higher price) of water.

Two among many examples and approaches are water efficiency improvement measures in a textile factory in Bangladesh (case 1) or water infrastructure investment in Saint Lucia (case 2). If the price of water is low, then the incentive to invest in water efficiency is low as well.

6.5 The Case of No Barrier

As this study focuses on private finance, it seems worth noting that we also observe many cases of adaptation investment where no significant barrier is holding back the flow of finance. **However, we see many examples where adaptation investments do not face fundamental barriers. This seems to appear more often if the adaptation investment is related to a business opportunity arising from climate change.** Some examples based on our set of case studies come from companies selling emergency products such as

x The miss-allocation of capital by financial markets, partly due to policy and regulatory rules, which, for example, results in risk mispricing, or excess capital weighting for specific asset classes and create distortions in the risk/return profile of an adaptation investment.

bed nets or textiles (cases 13 and 14), which are typically bought by governments or government-mandated institutions for distribution, or medical healthcare products for which demand is expected to increase (e.g., cases 15, 17, 18).

Based on the study's broad understanding of what constitutes an "adaptation-related" activity it seems likely that many investments happening around the globe match the study's definition, but are generally not implemented with adaptation as a core goal. Likewise, many of those activities might not face major barriers. This supports our earlier statement that considerable investment in adaptation is already happening without public intervention.

The conceptual summary of the barriers and their underlying mechanisms is shown in Table 4, which sorts the main barriers into columns according to the underlying market imperfection. The rows indicate the investor's perspective, the consequence of the barrier on the risk, or the return of the investment. This table enables a systematic identification of the most relevant barriers and can be applied at different levels, e.g. for a given sector, country, or project level from different actors' perspectives.

6.6 Implementing the Approach

At the project level, the identification of barriers and the resulting risk-return impact could support the decision to provide public support to a project, for example, if the Green Climate Fund (GCF) wants to determine whether to provide financial support to a given project. At the national level, a differentiated analysis of the barriers to adaptation-related activities per sector or region guides a systematic analysis of the market-functioning related to adaptation. This can be the base for national policies or an input to national adaptation planning.

Simply put, this framework can be flexibly adapted to gain a general idea of a market imperfection and its risk-return impact for different actors informing policy or support decisions. However, it does not provide an indication regarding the prioritisation of the observed barriers.

The twofold perspective on the barrier identified in Table 4 (i.e., the conceptual economic perspective and the financing perspective) will naturally point to two general approaches to overcome the barriers:

1. **Correcting the market imperfection:** either market institutions or regulation might be altered in order to remove or decrease the market imperfection. A variety of instruments exist to correct the market failure. Market failures due to a public good can, for example, be addressed through taxes or subsidies tied to the public good. Asymmetric information, for example, when MSMEs are not aware of risk and impacts of climate change on their business activities, can be addressed through awareness campaigns and information provision or, provision or strengthening capacities of business multipliers;
2. **Compensation/settlement of the private actors for the effects on the risk/return profile**: this involves considering the consequence for the risk-return profile and compensating the private actor accordingly. This would mean directly increasing the attractiveness for the investor through investment support, without correcting the market imperfection. For example, grants and subsidised loans increase the return, and guarantees improve risk profiles. While the strategy of compensation is not as close to the actual market imperfection, it might use the fact that, for example, return impacts are typically cumulative. This scheme might also be helpful in determining the appropriate use of funds dedicated to adaptation purposes such as the GCF.

How this mapping can be used to guide policies, measures, and public finance interventions will be elaborated in Chapter 8.

Table 4. Overview of Different Views on Barriers Relevant to Financing Adaptation-Related Projects: the Economic Versus Demand of Financing Perspective

Economic / Financing	Externality*		Imperfect capital market	Asymmetric information	Other market imperfections
	Public good provision	Technology externality			
Reduced return	Adaptation-related project generates public goods on top of commercial private goods	Innovation externality experience with new project types generates learning from which others profit	New project types face difficulties to get funding (e.g. because the risk is difficult to estimate for the loan officer)		
			Investment lifetime is similar to climate change impact timescale but investment decision is myopic	MSME face general funding difficulties as their businesses are hard to understand / standardise Principal agent problems (e.g. Water infrastructure owner different from water user)	
Risk/return				project/MSME not aware of climate change impacts to be expected	
Output risk	No (public good) infrastructure available to perform the commercial activities (e.g. to provide treatment for pests and diseases)	Climate robust production technology e.g. heat resistant crop (then also used by others)	No insurance available for many climate risks	Actors not informed about best available option e.g. best plant varieties, farming option	No market price for water
Input factors' risk			No insurance available for many climate risks		
Labour force risk (input factor)			Lack of willingness to pay for climate related health care e.g. poverty induced myopic behavior	Actors not informed about climate related preventative health care	
Liquidity risk			Increasing capital cost illiquid long term debt market (long pay back of many adaptation related projects)		
Regulatory and policy risk				Public actors are not informed about the right data and information to build policies and regulations on	Unpredictable bureaucracy, corruption

7. IMPLICATIONS FOR PUBLIC POLICY AND FINANCE

This study aims to provide guidance on the design of public policies and the spending public climate funds so as to facilitate the transformational change of an economy as it adapts to climate change.

How Can This Study be used to Design Policy and Support Measures?

Conceptually, the most important step is a barrier-analysis that identifies – for a given country in the defined sectors – the barrier to adaptation investment, on both the demand as well as the supply side of private finance. Table 4 shows how the identified barriers will typically manifest financially, from the perspective of private enterprise and private financiers, as well as economically from the perspective of Policy makers.

Once the barriers have been identified, they can be tackled in different ways. One option is to modify the **market environment in a way that the barrier is eliminated**. The other is **Compensating the private actors for the effects on the risk/return profile**.

In cases where an adaptation-related investment generates positive externalities, a public subsidy could be paid to the investor based on the amount of positive externalities generated. This would incentivise adaptation investments in adaptation measures that feature socially desirable externalities. However in market environments quantifying and monetising the externality may prove difficult and impractical. In these cases there is the option to consider the other dimension of table 4, which shows the manifestation of barriers from the financial perspective of the investor. In this case, **a positive externality means that a positive impact is produced, but the investor does not receive additional cash flow from it and, as a consequence, the return on the investment is not as high as is should be** (reflecting the true value of undertaking the activity). If this is understood, it might be a simpler and more realistic option to provide subsidised investment support. This will improve the return from the commercial investors' perspective and could bring it closer to the true value ("social rate of return") of the adaptation project.

However, in some cases there are more straightforward options to address market imperfection, such as informational campaigns to correct information asymmetries or subsidies to adjust for public good provision, once a public good is identified. In other cases it will be more challenging or unrealistic (e.g., quantifying the innovation spill-over). In either case, it is helpful to identify the barriers and to analyse them, not only from the economic perspective of Policy makers, but also from the financial perspective of the investor (the perspective of the private enterprise and/or financier). Reduced returns can, for example, be compensated by grants or concessional loans, while increased risk due to fundamental climate uncertainty could be addressed through the government providing insurance not offered by the market, or by providing specific guarantees to the investor.

The role of the policy makers

Addressing market imperfections – presuming they require changing the regulatory environment in which markets operate – falls largely within the remit of national governments and national regulatory bodies to address. The international community, including the multilateral climate regime and its financial mechanisms, however, can play an important role in supporting developing country governments, which often lack institutional capacity and resources. For example, supporting national governments to remove barriers or provide financial incentives and sanctions to compensate for the non-removal of market imperfections, or support 'subnational' and market actors. Some general policy recommendations can be identified based on the case study analysis within this study.

Addressing Positive Externalities of Adaptation-Related Investments

Supressed return expectation may occur as a result of a positive externality, such as a public good or technological externality that is generated by a project or activity but which is not captured in project or company revenues. Positive externalities can, for example, be addressed through subsidies and incentives, or adaptation-equivalents of Payments for Ecosystem Services (PES) that could enable the internalisation and monetisation of extra-financial benefits. Alternatively, public finance could be used to bring down the cost of adaptation investment capital and increase the expected return on investment, in order to compensate for the lack of capital from public good provision through tools such as grants or concessional/subsidised loans (e.g. case 7).

Technological externalities (positive innovation effects that do not generate direct revenue) can limit investment in innovation and therefore result in a shortage of technologies necessary to contend with the challenge of a changing climate. It is critical that governments work to improve institutional and legislative frameworks that could reduce this positive externality, for example through intellectual property rights or royalty systems that could compensate for investment in R&D and innovative responses to climate change. PPPs can go some way to fostering private sector engagement investment (e.g. cases 20 and 21), and public funds can also be used to establish seed capital facilities for technological innovation in adaptation and climate resilience, which are of the highest risk and therefore still very expensive. Such a facility would reduce the risk faced by the innovator or MSME and encourage more investment in adaptation-related activities and technologies.

Addressing Incomplete or Asymmetric Information

Public policy interventions to address incomplete or asymmetric information include awareness campaigns, for instance knowledge transfer and capacity building for private actors (training, climate risk assessments). These measures can also be offered to policy makers who need to develop and implement supportive regulatory frameworks in order to achieve the successful implementation of programmes and projects. Other examples include improved data collection on the potential impacts of climate change on communities, sectors, and industries, improved climate-forecasting capacity (or citizen monitoring and reporting schemes for farmers and rural communities), cost/benefit assessment tools and establishing public-private dialogue platforms.

Public grants can be used to provide technical assistance, to build the capacity of market actors by investing in activities such as market research, climate risk assessment tools/approaches, staff training and business planning, (training of) trainer concepts, and the development of new financial products. This will enable the private sector to respond better to the changing market conditions created by climate change (see case 3).

Addressing Imperfect Capital Markets

Policy makers can take several actions in order to address the imperfections on capital markets. They can ensure the supply of long-term credit to match the timescale of investment, for example, through a guarantee to the financiers of the adaptation investment or credit lines. Signals to the market can be generated through introducing technical standards that promote innovation in climate resilient technologies, or zoning regulations that take into account changing climate risks that can help increase confidence in the longevity of the investment. Public finance can be used to fund research, pilot projects, and the data collection that underpins local index-based insurance to address the incomplete capital market.[97,98,99]

A policy action that can often be observed is compensation towards MSMEs and corporations through public support instruments such as grants, securitisation of loans, or on-lending facilities, which increase the expected return of investment in adaptation activities, while public auctions of guarantees can improve their risk profiles. For example from the analysed case studies, public finance is provided at the development stage of the business or a new product, where the risks for the investment are relatively high. **Following the development stage, in many cases the business or product became commercially viable and no additional (public) incentive was necessary to ensure private sector financing for**

MSMEs or larger corporations. One example is case 5, where the IFC Study grant identified the main areas of the port likely to be affected by climate change, and the implications for Terminal Maritimo Muelles El Bosque. The study on environmental performance addressed the information asymmetry, finding potential cost-saving opportunities in, amongst others, reduced dredging requirements and mangrove regeneration as adaptation measures. As a direct response to this study, MEB announced plans for USD 30 million adaptation investments in two ports, including USD 12 million that had already been invested, having been financed through a commercial loan.[100]

Transferring credit risk partially from originators to investors through securitisation of MSMEs or corporate liabilities creates headroom in banks' balance sheets and allows them to further on-lend to MSMEs or corporations. At the same time, it seems appropriate that banks continue to originate the bulk of small loans, leveraging on their expertise, infrastructure, local presence, and relationships, while keeping some exposure in their books to ensure robust origination practices are followed. **Providing credit enhancement in the form of guarantees can reduce the risk of adaptation-related lending to MSMEs or corporations for the lender.** Government guarantees can reduce the collateral requirement for MSMEs and corporations and attract more commercial bank lending. Public auctions of credit guarantees to commercial banks can reduce the burden to the public finance institution and further reduce the cost of borrowing to MSMEs or corporations, which has a knock-on effect of freeing up capital for further investment in other activities.

Concluding Remarks

Climate change will affect all sectors, albeit in different ways. Businesses active within these sectors adapt in different ways, as shown in this study. **There is a heterogeneity of the adaptation projects not only regarding their intended objective, but also their scale and project lifetime, revenue streams, and costs, and therefore required financing instruments.** This climate-induced structural change comes with challenges for both the individual private actors (who have to respond flexibly to a changing business environments) and governments that try to facilitate the structural change or intervene directly.

The report argues that it is in the private actors' own interests to play a constructive and significant role in implementing the structural change, although this process is likely to require significant additional investment and financing. The main strength of businesses is their built-in capacity to do business (i.e. generate added value and profit) in a changing environment. Climate-related risks are considered in the investment decision of the private actors in a similar way to other risks. Therefore, projects also face similar barriers as non-adaptation projects.

Governments and public finance institutions can enable businesses to unlock their creativity. The difficult role of the government is to prioritise areas of intervention. If priority areas for public interventions are identified, then the case study analyses developed here may be helpful to identify which barriers appear most relevant, and which may then be helpful to consider policy and regulatory approaches. The reference to economic efficiency ensures orientation towards mobilising private finance and orientation towards efficient use of public budgets. For governments it seems worth considering the following:

- **Integrating the actor-based perspective into national adaptation planning**, rather than limiting the process to top-down planning approaches. Consider the risk-return perspective businesses have when making investment decisions. Focus on the positive impacts of private adaptation activities on other actors (positive externalities of public good provision) and incentivise corresponding activities. Examples would be to revise the corresponding technical guidelines and adjust training programmes;
- **Enable and stimulate the creativity of the private sector.** This could be done through increasing the support for enhanced knowledge generation and innovation. This would be sector- and potentially actor-specific and should be aimed at contributing to a general climate of innovation where there is also room for new business models to emerge. Helping to identify profitable opportunities is as valuable as reducing losses due to climate change on an aggregate level.

- **Use the diversification potential of adaptation-related projects**, as some might be negatively correlated with other climate risks. This enables a diversification of the risk of the whole economy or – when combined in a portfolio – could generate a hedging or diversification strategy that has value on the financial markets.

As public funds are limited, the efficient use and allocation of this funding is important. This study has identified some **guidance for the investment/spending criteria** of public funds (national and international) that could facilitate private sector adaptation along the lines of the market imperfections:

Step 1. Identify the impact areas and sectors to be addressed by a public fund;

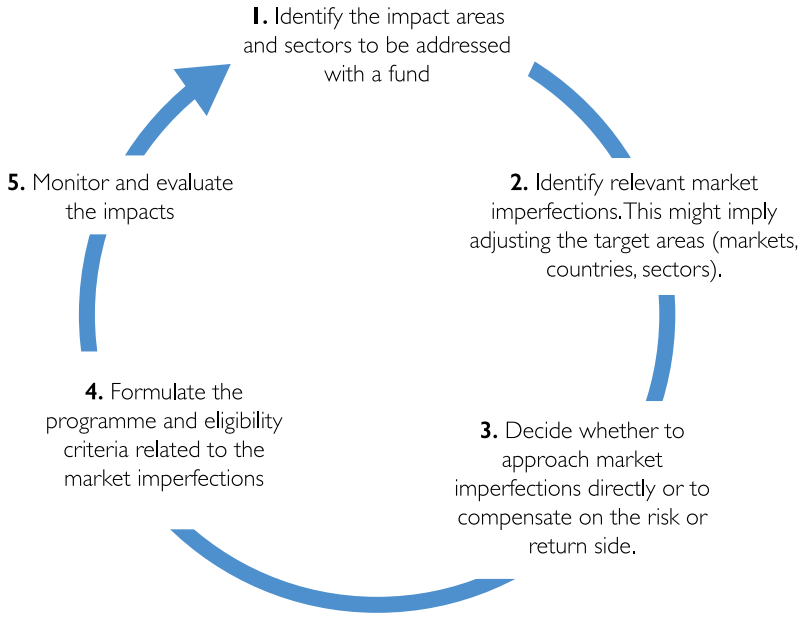
Step 2. Identify the barriers/market imperfections that are most relevant in the target areas. Note that this might imply focusing on the target areas (markets, countries, sectors);

Step 3. Decide whether to approach market imperfections directly (policy/regulation) or whether to compensate on the risk or return side. Consider the consequences in case of risk/return compensation. Question whether this distorts other markets and identify the long-term effects;

Step 4. Formulate the programme and eligibility criteria related to the market imperfections as identified above to the extent they are observable. Develop a method to monitor and evaluate impacts of the programme;

Step 5: Monitor and evaluate the impacts.

Figure 10. Steps for the Assessment of Investment/Spending Criteria of Public Funds



Source: Authors

Do not reinvent the wheel. As this study shows, adaptation projects are similar to non-adaptation related projects regarding both risks and barriers. Public and private financing instruments to address these barriers for private sector investments also exist already, and either compensate private actors or address market imperfections. Existing instruments and initiative, as well as their consequent public sector expenditure, may be revised to include the adaptation and climate change impacts.

ANNEX 1: PRIVATE SECTOR ADAPTATION - CASE STUDY ANALYSIS

Each case study provides the framework for discussing private adaptation activities according to 1) major climate impacts and affected private actors, 2) adaptation measures undertaken by the private actor in response to the impact (adaptation-related activities), and 3) the financing instrument typically used by private sector actors in implementing this adaptation measure.

Each measure first describes the macro perspective of the four climate impacts described in section 3.1. Climate insurance (measure 5) relates to all impacts, while early-warning systems against extreme weather events (measure 6) comprises drought, flooding.

The analysis then moves to the actor-based perspective through a description of private actors involved and their motivations to invest in adaptation, through a sample of 28 case studies focusing on MSMEs, corporate actors, and infrastructure projects, primarily in developing and emerging countries.xi The case analysis includes barriers and market imperfections as well as the approaches that were chosen to overcome them.

CASE STUDY ANALYSIS OF ADAPTATION MEASURE 1: WATER SAVING MEASURES TO REDUCE THE RISK OF WATER SCARCITY AND DROUGHT

The following four cases on water saving measures are analysed:

1. Textile factories in Bangladesh partner to improve water efficiency (DBL);
2. Sustainability of water resources and supply of the Vieux Fort Region (St. Lucia);
3. Microfinance ecosystem-based adaptation (MEbA); and
4. Coffee-processing in Rwanda.

These case studies cover: improving water efficiency of the supplier (1, 4) and small-scale producers (3, 4); reducing water use within the company's own operations (1, 2); and business opportunities created through water efficiency (3); Table 5 provides on analysis of the cases from an actor-based perspective according to the criteria introduced in Chapter 2. Each case study and the detailed analysis is provided in Annex 1. Brackets indicate that there is an element of this criteria present in this case.

xi The authors searched through the extant literature and conducted internet research to find case studies matching the themes. If private actors invested in water efficiency without reporting on it, we cannot analyse such a case study. In general, the likelihood of reporting probably increases when a public actor is involved in a project, meaning that our data might be skewed towards such projects.

Table 5. Adaption Measure 1: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

		Adaptation Type		Risk/ Benefit		Exposure		Focus	
		Reactive	Anticipatory	Direct	Indirect	Distant	Local	Reduce physical climate risk	Business opportunity
Case Study	1	×		×			×	×	
	2	×			×		×	×	
	3	×		×	×		×	(X)	×
	4	×		×		(X)	×	×	

These cases showcase examples of businesses mainstreaming adaptation measures into their daily business operations, and their motivation is largely centred on cost saving, ensuring security of supply at a reasonable price, as well as reputational benefits. Initial grants provide a level of security for commercial investors in a first step. The ability for these actors to fund adaptation measures, however, rests within their willingness to allocate internal revenues and plan for future sustainability through traditional finance sector with a commercial perspective, which is more easily implemented following an exchange of knowledge on climate change and effective adaptation strategies. Obtaining a bank loan remains challenging for MMs. Additional awareness for private financiers could be provided to develop appropriate financing instruments, particularly loans for MSMEs, which have addressed potential climate impacts and reduced their risk profile.

Water efficiency has long been on the 'radar' of environmentally conscious businesses. Measures can be implemented across a range of scales, making it applicable to enterprises of a range of scales, from MSMEs right through to large multinationals. Larger corporates also support smaller suppliers to address risks associated with water scarcity, whilst at the same time strengthening their resilience to supply chain disruption or price volatility.

It is probably one of the easiest entry points for businesses to mainstream adaptation-related activities into daily business activities, as private actors react to already observable climate impacts. The private adaptation activities implemented by the actors in the four cases are primarily motivated by reducing direct climate risks to the daily business, resulting from water scarcity impacting on goods production or productivity (e.g. agricultural output). Case 2 demonstrates an indirect risk; business operations would have continued (at least in the short-medium term) without the adaptive measure; however, these measures also secured future operations. It also led to (potential) regulatory risk (new regulation for the sector to implement adaptive measures). All cases have a local climate exposure: water scarcity directly affects business operations; however, there is also an element of distant exposure for the fourth case as the actor also addressed the supply chain disruption that affected its operations.

All four cases had sustainable business models that were strengthened through the implemented adaptive measure. The introduction of adaptive measures supported the cash flow from existing operations, either through reduced production costs, savings, or new income generating activities.

Although water efficiency measures typically reduce costs for the private actor in their daily business activities, all case studies were initially implemented with grant financing; from global development institutions or government-funded. In three cases, the initial grants were used to purchase equipment to help the businesses implement the adaptive measure, and to partner with technical service providers for appropriate technologies and develop new loan products. Three of the case studies were also supported through Technical Assistance (TA) at the project onset, which built the capacities of the actors to understand effective adaptation activities suited to their business models, have appropriate tools and know-how to implement these activities and reduce their potential vulnerabilities to climate impacts. The grant finance compensated the private actor by increasing their awareness of climate impacts on business operations and identifying and implementing the best available adaptation solutions.[xii]

All four cases used the adaptation solutions to strengthen existing business models; cases 1 and 2 faced higher production costs resulting from climate impacts on operations and reduced these costs. Subsequently, additional private finance was attracted; the donor developed a blended finance model for the actor in case 1, while case 2 utilised a co-financing agreement. Case 3 works as a revolving structure. Loan products were introduced coupled with EbA technologies, which strengthened the MFI loan portfolio allowing additional loans

xii Chapter 6 analyses the barriers to adaptation investments through two dimensions: the economic and the financing perspectives. Further information on each case is provided in Annex 1 and Table 4.

to be provided in future loan cycles. In this case the risk reduction measure provided a new business opportunity both for the MFI and their clients. Case 4 implemented low-cost adaptation options, which improved their yield and quality, as well as lowered their production and labour costs. Although the actor has not yet secured additional commercial loans, they have strengthened their business model against climate impacts, which should help them attract private finance in the future.

CASE STUDY ANALYSIS FOR ADAPTATION MEASURE 2: MEASURES TO REDUCE RISK OF INCREASED FLOODING

Three of the four cases selected are large private infrastructure projects (a port, a sea wall, and a dike). The fourth case is a comparatively smaller public infrastructure projects (Fetau trees). The cases are:

5. Terminal Maritimo Muelles El Bosque (MEB), in Cartagena, Colombia;

6. Coastal development Jakarta, Indonesia;

7. Dike around hi-tech industrial estate in Ayutthaya, Thailand; and

8. Conservation Fetau trees, Samoa.

These case studies cover: public sector involvement to conduct extensive risk assessment (5); protecting infrastructure against current and future climate risk (5, 6, 7 and 8); private adaptation as public maladaptation (7) and natural coastal protection measures (8). Each case study is provided in more detail in Annex 1.

Table 6. Adaption Measure 2: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

		Adaptation Type		Risk/Benefit		Exposure		Focus	
		Reactive	Anticipatory	Direct	Indirect	Distant	Local	Reduce physical climate risk	Business opportunity
Case Study	5		×	×			×	×	
	6		×	×		(X)	×	×	(X)
	7	×		×			×	×	
	8	×	×	×	×		×	×	×

The selected case studies all demonstrate a direct risk to infrastructure assets, with local exposure such as business interruption and damage of physical assets. Two cases (5 and 6) anticipated these risks through the results of feasibility studies. Case 7 experienced severe flooding and is implementing an adaptive measure in reaction to this, while case 8 is both reacting to observed changes as well as the anticipation of future impacts. Case 6 also carries distant exposure. Communities in Indonesia may not be directly affected but are still protected by the creation of a sea wall. **As a result of the direct risk with local exposure, all cases are implementing adaptation solutions to moderate harm to their infrastructure and to protect their businesses.** Case 6 also realises new business opportunities, both for the actors involved in construction of the sea wall, and for new businesses through, for example, the design of a new international port. Case 8 also provides new business opportunities for the local community through the sale of products from the Fetau trees.

These actors, in highly exposed locations with large fixed assets (i.e. ports or industrial estates), are implementing measures "within their fence line" to protect against floods. However, as well as the high costs associated with the construction and maintenance of flooding protection measures, such assets also typically create socio-economic benefits. **Investments which result in the creation of public goods typically require public (co) financing.** In support of this hypothesis, each case carries elements of public involvement. *Terminal Maritimo Muelles El Bosque* (case 5) began with a feasibility study financed by IFC to

identify the risks to their investment in the port. Following the study, MEB identified a number of adaptation solutions and obtained a commercial loan for their implementation. These adaptation measures increased the cost-saving opportunities of the port. The *Coastal development Jakarta* (case 6) was initiated by the national government and publicly funded feasibility studies, and was enabled by private actors through a PPP arrangement. The risk for this project was transferred to the public sector with the city administration guaranteeing a buy back, and many costs were transferred directly to the end-user, through for example toll roads and increased utility fees. The protective measure implemented for the *Dike around Hi-Tech Industrial Estate in Ayutthaya, Thailand* (case 7) was led by the private actor with a concessional loan from the government, and costs transferred to the end-user through increased central utility fees. The *Conservation of fetau trees in Samoa* (case 8) was implemented by a partnership between a charity and a Non-Governmental Organisation (NGO). The community benefitted from the public project through the introduction of new income generating activities, the sale of Fetau oils. In addition, the charity partnered with an NGO to establish microfinance loans.

Large flood defence projects typically require public (co)financing because they involve many actors and stakeholders, and often generate positive externalities, in these cases primarily public goods. Public funding, for example through feasibility studies, concessional finance or grants, compensates the private actor for generating positive externalities and increase the attractiveness of the investment, despite also being to moderate harm to the business activity. Feasibility studies also reduce the asymmetric information barrier where private actors are unaware of either the climate risk, or the best available adaptation measures. Risk sharing, for example through a PPP or transferring costs to the end-users, also helps private actors lower their exposure to certain risks, and cover the investment costs.

CASE STUDY ANALYSIS FOR ADAPTATION MEASURE 3: PHARMACEUTICALS TO REDUCE HEALTH-RELATED CLIMATE RISKS

A number of case studies have been selected for different aspects of health care:

Preventative care:

12. Awareness raising campaign SC Johnson 'I Was Dengue';[101]

13. VestergaardFrandsen sells products tailored for prevention in times of disaster;[102]

14. A to Z Textiles Mills expanding network of entrepreneurs.[103]

Affordable health treatment facilities:

15. Unlimited primary health Care (Primedic, Mexico);[104]

16. Mobile clinics (e.g. Siemens);[105]

17. Tele medicine (e.g. Piramale Swasthya model;[106]

18. Affordable medical equipment (e.g. GE Healthcare).[107]

Improved access to drugs:

19. GSK's research facility in Tres Cantos, Spain;

20. The medicines for malaria centure (MMV);

21. GSK development of malaria vaccine (RTS,S) in PPP with MVI and the Bill & Melinda Gates Foundation.

Each case study is provided in more detail in Annex 1, while the private actor and macro-perspectives are summarised in Table 7.

These case studies highlight the role of private sector actors in a typical publicly funded sector (12, 19, 20); PPPs (13, 14, 16, 17, 20, 21), awareness raising (12, 17, 21) and R&D initiatives (13, 18, 19, 20, 21).

Table 7. Adaption Measure 3: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

		Adaptation Type		Risk/ Benefit		Exposure		Focus	
		Reactive	Anticipatory	Direct	Indirect	Distant	Local	Reduce physical climate risk	Business Opportunity
Case Study	12	(X)			X	(X)	X		X
	13	(X)			X	(X)	X		X
	14	(X)			X	(X)	X		X
	15	(X)	(X)		X	(X)	X		X
	16	(X)	(X)		X	(X)	X	X	
	17	(X)	(X)		X	(X)	X		X
	18	(X)	(X)		X	(X)	X		X
	19	X			X	(X)	X		(X)
	20		X		X	(X)	X		X
	21	X			X	(X)	X		X

Climate impacts such as temperature change and water scarcity typically pose a direct risk to health, but an indirect risk to the private actor implementing an adaptation-related activity. For private actors in the healthcare sector, these indirect health risks pose a direct opportunity for businesses focusing on healthcare to develop concrete business cases.

Preventative care

Preventive care is the most cost-efficient way to deal with increasing health issues.[108] Low ability of developing country populations to pay for this care challenges the scale of business opportunities, and government and donor initiatives, such as vaccination, drives further dilution of consumer interest.[109] Nevertheless, there are clear opportunities for private actors to be involved in both the provision of preventive treatment and in consumer products, such as bed nets, mosquito repellents, vitamins and dietary supplements.

To date, it has typically been large companies who have entered the market through innovative demand generation, tailoring healthcare products and developing new delivery channel networks[110], as demonstrated in cases (12-14). The private actors in all three cases have a reactive adaptation component; businesses supplying healthcare products need to react to the changing health issues that may also arise from climate change, although this presents an indirect contribution to climate adaptation.

All three cases highlight private corporate actors that developed innovative delivery channels to enable them to reach the poorest communities and create demand for their healthcare products. For example, *SC Johnson* (case 12) sells memberships offering a bundle of products and group coaching sessions as part of their awareness raising campaign. *VestergaardFrandsen* (case 13) sells products to public and private sectors that lowers the price for vulnerable people but maintains demand for the products. *A to Z Textiles Mills* (case 14) sells products directly to end-users but expanded their network through distribution and voucher systems in hospitals, antenatal clinics and immunisation campaigns.

All three actors invested internal revenues for R&D in innovative programmes and developing new products for the healthcare market, particularly in developing countries. Two of the actors also provide in-kind contributions to public institutions for further R&D activities to develop market-based solutions (cases 12 and 14).

All three actors relied on a type of PPP with public institutions and governments to scale up their product outreach; however, all three also have sustainable business models. *The awareness raising campaign of SC Johnson* (case 12) was piloted together with Foundation finance, but membership sales ensure the sustainability of the model. *VestergaardFrandsen* (case 13) is financed privately through sales to the public (and private) sector, while *A to Z Textiles*

Mills (case 14) utilised grant finance from public and private institutions for private market development and marketing promotion.

This demonstrates that, while for healthcare products a number of different stakeholders may be involved, there is a market for corporates in preventative healthcare. Some projects generate positive externalities in the sense that they not only provide learning and information but also sometimes provide infrastructure that has elements of a public good, as it will facilitate other activities from which the project may not directly draw commercial profit.

Affordable health treatment facilities

While the knowledge required to treat climate-related diseases exists, such treatment's affordability and accessibility remains a challenge in developing countries.[111] A number of emerging business models address this issue of 'last mile delivery' – delivering the product to the consumer – by lowering the cost of production or distribution, creating novel ways to access the market.[112] These could help to address climate-related diseases in developing countries. The cases demonstrate elements of reactive adaptation; businesses supplying healthcare products need to react to the changing health issues, but also an element of anticipatory adaptation since healthcare facilities can be adapted in advance.

Three of the four cases present a new business opportunity. *Primedic in Mexico* (case 15) provides access to unlimited primary health care at affordable rates, raising funding through subscription fee revenues and found equity investors to support expansion. The business model is similar to an insurance scheme; beneficiaries pay an individual monthly membership fee and receive unlimited medical consultations with medical specialists in internal medicine, paediatrics and gynaecology. *Tele Medicine* (case 17) provides a new business opportunity for trained doctors who work as micro-entrepreneurs under a franchise model and earn revenues from their patients. However, the consortium providing the training is public and there is no business opportunity for these actors. *GE Healthcare* (case 18) also presents a new business opportunity providing low-cost medical equipment funded through PPPs and consortia for project finance to develop infrastructure for their operations, including hospital operations and technology,[113] partnering with governments, health systems, financiers and contractors which demonstrates a role for PPPs and flexible financing options. There is no business opportunity in the case of *Mobile Clinics* (case 16) as the actor invests in adaptation-related activities under Corporate Social Responsibility (CSR); however, this type of business model may present business opportunities for other private actors. Again, in many cases we observe challenges related to (often non-existing) infrastructure with public good characteristics.

Improved access to drugs

Improved access to drugs suggests a reactive adaptation component also resulting from the changing business environment. *MMV* (case 20) aims to discover, develop and deliver safe and effective anti-malarial agents suggesting an anticipatory nature.

Pharmaceutical manufacturers can help society respond and adapt to a changing climate, for example by using their technical capabilities and financial resources to reducing knowledge gaps, stakeholder engagement, bolstering healthcare systems and improve access to medicine in the developing world.[114] In 2011, pharmaceutical multinational GlaxoSmithKline (GSK) published a report with Accenture and the University of Oxford's Smith School of Enterprise and the Environment exploring the impact of climate change on health[115] to provide a snapshot of the current state of knowledge, raise awareness and develop partnerships. All three cases support R&D, which has also led to new products being developed (new business opportunities) in two cases (20 - *MMV* and 21 - *GSK development of malaria vaccine*). *GSK's research facility in Tres Cantos* (case 19) has the potential to lead to new business opportunities depending on the outcome of the research findings. This case focuses on health benefits rather than commercial return and is supported by a number of public actors and GSK equity.

Frequently, such initiatives are accelerated by private not-for-profit funding, for example through the Bill & Melinda Gates Foundation[116] and the Wellcome Trust.[117] For example, *MMV* (case 20) received early seed capital financing to increase the attractiveness of the new

venture and leading to further private investment. The *GSK development of malaria vaccine* (case 21) demonstrates a successful PPP through which the main private actor will generate a small return to be reinvested into R&D.

For many actors, climate change has not yet significantly changed the preventative care market, affordable health care provision and drug provision, but there are opportunities for expanding existing business models to develop new healthcare products and support awareness campaigns to drive demand for such products. There are also examples not explicitly highlighted of the increasingly important role of SMEs in the healthcare sector, presenting a new demand for finance but also new opportunities for supplying this finance. Intec Capital Limited is a leading non-banking financial institution providing loans for acquisition of machinery with a focus on growing sectors of the economy, including healthcare.[118] For example, Intec Capital Ltd focuses on serving SMEs which require access to finance for specialised equipment such as tablet making machines, tube making machines, labelling machines, therapeutic equipment, etc., to sell these products to larger pharmaceuticals in the healthcare sector, also demonstrating an increasingly important supply chain in this sector.

Here, cases involve a spectrum of barriers. In addition to public-good-related barriers the generation of (positive) innovation spillovers is important here. As it is unlikely that the projects developing innovations will benefit to the extent of the full utility that the innovation would justify, support appears justified.

CASE STUDY ANALYSIS FOR ADAPTATION MEASURE 4: SPATIAL PLANNING FOR REDUCING RISKS ASSOCIATED WITH HEAT STRESS IN URBAN AREAS

Cities such as Tokyo and Rotterdam (see below) include a role for private sector actors in financing and implementing mitigation of the UHI effect. However, neither literature nor cities are concrete about the exact roles of private actors. The case studies presented below highlight a role for private actors within urban planning (22 - Toronto, 23 - Rotterdam), and the role of PPPs (24 - Tokyo).

Table 8. Adaption Measure 4: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

		Adaptation Type		Risk/ Benefit		Exposure		Focus	
		Reactive	Anticipatory	Direct	Indirect	Distant	Local	Reduce physical climate risk	Business opportunity
Case Study	22	×	×	×	×	×	×	×	
	23	×	×	×	×	×	×	×	
	24	×	×	×	×	×	×	×	

All three cases represent reducing climate impacts rather than the creation of direct business opportunities. In addition, all activities are a planned response to observed climate impacts (reactive), while also anticipating a need for structural change to curb future impacts. All cases analysed present direct and indirect risks to businesses, with local and distant exposure. For example, extreme weather, temperature change and water scarcity present direct risks with local exposure to, for example, damage of physical assets. Adaptation measures may include greening of exterior walls (*Tokyo* – case 24). Indirect risks with local exposure for businesses may include physical work during heat waves affecting the workforce and private actors can implement adaptive measures such as city-workers uniforms to lighter colours during summer months (*Toronto* – case 22).[119] Due to the geographical nature of the UHI Effect, businesses may be impacted by regulatory and/or political risk (indirect risk, distant exposure). Regulation also plays an important role in addressing the UHI Effect, for

example national or city level plans with clear incentives for private investment (beyond daily business activities). There may also be increased competition for resources such as water. Initiatives such as the Blue Corridor in *Rotterdam* (case 23), providing cleaner water and serving as the water supply line in times of aridity, help to overcome more distant, indirect risks.

Cities require the cooperation of relevant government departments, private actors and inhabitants, and all actors have important roles to play in ensuring the practical implementation of policies. For example, *Rotterdam* (case 23) demonstrates a role for architects, landscapers and urban designers in a publicly initiated adaptation strategy. The cities in all three cases have developed adaptation strategies to create a more attractive investment environment for private actors. In all three cases there is also an important role for PPPs, e.g. integration and multi-functional spatial use requires cooperation with the province, housing corporations, developers and property owners.

The ability of adaptation or resilience projects to attract private investment is generally linked to the integration of non-revenue producing projects with a broader upgrading or re-development strategy.[120] In general, a shift away from a focus on risk reduction towards revenue-generating opportunities should generate more private investments.[121]

There is an important role for individual companies within the adaptation planning perspective regarding spatial planning and heat stress in urban development. Collective action and an integrated public-private approach are necessary to adapt to the UHI Effect. Individual approaches are implemented by private actors through their business activities that should be incentivised through public policy. Governments also play a role in preventing maladaptation.

CASE STUDY ANALYSIS FOR ADAPTATION MEASURE 5: CLIMATE-RELATED INSURANCE

The following four cases are analysed:

9. Ethiopia: Horn of Africa Risk Transfer for Adaptation (HARITA);

10. Mozambique: Guy Carpenter LLC; and

11. Thailand: Sompo Japan Insurance.

The case studies cover: developing the insurance market through a public initiative (9); supply chain management (10); a PPP (11). Each case study is provided in more detail in Annex 1, while private actors and the macro-perspective are summarised in Table 9.

Table 9. Adaption Measure 5: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

		Adaptation Type		Risk/ Benefit		Exposure		Focus	
		Reactive	Anticipatory	Direct	Indirect	Distant	Local	Reduce physical climate risk	Business Opportunity
Case Study	9	(X)	X	X			X		X
	10	(X)	X	X		(X)	X		X
	11	(X)	X	X			X		X

Public support can be used to develop insurance schemes in a way that they do not only cover farmers' losses from climate-related impacts, but also stimulate pro-active adaptation to climate change. Public institutions can also play a role in helping to cover insurance premia particularly in drought years where claims may exceed premiums collected (as in case study 10). Pre-financing from external private actors, such as agribusiness-firms, is another example of a private financier supporting an adaptive solution. However, well-developed climate insurance is typically a sustainable business model and as demonstrated above, can be launched and run without any public intervention.

Weather index insurance typically deals with local weather and corresponds to a direct, local risk for farmers. However, the changing climate impacting farmers can represent indirect, distant risks to insurers. Each case represents a new business opportunity for the insurer. Particularly case 10 (*Mozambique: Guy Carpenter LLC*) presents a multi-stakeholder approach with all actors invested in agricultural risk management, which may disrupt the supply chain. While insurance is typically anticipatory in nature, each of the cases demonstrates the role of historical data on the changing climate and observable weather events in designing and developing insurance in a given region or sector; thus the products also have a reactive element.

Weather index insurance represents a growing market with increasing private sector involvement and offers new business opportunities for different private actors. Nevertheless, these insurance schemes are frequently seen as being implemented in collaboration with government agencies and/or supported by donor organisations in order to address the high up-front costs.[122]

All three cases present a new type of insurance for the local market successfully launched and scaled-up after the pilot. The *HARITA Ethiopia* (case 9) utilised public donor funding to indirectly purchase farmers' labour for community-identified projects to build climate resilience. Case 10 (*Mozambique: Guy Carpenter LLC*) was also initiated through a public grant but did not require additional public finance. The actor uses a different model where agribusiness firms pre-finance the insurance premia for groups, thus lowering the cost of the premium, which are recouped from the farmer at the end of the crop season. Case 11 (*Sompo Japan Insurance, Thailand*) presents a purely private adaptation activity with no public intervention. Cases 9 and 11 demonstrate the effectiveness of bundling index insurance and loan products, which provides a security for the farmer and the private financier that the loan can be repaid in the event of climate impacts.

CASE STUDY ANALYSIS FOR ADAPTATION MEASURE 6: EARLY WARNING SYSTEMS AGAINST EXTREME WEATHER EVENTS

The cases analysed are:

25. Telvent;

26. Farmerline;

27. Nokia; and

28. Ericsson.

The case studies show that many private investments here remain in the form of PPPs (25, 28); CSR (27, 28); with new or potential business opportunities in mobile technology and applications (26, 27, 28). Each case study is provided in more detail in Annex 2.

Table 10. Adaption Measure 6: Reflecting the Actor-based Perspective (Cases) to the Macro Perspective of Adaptation

		Adaptation		Risk/ Benefit		Exposure		Focus	
		Reactive	Anticipatory	Direct	Indirect	Distant	Local	Reduce physical climate risk	Business opportunity
Case Study	25	(X)	(X)	X		X			X
	26	(X)	(X)	X		X			X
	27	(X)	(X)	X		X			X
	28	(X)	(X)	X		X			(X)

PPPs are one instrument to ensure that weather and climate networks are maintained with the highest degree of reliability for the general public and institutional end-users, while reducing the total cost for the developing country.[123,124]

The prevalence of cases charging subscription fees demonstrates the demand and viability for certain early warning products. Each actor in the cases has further demonstrated the replicability and scalability of early warning systems.

All four cases were implemented by private actors which recognised the direct nature of extreme weather events on business operations to their clients, including damage to physical assets, business interruption, increased operating or production costs, etc. However, the exposure is distant since the implementing actors are not directly exposed to the climate impacts.

The analysis of the four cases supports the notion that early warning systems represent both business and risk reduction opportunities for private actors, although case 28 was provided as a free pilot it has the potential to generate additional income for the main actor. The analysis demonstrated that all cases are new products which aim to strengthen clients against future impacts (anticipatory adaptation) based on observed climate impacts (reactive adaptation). The introduction of new technologies is a good example of a business opportunity created by climate change.

Farmerline (case 26) financed their business in the same way as many early-stage entrepreneurial ventures: development through an initial grant, seeking equity following expansion of the business and finally looking to attract debt finance. The business model is sustainable through subscriptions to the service. In the cases of *Telvent* and *Nokia* (cases 25 and 27) internal revenues to develop a new product in line with existing business activities were used. Both cases realised new sources of income. *Nokia* (case 27) refocused its CSR investments towards the new product, resulting in social benefits at low cost, since they now offer a subscription-based service. This demonstrates the fine line between delivering such systems as a public good or as a new business opportunity; the business chose to launch the product as a business benefit that encouraged further private partners to support the venture. *Ericsson* (case 28) realised the potential to generate income although it was initially offered as a free service. This case required a complex PPP with multiple stakeholders as well as training for pilot beneficiaries.

Adaptation Measures: Case Study Analysis and Specification of Financing Instruments

Table 11 below shows an overview of all examined adaptation cases, in some cases differentiated by involved actors. The cases are sorted by the adaptation intervention as developed in chapter 4. For each case the table displays the climate impact that essentially caused the adaptation measure and the financing instrument that was used to finance the activity. The last part of the table makes an attempt to identify the barriers that were relevant in the context of each case studies.

- For the intervention 1 (water saving/scarcity) and 2 (protection against floods) it is observed debt financing as the dominant financing instrument, frequently combined with grants. While barriers within intervention 1 are quite diverse, spanning imperfect capital markets, asymmetric information and – importantly – a not-scarcity-driven price of water, intervention 2 is dominated by public good issues.
- Cases within intervention 5 (climate-related insurance) often use risk-mitigation instruments, sometimes in PPP constellations, in selected cases combined with grants. The corresponding dominant barrier is capital market imperfections. Financing instruments within intervention 4 (role of pharmaceuticals in health-related climate risks) have the highest diversity including a number of PPPs and also an important role of equity contributions. The latter is most likely due to the comparatively risky business of developing and establishing pharmaceutical in general. Most relevant barriers here are the public good provision and the technology-spillovers – due to the knowledge-intense business.
- In interventions 4 (spatial planning) and 6 (early warning systems against extreme weather events) a number of different financing instruments were used. However, less frequently were these debt instruments. While for spatial planning barriers related to public good provision are dominant, early warning systems are related to the challenge of asymmetric information.

Across all cases that form the base of evidence in our study, the barriers related to asymmetric information appears to be the most frequent one, followed by the lack of or unpaid public good provision in context with an activity.

Table 11. Adaptation Measure: Case Study Analysis According to the Actors, Climate Change Impact, Instruments and Barriers

No.	Adaptation themes		Case study	Actors			Climate Impacts				Instruments							Barriers				
				SME	Corporate	Infrastructure	Water Scarcity and Drought	Increased Flooding	Extreme HEat Events	Health-ralated climate risks	Debt instrument	Equity instrument	Mezzanine instrument	Risk mitigation instrument	Public-private partnership	Grant	Public good	Technological spill-over	Imperfect capital market	Asymmetric information	Other market imperfections
1	Water saving measures associated with water scarcity and drought		Textile factories in Bangladesh partner to improve water efficiency		×	×	×				×	×			×	×				×	×
2			Sustainability of water resources and supply of the Vieux Fort region (Saint Lucia)	×		×	×				×					×				×	×
3			Microfinance for ecosystem-based adaptation (Meba) Actor 1: MFI Actor 2: MFI clients	× ×			× ×				× ×					× 				× ×	× ×	
4			Coffee processing in Rwanda	×			×				×					×				×	×	
5	Protection against flood risks		Terminal Maritimo Muelles El Bosque (MEB), in Cartagena, Colombia			×		×			×			×						×	×	
6			Coastal development Jakarta, Indonesia		×	×		×			×				×		×					
7			Dike around hi-tech industrial estate in Ayutthaya, Thailand		×	×		×			×					×	×					
8			Conversation fetau trees, Samoa	×				×			×					×	×					
9	Climate-related insurance		Ethiopia: Horn of Africa Risk Transfer for Adaptation (HARITA)																			
			Actor 1: Farmers	×			×				×			×					×			
			Actor 2: Public initiative funding HARITA		×		×								×	×						
10			Mozambique: Guy Carpenter LLC																			
			Actor 1: Farmers	×			×	×						×					×	×		
			Actor 2: PPP funding insurance scheme		×		×	×						×	×	×		×		×		
11			Thailand: Sompo Japan Insurance																			
			Actor 1: Farmers		×		×							×								
			Actor 2: PPP funding insurance scheme		×		×							×	×						×	
12	The role of pharaceuticals in health-related climate risks	Preventative care	Awareness raising campaign SC Johnson: "Iwas Dengue"		×					×	×				×	×				×	
13			VastergaardFrandsen sells products tailored for prevention in times of disaster		×					×					×						
14			A to Z Textiles Mills expanding network of entrepreneurs		×					×	×				×						
15		Affordable health treatment facilities	Unlimited Primary Health Care (Primedic, Mexico)		×	×				×		×		×								
16			Mobile clinics (e.g., Siemens)		×	×				×					×		×					
17			Tele medicine (e.g., GE Healthcare)																			
			Actor 1: Microfranchise model	×						×							×					
			Actor 2: PPP		×					×					×	×	×	×				
18			Affordable medical equipment (e.g., Piramale Swasthya model)		×					×		×										
19		Improved access to drugs	GSK's research facility in Tres Cantos, Spain		×					×		×					×	×				
20			The Medicines for Malaria Venture (MMV)		×					×		×			×	×		×				
21			GSK development of malaria vaccine (RTS,S) in PPP with MVI and the Bill&Mellinda Gates Foundation		×					×					×	×		×				

22	Spacial planning to address risks associated with heat stress in urban aresa	Toronto City Climate Change, Clean Air and Sustainable Energy Plan: Applictions are currently being accepted for residential, industrial, commercial and institutional buildings	X					X			X				X	X				
				X				X			X				X	X				
					X			X			X				X	X				
23		UHI effect mitigation and adaption to the UHI effect Rotterdam: Adaptive development strategies for out-like Rotterdam and Rotterdam dike		X	X		X	X								X			X	
24		UHI effect mitigation and adaption to the UHI effect Rotterdam:- Blue Corridor			X		X	X						X		X			X	
		Urban heat island effect mitigation measures Tokyo	X	X	X		X	X								X			X	
25	Early warming systems against extreme weather events	Telvent (e.g., PPP with World Meteorological Organisation, WMO)																		
		Actor 1: Farmers	X			X	X				X			X					X	
		Actor 2: Telvant with PPP		X		X				X									X	
26		Farmerline, Ghana																		
		Actor 1: Farmers	X			X					X								X	
		Actor 2: Farmerline		X		X					X									
27		Nokia (Nokia Life and Nokia Daa Gathering helping climate-vulnerable farmers)																		
		Actor 1: Farmers	X			X	X				X								X	
		Actor 2: Nokia Life		X		X	X							X	X					
28		Ericsson's Mobile Weather Alert Project, helping fisherman make informed decisions																		
		Actor 1: Farmers	X				X								X				X	
		Actor 2: Ericsson		X			X							X						

THE BUSINESS CASE FOR ADAPTATION:

The case study analysis supports the hypothesis in Chapters 2 and 3 that some business activities are negatively affected by climate change, while many actors are also reacting to new business opportunities or the creation of new markets.

The cases demonstrate that private actors are actually performing adaptation measures to a significant extent. Those activities can achieve commercial returns on adaptation related investments. This may be through increasing financial efficiency by reducing capital or operating expenses, securing the supply chain, or realising new business models. A broad spectrum of financing instrument ranging from debt or equity provision to risk sharing instruments is already applied.

Where barriers to private adaptation-related activities exist, public support is already and frequently used to either reduce or remove the barrier, or compensate the private actor. In some cases, for example in urban planning, collective action, an integrated approach, or effective burden sharing can provide additional incentives for private actors.

ANNEX 2: CASE STUDIES

MEASURE 1: WATER SAVING MEASURES TO REDUCE THE RISK OF WATER SCARCITY AND DROUGHT

1 Textiles factories in Bangladesh partner to improve water efficiency.

With 18 factories, the DBL Group is one of Bangladesh's largest garment and textile conglomerates. In Bangladesh the water price is not determined by the market, but fixed at a lower level by the government.[125] Because water has such a low price, businesses are hardly incentivised to increase water efficiency. In 2011, the DBL upgraded equipment and fixed insulation and leaks in order to conserve water. Upgrades included installing new dyeing machines which consume 50% less water than average dyeing machines. The primary actor, therefore, is the corporate (DBL Group).

These upgrades were originally undertaken as a pilot under IFC's Cleaner Production project. DBL took part in order to reduce their environmental impact and to lower production costs.[126] From the initial grant investment of USD 100,000 the Group reduced water, energy, steam, dye and chemical waste, which amounted to savings of USD 500,000 in year one.[127]

Following this, as IFC's Cleaner Production and resource efficient partners, DBL Group took part in a second phase under the Dutch funded 'Partnership for Cleaner Textile' (PaCT) project. The PaCT project is IFC's USD 11 million project, in partnership with NGO Solidaridad, the Embassy of the Kingdom of the Netherlands, global brands, local factories, and the Bangladesh Garment Manufacturers and Exporters Association (BGMEA). PaCT's investment support includes the development of a blended finance business model for factories, combining a USAID grant, a local bank refinancing scheme (with a 9% interest rate for listed technology and activities), owner's equity and bank finance at a commercial rate.[128]

Bangladesh has a fixed low water price, which reduces the return of water efficiency projects compared to a situation where water price is cost-covering.[129] The first solution to reaching an efficient outcome would be to incorporate the market imperfection through introducing a water market price. However, governments are faced with multiple optimisation problems where social aspects such as easy access to safe, fresh drinking water are essential. Therefore, removing the underlying market imperfection does not correspond to an improved social optimum. An alternative solution from the financing perspective is therefore necessary. This case shows that public intervention, a grant as compensation for DBL to remunerate the reduced return and make the investment in water more attractive, helped to mobilise additional private investment that contributes to adaptation, while the original market imperfection still exists.

A second market imperfection, information asymmetry, was also identified. PaCT identified a lack of awareness in the sector of the "'true cost' of resources" and "un-metered resource use" as major problems.[130] Therefore, DBL Group may not have invested in equipment upgrades because they were unaware of the necessary upgrades, available solutions, or the savings which could be realised. IFC's Cleaner Production and the PaCT projects both helped to remove this barrier through working with the factories to identify and implement best practices through, for example, a series of assessments and tailor-made advice on resource efficiency measures. [131] This demonstrates the long-term benefit of overcoming a market imperfection to advance an entire sector.

2 Sustainability of Water Resources and Supply of the Vieux Fort Region (Saint Lucia).

Water scarcity and drought, as well as excessive rainfall affect the business community in Vieux Fort (St Lucia). The unreliability of the water supply system affects productivity and profitability with implications for business growth, investment, and job creation.[132]

In 2005, the GEF financed the Implementation of Pilot Adaptation Measures in coastal areas, with St Lucia as one of the case studies. The project supported the SME 'Coconut Bay Beach Resort and Spa' to implement water management measures that increase resilience to the impacts of climate change and variability. The 250 room all-inclusive hotel was responsible for using 12% of the potable water supply of the community[133].

While the main actor in this case is the SME, infrastructure also plays a large part since these measures included the construction rainwater harvesting tanks to provide at least 3,000m3 reduction in the consumption in water utility, and the construction of an irrigation network for the recycling of sewer wastewater to be used in landscaping.[134] The project was supported with co-financing totalling USD 4 million, although it is unclear how much the Coconut Bay Beach Resort and Spa contributed.

Similar to case 1, the lack of a water price determined by the market resulted in fewer incentives to provide safe water (other market imperfection). In addition, the project led by the Ministry of Physical Planning and Environment in coordination with the hotel, organised information dissemination events for other hotels and resorts to increase the regional impact on tourism. The Ministry of Environment also prepared legislation requiring hotels to build rain harvesting strategies to reduce the consumption of water, based on the results of the GEF project.[135] The case demonstrates learning by doing characteristics for other hotels and resorts in the area (for example technology externality and information asymmetry). Rather than correct these market imperfections, the private actor was compensated through initial GEF funding, a grant of USD 2.4 million.

3 Microfinance Ecosystem-based Adaptation (MEbA)

Three Microfinance Institutions (MFIs) in Colombia and two in Peru have partnered with United Nations Environment Programme – Regional Office for Latin America and the Caribbean (UNEP-ROLAC) and the Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance, executing agency) to introduce (micro) financial products and services under the Microfinance Ecosystem-based Adaptation (MEbA) project. This project increases awareness of climate change and its impacts of MFIs by providing training and advice, and also helps to develop dedicated loan products for ecosystem-based adaptation (EbA) measures in partnership with local technical service providers. EbA measures include diversification of agricultural production; protection of nature through eco-tourism; land and water conservation activities; and use of organic fertilisers and drought-resistant seeds. Through increasing information provision to these private actors (the MFIs), MEbA reduced the existing asymmetric information barrier.

The MEbA project also addresses market imperfections for the second actors, the MFI clients. By introducing dedicated loans to finance measures to adapt to climate change, MEbA addresses the barrier of an imperfect capital market for MFI clients. These new loan products for adaptation measures both decreases the default rate of loans in the MFI portfolio by increasing clients' resilience to climate change, and presents a new business opportunity for both the MFI clients diversifying their income generating activities, and for the MFI diversifying its loan portfolio.

Note, only decreasing the awareness of MFIs is often insufficient. Decreasing the asymmetric information of the MFIs increases the perceived risk of climate impacts on their clients' business activities, which runs the risk of making it more difficult or expensive for farmers to access adequate finance. MFIs become aware that their clients may face challenges in repaying their loans if the agriculture they are dependent on is damaged or destroyed by increasing incidents of drought or floods. Only through providing information about products dedicated to adaptation enables them to understand the comparative advantage of adaptation measures to non-adaptation investments.

To date, more than 800 MFI clients have been interviewed and trained on EbA measures, and 2.300 EbA-related credits have been disbursed. The MEbA project is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB). The total project volume is EUR 4,9 million, which was provided as a grant. Upfront grants such as this, particularly for a pilot project, are an example of compensation from the financing perspective, as private actors face technological spillover effects. Pilot projects face innovation externalities and are typically riskier than a more mature project.

4 Coffee-processing in Rwanda.

Coffee-processing practices include growing or purchasing coffee berries, pulping, fermenting, washing, hulling and roasting the coffee. This process involves many actors along the supply chain, many of which are being impacted by changing climate conditions such as longer dry seasons delaying the flowering of coffee, less rain prolonging the ripening process of coffee cherries, and shorter harvesting periods. This may cause actors along the supply chain to default on contractual agreements such as product delivery, or suffer raw produce spoilage. However, given the asymmetric information on climate change, adaptation and potential available adaptation solutions, not all actors are incentivised to take action.

One coffee-processing company in Rwanda purchases coffee berries from associate farmers, processes the major part into coffee for export, and sells the smaller part at the local market. The company is increasingly affected by climate change impacts,[136] particularly shifting seasons decreasing yield, intense rainfall events affecting the drying process, floods affecting the washing process, drought affecting the coffee quality, the probability of pests and diseases increasing, and landslides affecting transportation of the product. As part of its Private Sector Adaptation to Climate Change programme, GIZ undertook an assessment of the vulnerability of the company and identified adaptation measures to strengthen their core business as well as measures to strengthen their supply chain. This assessment addressed the information asymmetry barrier through the identification, and eventual implementation, of low-cost, no-regret adaptation measures.

In response to the assessment of water scarcity, the company has planted shady trees across the coffee plantations, applied organic pesticides and is considering new pest-resistant coffee plant varieties. Beyond these smaller measures, the company identified more structural adaptation measures, such as the installation of a renewable/biomass fuel-powered dryer. The coffee-processor in Rwanda was unable to obtain a bank loan for these operations (imperfect capital market barrier). As explained in case 3, awareness for the financial sector in a first step may increase the perceived (climate) risk for private financiers and therefore increase the difficulties for enterprises to access finance. In a second step, awareness raising measures and assistance for private financiers to develop appropriate financing measures should reduce the risk of loans for adaptation compared to loans of investments not taking into account potential climate impacts.

MEASURE 2 – MEASURES TO REDUCE RISK OF INCREASED FLOODING

5 Terminal Maritimo Muelles El Bosque (Colombia)

Terminal Maritimo Muelles El Bosque (MEB) was the first privately owned maritime terminal in Colombia; established in 1992 with a concession from the Colombian government to develop and manage the port until 2032.

In 2011, the IFC Adaptation Programme analysed the potential risks and opportunities from climate change for MEB, and provided the MEB with recommendations of financially and economically viable adaptation measures. The IFC Study identified the main areas of the port likely to be affected by climate change, and the implications for MEB, including (but not limited to): financial (climate change affecting earnings), operational, health and safety (climate change effects on worker health and productivity), external stakeholders (adaptive measures requiring cooperation, funding, or buy-in of governments), and reputation (climate change affecting external views on the reliability and quality of the port facility).[137]

The highest risk came with increased seawater flooding of port areas; goods damage or loss due to seawater flooding. The adaptive measure recommended by IFC was to raise the causeway by 20cm at a cost of USD 380,000 (with no discount rate); while the cost of flooding on the causeway (under an accelerated sea level rise scenario by 2030) is estimated at USD 2,040,000.[138] The study further highlighted that the causeway can be raised additionally as needed in a relatively short timeframe. Overall, the net present cost of adaptive management option was below the net present cost of the 'one-off adaptation' option for discount rates above 0,2%.[139]

The study on environmental performance addressed the information asymmetry barrier, supporting MEB to understand the climate risks to their physical infrastructure, and recommending cost-saving adaptation opportunities in, among others, reduced dredging requirements and mangrove regeneration.[140] A financial analysis within this study showed that under an accelerated sea level rise scenario, the increased draft would decrease the volume of material to be dredged, reducing dredging costs by USD 325,000-400,000 by 2100.[141] A reduction of water use for spraying coke would amount to a saving of USD 14,000 per year (assuming that water use and rainfall changes are directly and inversely proportional). As a direct response to this study, MEB announced plans for USD 30 million adaptation investments in two ports, including USD 12 million that had already been invested,[142] financed through a commercial loan.

The IFC study also stated that climate change will more likely lead to increased maintenance costs or reduced useful life of the port rather than significant damage costs that would be covered by insurance.[143] The owners of MEB took out Contingent Business Interruption insurance where a physical loss or damage to an insured asset results in business interruption loss. MEB's insurance covers typical perils, including weather-related events of a sudden onset nature which cause damage such as: flood, heavy rains, wind storms, tropical cyclones and extreme temperatures. However, the insurance does not extend to potential indirect climate-related impacts (imperfect capital market) including: robbery following natural disasters; suspension or reduction of utility services (including electricity, gas or water) because of losses or damage due to towers, posts, transmission and distribution lines; business interruption because of a reduction of the water depth of the access canal (either from sedimentation or low water levels). This example nicely illustrates how improved awareness can lead to private investments in adaptation measures as soon as the market imperfection is removed.

6 Coastal development Jakarta, Indonesia.

One of the biggest challenges for the future of Jakarta is to protect its 10 million inhabitants and fast growing economy against increasing flood risks. The northern part of Jakarta is expected to subside up to 5 metres below sea level by 2050[144] due to combined effects of sea level rise and land subsidence caused by water abstraction. The National Capital Integrated Coastal Development program (NCICD) provides an integrated approach to address this challenge, with flood protection, improved sanitation and water supply, improved connectivity and sustainable community development considerations included in the development of the metropolitan coastal area.[145] The coastal development corresponds to a typical infrastructure project and will create a public good provision. The aim is to construct a completely new zone in front of the city's waterside in three phases: (1) reinforcing the current seawall, water treatment projects and revitalisation of the coast; (2) constructing the Garuda-shaped western seawall and new city; (3) constructing an eastern seawall with a port expansion and new airport.[146]

The Dutch government financed both a feasibility study of the development of the coastline and the construction of new infrastructure and the development of a National Programme. The corporates involved in this process, including: Dutch firms Witteveen+Bos and Grontmij (hydraulic engineering and urban development), KuiperCompagnons (design), Ecorys (economic feasibility) and Deltares (hydraulic analyses). This PPP arrangement also extends to financing with several private companies expressing interest in investing in this project.[147] The construction of the Giant Sea Wall is estimated to cost USD 40 billion, with a 20 year construction period.[148] 17 artificial islands will be created with homes and office space; the exploitation of which will cover a large share of the investment costs. As the project provides a public good (protection against flooding), the project development is not envisaged to be profitable, and the city administration is reducing the risk of the private

sector actors by guaranteeing to buy back the islets from the construction companies. In addition, advances payments of USD 13.8 billion were required from the government to initiate the project.[149] Some of these costs will be recovered directly from the end-user through, for example, toll roads. The provision of advance payments, a guarantee to buy back the islets, and plans to recover costs provide assurances to private investors, reducing the public good barriers. The city administration is also drafting the design of an international port which will be operated by city-owned property developer PT Jakarta Propertindo (Jakpor). The city administration is also expected to form an asset management company and additional financial support is being provided by the Dutch government.

7 Dike around Hi-Tech Industrial Estate in Ayutthaya, Thailand.

Thailand suffered its largest ever flood in 2011, which caused 813 deaths nationwide, and led to flood damage to seven industrial estates and 804 companies. Total losses ran into tens of billions (USD).[150,151,152] Following the floods, the government proposed flood prevention measures, including around USD 11 billion of water management projects, and aims to build a nearly 200-mile-long series of flood walls along a vulnerable stretch of the Chao Phraya river.[153]

Hi-Tech Industrial Estate was also flooded and had to invest around 100 million Baht (around USD 3.2 million) to restore its utilities. The estate decided to build its own new 11 km long dike around the estate,[154,155] despite an environmental group protesting that the dike would cause damage to the homes of villagers living nearby in the event of future floods, and have serious social and environmental impact as the dike alters the natural water-flow.[156] From an economic point of view this 'maladaptation' (increasing the vulnerability of the villagers) corresponds to a negative externality. One way to address this market imperfection would be that the utility has to compensate the villagers financially.

The costs of the new 11 km dike are estimated at 330 million Baht (around USD 11 million). Hi-Tech Industrial Estate sought a 15 year concessional loan of 15 billion Bhat from the government (0,01% interest rate for 7 years). The Estate wants the government to consider further assistance in the form of a favourable interest rate for the remaining 8 years.[157] The Industry Ministry originally planned to finance two-thirds of the cost with funds from the insurance pool, with estate operators taking out soft loans from the Government Savings Bank for the remaining amount.[158]

The Estate plans to increase the central utility fee by 1.200-1.500 Baht on top of the current 900-1,000 baht per rai.[159] The increased fee will be applied for 15 years and will be used to repay loans for building the dike.

8 Conservation fetau trees, Samoa.

Natural coastal protection measures, such as beach nourishment and the restoration of mangrove forests, frequently depend on public sector planning and financing, because of the public good nature of coastal protection. However, in Samoa, Oxfam New Zealand (an NGO) together with Women in Business Development Incorporated (WIBDI) have been actively involved in the conservation of native fetau trees to offer local communities protection from cyclones, tsunami, storm surge and sea level rise. The trees strengthen coastal defences, help to minimise the impact of waves, sea surges and increased erosion.

To address the public good character of this project, grant funding of NZD 1,470,000 (around USD 970,000) from Oxfam New Zealand; the New Zealand Aid Programme's Humanitarian Action Fund; Oxfam Australia; Oxfam America; Oxfam Canada; Canada Fund; the German Consulate; and donations from corporate organisations and the public in New Zealand and Australia were mobilised to finance the project.

In addition to the adaptation component, the initial investment also aimed to provide local communities with new income generating activities. The trees are a non-invasive species and their nuts fall naturally. Following a two-month drying process they release a rich oil which can be extracted and fetch up to NZD 400 per litre (USD 290). WIBDI is now working with cosmetic retailers to enter the growing European and US market for fetau oil.[160] The main actors are the public institutions which fund this project, which demonstrate that new, private, business opportunities can be established based on publically funded adaptation measures which initially aimed to provide a public good.

9 Ethiopia: Horn of Africa Risk Transfer for Adaptation (HARITA).

Farmer's harvests and incomes are already threatened by droughts in Ethiopia, which will be exacerbated by climate change impacts. Local MFIs are aware of such threats and impacts and the corresponding default rate of loan repayments. To improve farmers' access to finance, Oxfam commissioned a demand assessment for weather index insurance in 2007. The assessment was supported by the Micro Insurance Association of the Netherlands, the Development of Humane Action Foundation of India, the Centre for Research on Environmental Decisions, and Addis Ababa University. Swiss RE was involved as a technical partner in the design of the programme, and now acts as re-insurer. Weather data collection and analysis requires in-depth knowledge and is often the source of information asymmetry but the Ethiopian National Meteorological Agency collected weather related data for the demand assessment. Based on the assessment, in 2008, Swiss Re, Oxfam, the Ethiopian government, a local NGO and others initiated the Horn of Africa Risk Transfer for Adaptation (HARITA) project, which provides weather-index insurance for smallholder farmers in Ethiopia. The HARITA project serves as an important step toward developing Ethiopia's nascent insurance market.[161] This case highlights a combination of climate resilience projects (risk reduction), insurance (risk transfer), microcredit ("prudent" risk taking), and savings (risk reserves).

The main actors, the farmers, must be part of Ethiopia's Productive Safety Net Programme as this signals that they are the poorest households. In this case, there was no major barrier faced.

Farmers have to pay 100% of the insurance premium; however, they have the option to pay in labour rather than cash. In the first year of enrolment, 100% of the premium can be paid in labour, in future years they pay 10-15% in labour and the remainder in cash. This labour component is indirectly purchased through the donor funds, and is used for community-identified projects to build climate resilience. Insurance companies then issue insurance policies to the MFI which transfers the policies to cooperatives which provide coupons to the insurance-for-work farmers. The weather index insurance determines whether payouts need to be made, and when they are, they are communicated to insurance companies which transfer payouts to the MFI which are transferred to cooperatives to disburse them to farmers. Providing farmers the opportunity to buy insurance in labour and cash (insurance-for-work model) addresses the imperfect capital market, a typical barrier for farmers and SMEs.

The secondary actors include Swiss Re, USAID, Norway, Rockefeller Foundation, Oxfam America, the key funders of the programme, with funds managed by Oxfam and World Food Programme (WFP). Debit Credit and Savings Institution (DECSI), a local MFI, offers farmers to bundle the insurance with their credit and savings, which are used to increase productivity (e.g. credit for investing in productive assets) to increase the loan repayment rate, together with an insurance against certain climate impacts.

10 Weather index insurance by Guy Carpenter LLC. (Mozambique)

In 2012, a grant by the IFC Global Index Insurance Facility (GIIF) supported the micro-insurance broker Guy Carpenter LLC and the insurance companies Hollard and EMOSE to launch satellite-based weather index insurance in Mozambique. The insurance scheme covers cotton and maize farmers against risks of drought, low temperatures and excess rainfall. It also enables them to access the capital they need to invest in inputs and production to improve crop yield and food security.[162]

The main actor is Guy Carpenter LLC, which also implemented its product at the portfolio or "meso-level", through an aggregator (e.g. a delivery channel, association or other farmer group), in this case agribusiness firms Olam and SANAM which purchased one insurance policy to cover its group members (cotton and maize farmers). The model uses 'portfolio pricing' whereby the sum insured in a given region forms the basis for risk calculation, which helps to lower the cost of the insurance premium for farmers. Portfolio sales are less expensive than retail index insurance sold to individual clients. The agribusiness firms and the Cotton Institute of Mozambique pre-finance the insurance premia to act as a hedge against the climate risk to the future harvest of their farmers, and are recouped from the

farmers at the end of the season.[163] Therefore, the insurance provides cover for both the farmer and the agribusiness firms in the event of drought. Insurance policies are provided by two local insurance companies, Hollard Mozambique and EMOSE.

The average insurance cost is reported at 15% of the total insured amount, which at the portfolio level comes to approximately USD 100,000 (total insurance portfolio of USD 680,000 in 2012/13). During the first year of operation, the claims exceeded the amount of premiums collected: 2013 was a drought year, and the total insurance payouts amounted to USD 230,000.

The biggest challenge for this PPP was the lack of data on historical exposure and crop yield, which increased uncertainty around product design.[164] Disseminating technical information regarding the product to smallholder farmers was also identified as a challenge. The design of the project, with a multi-stakeholder approach with all actors invested in agricultural risk management helped to overcome this asymmetric information barrier for both private actors (the farmers and the PPP).

Since the pilot phase the product has been successful, the Cotton Institute of Mozambique aims to expand the index insurance coverage to all cotton farmers in Mozambique and eventually to other agricultural sectors. However, before the scheme there was no market for agriculture insurance products in Mozambique and this scheme helped to address this imperfect capital market barrier faced by clients. Since technological spillover is particularly present in the case of new products or business models, the initial grant from IFC compensated Guy Carpenter for the social benefits generated through piloting such a scheme.

11 Thailand: Sompo Japan Insurance.

In 2010, Sompo Japan Insurance (Thailand) Co., Ltd. launched a weather index insurance scheme in Thailand in an effort to mitigate losses suffered by rice farmers due to drought.[165] One actor in this case study is the farmers who need to build resilience to climate change induced drought. The main actor, however, is Sompo Japan Insurance, which pays insurance to rice farmers in northeast Thailand if rainfall over a predetermined period falls below a predefined level.[166] The insurance product is offered to farmers who receive a loan from the Bank for Agriculture and Agricultural Cooperatives (BAAC). In the event of a payout, the insurance payment is also to be partially used to repay the BAAC loan.[167] The premium and coverage were calculated from historical data and affordability for farmers.

The project was initiated through a feasibility study conducted by Sompo Japan Insurance and BAAC. The results of the study led to the pilot of a rice crop insurance since it is a major crop in north-east Thailand, but is dependent on rain-fed irrigation.[168] The company also chose Thailand for this project because it had sufficient weather data to develop weather index insurance, and were supported by government organisations such as the Thai Meteorological Department to address the lack of information.

Sales rapidly increased from 1.158 in 2010 to 6.173 in 2011, and by 2014 the product covered 17 provinces. According to Sompo Japan Insurance there were three reasons for this: 1) BAAC requested scaling up to different provinces; 2) the realisation of a simple product that is easy for farmers to understand; 3) the partnership with the BAAC, which has a strong presence in agricultural areas of Thailand and which provided product guidance. This product was the first commercial index-based agricultural insurance in South-East Asia[169] and major lessons learned included the importance of a local partnership (such as with BAAC), the availability of data, and the premium payment capability, in this case coupling the insurance with a loan contract. This case illustrates that without major market imperfections the private sector can invest in adaptation-related insurance without public support.

MEASURE 3 – ROLE OF PHARMACEUTICALS TO REDUCE HEALTH-RELATED CLIMATE RISKS

This theme covers health-related climate risks and the cases identified aim to explore adaptation in the health sector. One challenge is finding a direct link to climate impacts, since climate change is predicted to impact on human health but the direct and indirect risks to businesses are unclear. Therefore, cases have been selected where businesses make an indirect contribution to adaptation including awareness raising and R&D initiatives.

Note, the literature disagrees whether health care provision is public or private good. For this study we distinguish between i) providing infrastructure for health; and ii) providing the health treatment itself. The former is seen as a public good, as the infrastructure itself is non-excludable and non-rivalrous in consumption, while the latter is treated as a private good for services provided to patients.

12 Awareness raising campaign SC Johnson: "I was Dengue".[170]

SC Johnson has a number of innovative programmes which aim to help tackle the public health threat of dengue (a mosquito-borne tropical disease). Programmes include providing educational materials, repellent sampling and spraying in areas affected by outbreaks.

Starting in 1999 in the Philippines as a public service initiative, SC Johnson placed a strong focus on R&D to prevent insect-borne diseases, the spread of which may be increasing due to climate change. SC Johnson also partners with public institutions to develop and promote their healthcare programmes. In 2012, SC Johnson and Cornell University's Center for Sustainable Global Enterprise launched the WOW™ club pilot in Ghana as part of a three-year project funded by SC Johnson and the Bill & Melinda Gates Foundation. This new business model is a membership programme to groups of 7 rural homemakers who benefit from a bundle of four SC Johnson products such as repellents and insecticides, as well as group coaching sessions on home and family-care best practice.[171] The company also co-financed, and provided in-kind personnel and resources for a study by Cornell University Center for Sustainable Global Enterprise aiming to develop a market-based solution to malaria infection.[172] They also distribute "Off!" mosquito repellents in cities; the campaign's success was later coined with the sale of one of the company's products "Off Insect Repellent Lotion" demonstrating the roles of media and private actors in creating public awareness and demand. The awareness campaigns address information asymmetry through educating people about health and climate-related risks, and at the same time create demand for these products. Through addressing the asymmetric information market imperfection SC Johnson aims to decrease the prevalence of malaria.

13 VestergaardFrandsen sells products tailored for prevention in times of disaster.[173]

The main actor in this case study is Vestergaard Frandsen, a Swiss textiles manufacturing global health company.[174] This company invests in an innovative platform to produce products and solutions for malaria, HIV/AIDS, diarrheal diseases and tropical diseases. The IPCC reported that risks from food and water borne, and vector borne diseases will increase (with high confidence) as a result of climate change and that rapid social and economic development is required to reduce impacts on health.[175] However, emergency response products such as those offered by Vestergaard Frandsen, are also important adaptation measures. Products offered include bed nets, curtains made of insecticide-incorporated plastic sheeting for malaria and dengue prevention and water purifiers.

Rather than sell their products directly to end-users, the Vestergaard Frandsen business model is set up to help the most vulnerable people who cannot afford these products, through selling large quantities to governments, aid agencies, NGOs, faith-based groups and the private sector.[176] Note, governments and aid agencies create demand for Vestergaard Frandsen's products, which does not correspond to policy measures to address market imperfections, as Vestergaard Frandsen does not face market imperfection barriers. For distributional reasons the government or NGOs often distribute medical products for the poorest for free or at low cost.

14 A to Z Textiles Mills expanding network of entrepreneurs.[177]

Since the 1960s, A to Z Textiles Mills (A to Z) grew from a small textile manufacturer to one of the largest vertically integrated plants in East Africa, serving both local and international markets as a manufacturer and distributor of a variety of textile and plastic products, including Long-Lasting Insecticidal Bed Nets (LLINS). Originally, an Olyset Consortium ((including Sumitomo Chemical Company, WHO, UNICEF, ExxonMobil, and Acumen Fund) produced LLIN bed net technology in competition with A to Z's bed nets. However, the Consortium was encouraged by A to Z's technology and a partnership was formed to strengthen and expand the outreach of the new product.

Sumitomo transferred its manufacturing technology royalty-free to A to Z and paid the cost of the World Health Organisation Pesticide Evaluation Scheme fee (USD 35,000). Part of the initial technology transfer from Sumitomo Chemical to A to Z was facilitated by Acumen Fund who also provided USD 325,000 debt financing for A to Z to buy equipment and factory modifications.[178]

In the first year of operations, A to Z sold 90% of their products to UNICEF, with financial support from the Rockefeller Foundation and ExxonMobil. UNICEF also assisted A to Z's operational expansion through distribution and voucher systems in hospitals, antenatal clinics and immunisation campaigns, with USD 250,000 grant financing from ExxonMobil. The partnership distributed 90% of the LLINs through public sector channels with 10% through private sector actors such as service stations.[179] ExxonMobil invested in total USD 11.3 million and leveraged its oil distribution networks to enhance the delivery of the nets. Acumen Fund provided a second loan of USD 400,000 and a grant of USD 275,000 for private market development. NGO Population Services International (PSI) invested USD 15,000 in marketing and promotional activities. This case provides a nice example of private investments in an environment with no market imperfection.

15 Unlimited Primary Health Care, Mexico[180]

Primedic, the main actor in this case study, aims to provide access to unlimited primary health care at affordable rates for low-income families in Mexico. The company offers a healthcare medical membership for primary care consultations costing around USD 10 per year, and patients have access to unlimited primary care consultations. In addition, members receive discounts on medicines, tests, and consultations with specialists. Primedic currently serves around 4,000 members in 6 clinics and is planning to expand across Mexico.[181]

By encouraging preventive care, Primedic lowers the overall costs incurred by the company and its patients by reducing claims for expensive treatments. The business idea is similar to the model of private health insurance and illustrates the creativity of private actors to develop, adjust and identify adaptation business models through, for example, the provision of healthcare services and infrastructure to improve basic public health measures to reduce the increasing climate impacts on health. This has been achieved in an environment without major market imperfections.

Primedic primarily raises funding through revenues from membership and subscription fees. However, IGNIA Venture Capital Fund (Mexico) and Tango Investors (US private investment company) have also provided funds for this initiative: both committed USD 3 million equity finance in 2008.[182,183] Primedic also has agreements in place with other service providers such as pharmacies to offer discounts on medicine or laboratory tests to their patients.[184]

16 Mobile Clinics[185] (India, South Korea)

Well-equipped medical vans staffed by medical staff are a low cost option in under-served, rural areas. Although these have primarily been donor-driven initiatives, there is scope for standalone enterprises to offer such vans as demonstrated by Siemens mobile clinics.

Siemens is the main actor in this case study: their healthcare business model is R&D to support, among others, therapy, molecular diagnostics and services.[186] They also partner with local public institutions to further their healthcare outreach, health promotion, preventative education and curative services. These are important adaptation measures as the IPCC predicts that climate change will increase demand for healthcare services including infrastructure and supplies for treatment.[187]

Siemens offers healthcare services as part of their Corporate Social Responsibility (CSR). The investments are not revenue-generating, but illustrate the social (and environmental) responsibility of Siemens to support the development of the public health infrastructure (often regarded as public responsibility). For example, under their Corporate Citizenship Initiative, Siemens deployed two mobile clinics to their Sanjeevan mobile clinics in India. To do this, they partnered with four public institutions in India; Smile Foundation; Medanta, the Medicity; the local public health system; and Panchayats.[188] In 2012, a Siemens Mobile Clinic was also launched in South Korea, jointly operated by Kids & Future Foundation (a social welfare organisation), and the Korean Society for Laboratory Medicine to provide a free healthcare service using a large-sized bus equipped by Siemens.[189]

Climate change is expected to seriously disrupt business as usual and private actors are increasingly redirecting CSR activities and investments towards adaptation measures. CSR efforts can be seen as part of a company's endeavours to broaden relationships with their stakeholders and address social and environmental concerns.

17 Tele Medicine[190] (India)

One response to potential increases in ill-health in many regions as a result of the changing climate is to improve the delivery of healthcare to remote and underserved areas. Piramal eSwasthya is an NGO in India providing healthcare services since 2007. Their business model focuses on both the patient and the doctors, to ensure trained doctors can provide high quality care to their patients. To do this, they offer a micro-franchise model, training village-based female health entrepreneurs who enable primary healthcare access to rural patients.

These health entrepreneurs use mobile phones to call the eSwasthya call centre, connecting with paramedics and doctors who provide provisional diagnoses. Sharing medical information, such as symptoms and test results, through telecommunications reduces the cost of expert consultations in underserved areas. In addition, the health entrepreneurs conduct preventive health workshops to generate awareness of hygiene and sanitation, among others, which is highlighted by IPCC as an important adaptation measure.[191]

Patients pay a nominal fee for the services. The entrepreneurs have to invest in the franchise license and earn revenues for delivering healthcare to the doorsteps of the rural population.

Piramal Swasthya has partnerships with state governments and philanthropic organisations to ensure a wide coverage for their services, demonstrating the role of consortia in offering a public good such as the provision of infrastructure for healthcare.[192] The health treatment itself, however, is a private good as patients are willing to pay. Initially, the case seems to demonstrate public good provision and the possibility of positive externality (external private actors implementing similar models through technological spillover). However, the private actor has used a PPP model effectively to reduce the risk of the model and reduce the potential public good provision of providing infrastructure for healthcare. The use of a microfranchise and telecommunications model also helps to reduce costs, making the services affordable for patients. Therefore, no major market imperfections hindered the implementation of the adaptation-related service.

18 Affordable Medical Equipment[193] (China and India)

Building on their of experience in medical equipment and R&D centres in China and India, GE Healthcare has committed to invest USD 6 billion by 2015 in the delivery of low-cost medical equipment. Their purpose is to create infrastructure, processes and solutions to transform the way healthcare is delivered, an adaptation measure linked to coping with climate change as a multiplier of existing health vulnerabilities and improving socio-economic and resilient development. GE Healthcare works with PPPs and consortia for project finance to develop infrastructure for their operations, including hospital operations and technology.[194] They partner with governments, health systems, financiers and contractors to develop Managed Equipment Service (MES) Agreements. Such agreements include the transfer of capital expenditure to operational expenditure funding and help to establish a long-term budget and capital planning as well as equipment guarantees and performance metrics.[195]

GE Healthcare target emerging markets to drive their future growth. For example, they established a USD 570 million business in India, with 3 manufacturing plants in Bangalore,

GE Healthcare aims to manufacture an extended line of low-cost medical equipment for export to emerging markets globally.[196] In 2012 they stated that they expect annual sales revenue of more than USD 1.5 billion from 2012.[197] The expected revenues illustrate that health-related adaptation measures, although not directly labelled as 'adaptation' from the macro perspective, are happening and are expected to be a promising business sector. New activities such as this face potential technological spillover if other private actors generate positive learning effects from the business model. However, GE Healthcare is one of the largest foreign investors in the Indian healthcare system and also work with state governments to improve the healthcare sector, suggesting that technological spillover is not a major barrier as it would not financially impact their business model as may be the case for smaller private actors.

19 GSK's research facility in Tres Cantos, Spain

GlaxoSmithKine (GSK) is the sixth largest pharmaceutical company in the world. As part of its R&D for diseases of the developing world (e.g. malaria and tuberculosis),[198] GSK established the NGO 'Tres Cantos Open Lab Foundation' in 2005 to provide funding and support to research into neglected diseases conducted at the Tres Cantos Medicines Development Campus in Spain.[199] The relationship between health and climate change is complex; however, it is widely reported that changes in infectious disease transmission patterns are likely to be a major consequence of climate change and R&D efforts are required to understand the underlying complex causal relationships.[200]

This foundation prioritises drug development based on their socio-economic and public health benefits, rather than commercial returns.[201] This centre has a number of academic and not-for-profit partners and GSK set up a patent pool in 2009 to facilitate access to intellectual property, industrial expertise and technologies to stimulate research into neglected tropical diseases.[202] This open sharing of knowledge and expertise, which will come at cost to the companies involved, is a critical way the pharmaceutical sector can contribute to development of solutions to address health-related climate risks.

GSK provided GBP 5 million (around USD 7 million) initial investment to support the foundation's objective,[203] and added another GBP 5 million in 2012. In addition, GSK is partnered with the Bill & Melinda Gates Foundation in early stage research into vaccine thermostability. In 2013, the partnership announced a USD 1.8 million investment to support a new joint initiative to make vaccines more resistant to heat, reducing the need for refrigeration,[204] and an increasingly important adaptation measure in the face of global warming. From an economic perspective, R&D activities and investments face many different barriers such as public good provision and technology externality, as well as aim to indirectly eliminate other barriers such as imperfect capital market (reducing the risk of new project types) or asymmetric information. Financial support from a Foundation for R&D conducted by a private actor can help to address the typical barriers which exist for new products which generate social benefits, as a form of compensation from the financing perspective.

20 The Medicines for Malaria Venture (MMV)

MMV is a not-for-profit 'product development partnership' aiming to discover, develop and deliver safe and effective anti-malarial agents. Such initiatives are increasingly important, as long-term climate warming favours geographical expansion of many infectious diseases, creating clustered outbreaks and affecting the timing and intensity of outbreaks.[205] MMV was launched in 1999 with an initial seed finance of USD 4 million from the Government of Switzerland, UK Department for International Development, the Government of the Netherlands, The World Bank and Rockefeller Foundation. Early stage enterprises and projects may transform the market; however, for new business ventures there may be a lack of enterprise development support particularly as a result of technology spillover (the learning effects for other ventures). Seed financing is one way to correct the technology externality of R&D in the early stage from the financing perspective.[206] MMV is now funded by public and private sectors[207] and includes 28 pharmaceutical companies, 13 biotechs, 56 universities, 38 research institutes, 72 clinical sites and 50 government agencies, demonstrating the importance of the initial seed finance to increase the attractiveness of the new venture or product for future private investment in public health infrastructure.[208]

MMV has the largest pipeline of anti-malarial drugs, with over 50 projects from discovery through to registration.[209] It has carried out 9 pivotal phase III trials in 3 years with 11,000 patients and remains a flagship PPP for neglected diseases research.[210] MMV receives funding and support from government agencies, private foundations, international organisations, corporations, corporate foundations, and private individuals. These funds are used to finance MMV's R&D portfolio. MMV also has 'mini R&D portfolios' with contributions in kind from three major private pharmaceutical companies.[211] One of MMV's partners, MSD, retains the option to become a development partner depending on the outcome of the clinical drug trial. If the drug is sold in malaria-endemic countries, MSD has committed not to profit.[212]

The number of SMEs supplying products and services to the pharmaceutical industry is increasing. For example, the pharmaceutical industry in India has witnessed significant growth and it estimated to be worth approximately USD 10 billion, growing at an annual rate of 9%.[213] New business opportunities are created for SMEs in this expanding market; for example R&D in bulk drugs, clinical trials, and manufacturing and opportunities to supply active pharmaceutical ingredients and related chemicals.[214]

21 Malaria Vaccine (RTS,S)

GSK have invested USD 350 million in the development of their malaria vaccine (RTS,S) through a PPP with the PATH Malaria Vaccine Initiative (MVI) and with support from the Bill & Melinda Gates Foundation.[215] The price of RTS,S will cover the cost of manufacturing the vaccine together with a small return of around 5% that will be reinvested in R&D for second-generation malaria vaccines, or vaccines against other neglected tropical diseases.[216] Philanthropy support corrects the technology externality (compensating the actor from the financing perspective) and was critical in enabling the development of the malaria vaccine and reducing the risk for GSK. Simultaneously, GSK supports practical, community-based initiatives to address climate-related health issues. Through the Africa Malaria Partnership (AMP), GSK committed over GBP 4.8 million to community initiatives since 2001 and partnered with organisations on the ground to promote the use of existing interventions, such as bed nets, indoor residual spraying, and anti-malarial treatments.[217] The promotion of interventions decreases the information asymmetry of (potential) customers not understanding the benefits of the product, which can also drive product demand.

MEASURE 4 – SPATIAL PLANNING FOR REDUCING RISKS ASSOCIATED WITH HEAT STRESS IN URBAN AREAS

22 Toronto

The Toronto City Council adopted its Climate Change, Clean Air and Sustainable Energy Action Plan in 2007. Measures to address the UHI effect include a commitment to double the tree canopy; to set performance targets for the design and construction of new developments; to promote green roofs as well as high-albedo roof and road surfaces; and changing some city-workers uniforms to lighter colours during summer months.[218] Although private actors are not explicitly mentioned as a financer of such measures, the city does state that in order to develop an adaptation strategy, it is essential to '*ensure that the public, businesses and other stakeholders are aware of the impacts of climate change, and engaged in thinking about and implementing solutions*'.[219]

For instance, in order to incentivise the creation of green roofs, the City Council adopted the 'Eco-Roof Incentive Program' in 2009 and funded the installation of over 100 green and cool roofs on buildings across the city by providing grants:[220]

- Eligible green roof projects receive USD 75 /m^2 up to a maximum of USD 100,000;
- Eligible cool roof projects receive USD 2 - 5 / m^2 up to a maximum of USD 50,000;
- Furthermore, Toronto decided on the 'green roof bylaw' in 2010, requiring green roofs on new developments or additions with a gross floor area of over 2000m^2.[221]

The green roof project addresses the UHI effects and each investment contributes to a public good to all citizens of Toronto (to limit warming in the city). The case illustrates that private actors may react to public intervention and invest in protecting their assets from the changing climate if they are compensated for the reduced return.

23 Rotterdam

Rotterdam aims to involve private actors in both UHI effect mitigation and adaptation to the UHI effect. Mitigation focuses on creation of co-benefits, for example by coupling measures for cooling with maintenance and renovation of buildings, restructuring as well as new building development. Examples include solar reflection and shadow; air-conditioning, isolation; options to open windows; and designing apartments with bedrooms on the north-side and not on the upper floor. Another important aspect is greenification of streets, quays, bicycle lanes and pavements (e.g. trees and parks) and buildings (e.g. green roofs and walls); as well as (streaming) open water.[222]

Rotterdam emphasises the role of private actors in its efforts to mitigate and adapt to the UHI effect, which depends on the availability of private investment, as well as various actors' maintenance budgets for city development. Rotterdam tries to increase public and private participation through awareness raising, one way to address the asymmetric information which may currently reduce the attractiveness for private financiers to invest. It has already started discussions with a variety of private actors, but it remains unclear what their particular roles will be in terms of financing and implementing adaptation projects.[223]

There are also separate initiatives under the Rotterdam UHI Effect plan; for example, the Blue Corridor initiative aims to construct a new waterway corridor in south Rotterdam as a new water supply line. The new waterway corridor will provide cleaner water in southern Rotterdam and will serve as water supply line in times of aridity. It will also guarantee water quality in the southern part of Rotterdam. The new corridor will contribute to the prevention of cyanobacteria (blue-green algae), as well as producing recreational benefits. Private actors such as Interreg IVB project MUSIC, TNO, Doepel Strijkers Architects, Sander Lap Landscape & Urban Design, and Drift, Erasmus University Rotterdam may be involved in the development of the Blue Corridor. Similarly to case 22, such PPP arrangements help to reduce the risk for private investors, as well as compensate a reduced private return as the adaptation measure provides benefits to the whole city.

24 Tokyo

In 2005 the Tokyo Metropolitan Government designated four areas for the 'implementation of urban heat island effect mitigation measures', based on several criteria including 'urban emergency redevelopment areas' that can attract environmentally-friendly development by the private sector. Private actors were encouraged to take part in developments, such as water-retentive pavements and greening of exterior walls,[224] but the results are not yet clear.

Although Tokyo realises the importance of public finance to tackle the UHI Effect, they have also established initiatives such as the Eco-finance project. Financial institutions began this project in 2009 through utilising Tokyo Metropolitan Government's JPY 7 billion Fund (around USD 61,000) to financially support environment-friendly projects carried out by households, NPOs, and business enterprises.[225] This public support compensates the reduced return of providing a public good to the citizens of Tokyo when investing in, for example, water-retentive pavements and greening of exterior walls.

MEASURE 6 – EARLY WARNING SYSTEMS AGAINST EXTREME WEATHER EVENTS

25 Telvent

This Spain-based global IT solutions and information services provider (now Schneider Electric) provides specialised weather forecasting services to weather sensitive industries and national governments, including technology and equipment for national meteorological services to enable them to improve weather and climate information, and issue forecasts and warnings for weather extremes.[226] Telvent is active in lower-income, climate-vulnerable countries such as Mozambique, Morocco and Bolivia and the information service they provide helps users (public services, but also individuals, SMEs, and weather-sensitive businesses) make essential preparations that can help mitigate adverse effects on people, assets and the economy.

This business model for national meteorological services allowed Telvent to enter new markets and establish a competitive position in a climate change relevant industry, as their equipment and technologies are sold primarily to public actors. This illustrates a private adaptation-related investment by a private actor which aims to address the barrier facing many public and private actors, asymmetric information, through the provision of equipment to enhance data gathering and analysis. This also has elements of public goods since the weather forecasts can be used to strengthen the whole economy. Together with the World Meteorological Organisation (WMO), Telvent helped the Bolivian National Service of Meteorology and Hydrology to modernise and expand its network of hydro-meteorological stations and improve its data gathering and forecasting capabilities for heavy rain, drought, and frost, including impacts due to the El Nino phenomenon.[227] This PPP contract between Telvent and the Bolivian National Service of Meteorology and Hydrology was more than EUR 4.5 million (~USD 4.9 million).

26 Farmerline

Ghana-based company Farmerline utilises mobile phone technology to provide a valuable link for farmers to better access markets, financing, weather forecasts and agricultural services through seasonal subscriptions. Farmerline provides reliable, daily information on weather forecasting and climate information that supports farmers to improve their yields and enhancing productivity, for example by sharing best practices in areas such as product storage, reducing pest infestations and bringing products to market. Farmerline's mobile messaging platform allows governments, development partners and businesses to provide farmers with fast, low-cost updates on crop management through outgoing messages (voice/SMS) and mobile surveys to ensure that they receive the right information for increasing yields. Therefore, a myriad of actors play a role in this case study. The two most important are the SME (Farmerline), which has responded to a market need and developed a new business opportunity. Sub-actors include the financiers of Farmerline, including a public Foundation, equity investors, and the clients of Farmerline: farmers (SMEs) which subscribe to the technology. The company aspires to expand its services across Africa and aims to reach an estimated 2 million farmers by 2024.[228]

This technology start-up based in Ghana, was able to identify and seize a new business opportunity in a unique place in the adaptation value chain facing no major market imperfections. Farmerline capitalised on the deep mobile-phone penetration in Ghana and developed an innovative platform to provide farmers with valuable information to help them increase crop yields by improving farming practices. The business model actually reduces the barrier asymmetric information for farmers, who are thus better equipped to continue their business as usual activities.

Farmerline financed their business in the same way as many early-stage entrepreneurial ventures. Farmerline was launched in 2013, shortly after it received a grant award of USD 9,000 from the UK-based foundation Indigo Trust.[229] With limited access to formal financial institutions, the grant enabled the start-up to expand and focus on revenue seeking opportunities. In July 2015, Farmerline received a USD 50,000 equity investment from the seed capital firm Village Capital.[230] And they are seeking further equity investments.[231]

Overall, as their subscriber base has grown to over 10,000 farmers, their revenues have increased from USD 52,000 to an estimated USD 200,000 by 2015.[232] Both the increased revenues and the outside equity investors, should help Farmerline to more easily look for bank financing and credit to further expand their operations.

27 Nokia

In 2009, Nokia made a strategic decision to refocus its CSR investments toward the promotion of the use of mobile technology for development. The company believes mobile technology for development can result in social benefits at low cost: once an up-front investment in mobile applications software has been made, the cost of replication is essentially zero. Nokia developed two mobile applications; Nokia Life and Nokia Data Gathering. The former helps climate-vulnerable farmers in India, Indonesia, Nigeria, and China by providing tailored information on weather forecasts and market prices, as well as advice on seeds, fertiliser and pesticides. In 2012, Nokia Life introduced a new 'Call an Expert' service for farmers to receive additional support.

Nokia Life is a subscription-based service costing approximately USD 0.05 per day.[233] In 2013, it was reported that in India the cost is INR 60/month; China Yuan 5/month; IDR 500/day and Nigeria N250/month.[234] It is reported that by 2013 over 95 million people had experienced Nokia Life services[235], although Nokia has never spent money on advertising; information about the service is included in the handset manual.

Nokia has partnerships with 18 operator billings in these four countries, including Vodafone, to support their information services and reach a potential 1,5 billion people. These operators technically integrate their servers and take a share of the Nokia Life subscription fees.[236] Nokia also works with more than 40 information sources including agricultural universities, governments, NGOs, and online services.

In the initial stages of Nokia Life, it was unclear whether the service should be provided as a public good or a new business opportunity. Although the product was launched as a business benefit no exclusivity was given to the operator partners.[237] This encouraged further partners to support the venture. This case illustrates that out of the idea of engaging in adaptation-related CSR investments a business opportunity emerged. From the new business opportunity, Nokia also reduced the barrier asymmetric information for farmers, who can obtain information to help them continue their business as usual activities.

28 Ericsson: Mobile Weather Alert project

Early warning systems can be used beyond the agricultural sector. In 2009, Ericsson, the WMO and the Ugandan National Meteorological Services formed a PPP to utilise Ericsson's mobile communication technology to enhance access to and delivery of weather and climate services for thousands of fishermen on Lake Victoria.[238] Fishing is usually done in small wooden boats, most fishermen cannot swim, and life jackets are not readily available. As weather conditions can change suddenly with winds causing waves that capsize ferries and fishing boats,[239] multiple boating accidents happen annually, which often result in fatalities. Accurate and up-to-date weather information and warnings could prevent accidents, as it helps fishermen to make more informed decisions on when and where to fish.[240]

In 2011, the Mobile Weather Alert service for mobile subscribers[241] was piloted for 1,000 fishermen in Kalangala District in south-western Uganda.[242] The Uganda Department of Meteorology provided the weather forecasts (which the UK Met Office helped to improve),[243] and MTN Mobile sent these through an application developed by Ericsson. Tailored local weather forecasts, in the local language Luganda, were texted to fishermen by SMS.[244] According to the WMO, the pilot project demonstrated the clear demand and need for these types of services in Uganda.[245] However, despite this demand, a PPP with multiple stakeholders was required to pilot the project as well as training for community leaders in what the weather alerts mean, for these leaders to train the fishermen. The project was launched as a free service,[246] but it is unclear whether it will continue to be free in the future as it demonstrates the potential for a new (adaptation) business opportunity. The role of Ericsson together with technical advice and support services from the WMO to remove the asymmetric information barrier is important for the livelihoods of the fishermen in Uganda.

ANNEX 3: CLASSIFYING SMES

Providing a macro definition of SMEs has proved challenging as it depends on the perspective and the economic development of the country or region of focus and the large amount of sectors involved. Different definitions of SMEs exist, comparing enterprises and their performance predominantly using three main criteria: persons employed, turnover and/or assets. The World Bank definition (2005)[247] serves as a benchmark for defining SMEs in developing countries. Enterprises must meet two out of the three criteria:

Enterprise category	Headcount	Assets (USD)	Annual Sales (USD)
Micro	< 10	< 100,000	< 100,000
Small	< 50	< 3 million	< 3 million
Medium-sized	< 300	< 15 million	< 15 million

Proxies for loan sizes for SMEs are also provided for this definition:

Enterprise category	Loan size proxies (USD)
Micro	< 10,000
Small	< 100,000
Medium-sized	< 1 million (< 2 million for some advanced developing countries)

END NOTES

1. 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp
2. 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp
3. World Economic Forum, (2015), Global Risks 2015, 10th Edition, Insight Report, http://www3.weforum.org/docs/WEF_Global_Risks_2015_Report15.pdf
4. World Economic Forum, (2013), The Green Investment Report: The ways and means to unlock private finance for green growth, A report of the Green Growth Action Alliance, http://www3.weforum.org/docs/WEF_GreenInvestment_Report_2013.pdf
5. Mercer LL, IFC, UK DfID, (2015), Investing in a Time of Climate Change, http://www.mercer.com/content/dam/mercer/attachments/global/investments/mercer-climate-change-report-2015.pdf
6. United Nations Environment Programme (UNEP), (2016), The Adaptation Gap Report 2016, United Nations Environment Programme (UNEP), Nairobi, http://web.unep.org/adaptationgapreport/sites/unep.org.adaptationgapreport/files/documents/agr2016.pdf/
7. 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., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32
8. Frankfurt School of Finance and Management, (2016), Basics of SME Finance, Certified Expert in SME Finance Online Course
9. Investopedia LLC, (2016), Corporation, http://www.investopedia.com/terms/c/corporation.asp
10. UN Global Compact, UNEP, (2012), Business and Climate Change Adaptation: Toward Resilient Companies and Communities, Caring for Climate, https://www.unglobalcompact.org/docs/issues_doc/Environment/climate/Business_and_Climate_Change_Adaptation.pdf
11. IPCC, (2014), Climate Change 2014 Synthesis Report Summary for Policymakers, IPCC Fifth Assessment Report, https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf
12. Pauw, P., (2014), Not a panacea: private-sector engagement in adaptation and adaptation finance in developing countries, Climate Policy, 15:5, pp. 583-603
13. Pauw, P., (2014), Not a panacea: private-sector engagement in adaptation and adaptation finance in developing countries, Climate Policy, 15:5, pp. 583-603
14. Demertzidis, N., et al, (2015), A benchmarking framework to evaluate business climate change risks: A practical tool suitable for investors decision-making process, Climate risk Management, Vol. 10, pp. 95-105, http://ac.els-cdn.com/S2212096315000315/1-s2.0-S2212096315000315-main.pdf?_tid=811b0358-1042-11e6-952c-00000aab0f6b&acdnat=1462179030_6db6a3a32ddafa8578c29ae38454a1d1
15. Tanco, M., Jurburg, D., and Escuder, M., (2015), Main difficulties hindering supply chain performance: an exploratory analysis at Uruguayan SMEs, Supply Chain Management: An International Journal, Vol. 20, No. 1, pp. 11-23, http://www.emeraldinsight.com/doi/pdfplus/10.1108/SCM-10-2013-0389
16. Tanco, M., Jurburg, D., and Escuder, M., (2015), Main difficulties hindering supply chain performance: an exploratory analysis at Uruguayan SMEs, Supply Chain Management: An International Journal, Vol. 20, No. 1, pp. 11-23, http://www.emeraldinsight.com/doi/pdfplus/10.1108/SCM-10-2013-0389
17. Agrawala, S., et al., (2011), Private Sector Engagement in Adaptation to Climate Change: Approaches to Managing Climate Risks, OECD Environment Working Papers, No. 39, OECD Publishing. http://dx.doi.org/10.1787/5kg221jkf1g7-en
18. RWE Npower plc, (2013), Business Energy Index 2013, https://www.npower.com/idc/groups/wcms_content/@wcms/@busi/documents/digital-assets/nbei9.pdf

19. 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland

20. IPCC, (2007), Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Solomon, S., and D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor, H.L. Miller (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

21. IPCC, (2013), Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

22. Simpson, M., et al., (2011), Climate Change's Impact on the Caribbean's Ability to Sustain Tourism, Natural Assets, and Livelihoods, IDB, http://www.uncclearn.org/sites/default/files/inventory/idb14.pdf

23. Nicholls, R. and Cazenave, A., (2010), Sea-Level Rise and Its Impact on Coastal Zones, Science, 328(18), pp. 1517-1520

24. Nicholls, R. and Tol, R., (2006), Impacts and responses to sea-level rise: a global analysis of the SRES scenarios over the twenty-first century, Philosophical Transactions of the Royal Society A, Vol. 364, pp. 1073-1095

25. Simpson, M., et al., (2011), Climate Change's Impact on the Caribbean's Ability to Sustain Tourism, Natural Assets, and Livelihoods, IDB, http://www.uncclearn.org/sites/default/files/inventory/idb14.pdf

26. Caribbean Development Bank, (2004), Financing growth and development in the Caribbean – the role of the Caribbean Development Bank, Economics and Programming Department, CDB, http://www.caribank.org/uploads/publications-reports/staff-papers/RevisedFinancingGrowth1.pdf

27. Field, C., et al., (2014), Technical Summary, 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-TS_FINAL.pdf

28. 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland

29. WHO, (2015), Neglected Tropical Diseases, http://www.who.int/neglected_diseases/diseases/en/

30. Agrawala, S., and Fankhauser, S., (Ed.), (2008), Economic Aspects of Adaptation to Climate Change: Costs, benefits and policy instruments, OECD, ISBN-978-92-64-04603-0

31. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

32. IFC, Opportunities and Trends in Investing in the Health Sector, https://www.wbginvestmentclimate.org/advisory-services/health/upload/Opportunities-and-Trends-in-Investing-Guide_for_Investors_in_Private_Health_Care_in_Emerging_Markets.pdf

33. Fischer, E. M., Oleson, K. W., and Lawrence, D. M., (2012), Contrasting urban and rural heat stress responses to climate change, Geophysical research letters, Vol. 39(3).

34. 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland

35. Buijs, S., and J. Streng, J., (2013), Rotterdamse adaptatiestrategie. Themarapport stadsklimaat, Rotterdam Climate Initiative, Rotterdam

36. Yamamoto, Y., (2006), Measures to Mitigate Urban Heat Islands, Quarterly Review, No. 18, National Institute of Science and Technology Policy, Japan

37. ICLEI, (2011), Financing the Resilient City: A demand driven approach to development, disaster risk reduction and climate adaptation - An ICLEI White Paper, ICLEI Global Report

38. UK Marine Industries Alliance, (2011), A Strategy for Growth for the UK Marine Industries, Department for Business, Innovation and Skills, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/31813/11-1310-strategy-for-growth-uk-marine-industries.pdf

39. Bouwer, L., & Aerts, J., (2006), Financing climate change adaptation, Disasters, Vol. 30(1), 49 263

40. 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 151

41. Naidoo, T., Vaz, K., and Byaby, 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, http://www.cti-pfan.net/sites/default/files/CTIPFAN_AdaptationPaper.pdf

42. Naidoo, T., Vaz, K., and Byaby, 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, http://www.cti-pfan.net/sites/default/files/CTIPFAN_AdaptationPaper.pdf

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

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

45. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, UNFCCC, http://unfccc.int/files/adaptation/application/pdf/intellecap_furtherinfo_250311.pdf

46. Botzen, W., (2013), Managing Extreme Climate Change Risks through Insurance, Cambridge University Press, Cambridge

47. Llewellyn, J., and Chaix, C., (2007), The Business of Climate Change II: Policy is accelerating, with major implications for companies and investors, Lehman Brothers

48. AMCEN, (2011), Drought in the Horn of Africa: Challenges, Opportunities and Responses, African Ministerial Conference on the Environment (AMCEN), Fourth Special Session Meeting of the Expert Group, Bamako, 13 and 14 September 2011, Mali

49. AMCEN, (2011), Drought in the Horn of Africa: Challenges, Opportunities and Responses, African Ministerial Conference on the Environment (AMCEN), Fourth Special Session Meeting of the Expert Group, Bamako, 13 and 14 September 2011, Mali; and Naidoo, T., Vaz, K., and Byaby, 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

50. GIZ, (2014), Final Evaluation: Adaptation to Climate Change and Insurance (ACCI), Kenya, Main Report

51. Pierro and Desai, (2011), The potential role of disaster insurance for disaster risk reduction and climate change adaptation, Climate and Disaster Governance, http://www.preventionweb.net/english/professional/publications/v.php?id=18210

52. GIZ, (2014), Final Evaluation: Adaptation to Climate Change and Insurance (ACCI), Kenya, Main Report

53. Llewellyn, J., and Chaix, C., (2007), The Business of Climate Change II: Policy is accelerating, with major implications for companies and investors, Lehman Brothers

54. Ranger, N., Harvey, A., and Garbett-Shiels, S., (2013), Safeguarding development aid against climate change: evaluating progress and identifying best practice, Centre for Climate Change Economics and Policy, Working Paper No. 157

55. UNISDR, (2015), Early warning must make sense, http://www.unisdr.org/archive/44541

56. See: UNISDR, (2015), Early warning must make sense; Intellecap (2010). Opportunities for Private Sector Engagement in urban climate change resilience building, The Rockefeller Foundation and the Asian Cities Climate Change Resilience Network (ACCCRN)

57. Zommers, Z., (2012), Climate Early Warning System Feasibility Report: Early Warning Systems and Hazard Protection, UNEP

58. Intellecap, (2010), Opportunities for Private Sector Engagement in urban climate change resilience building. Supported by The Rockefeller Foundation and the Asian Cities Climate Change Resilience Network (ACCCRN)

59. Biagini, B., and Miller, A., (2013), Engaging the private sector in adaptation to climate change in developing countries: importance, status, and challenges, Climate and Development, Vol. 5 Issue 3

60. PwC, (2010), Business leadership on climate change adaptation: Encouraging engagement and action, London: PwC

61. GEF and IFC, (2012), Private Sector Engagement in Climate Change Adaptation, Prepared by the GEF Secretariat in Collaboration with the International Finance Corporation, GEF/LDCF.SCCF.12/Inf.06

62. Frankfurt School of Finance and Management, (2016), Renewable Energy Finance and the Role of Project Finance, Certified Expert in Climate and Renewable Energy Finance Online Course

63. World Health Organisation, Climate change and infectious diseases, Climate change and human health, http://www.who.int/globalchange/climate/summary/en/index5.html

64. Intec Capital Limited, (2012), Leasing, http://www.inteccapital.com/leasing.php

65. Boulle, B., (2014), Unilever opens up Sterling green bonds with 4 yr, £250m ($411m) "sustainability" bond for CO2 & water improvements in manufacturing plants: 3x over-subscribed!, Climate Bonds, https://www.climatebonds.net/2014/05/unilever-opens-sterling-green-bonds-4-yr-%C2%A3250m-411m-sustainability-bond-co2-water

66. Kidney, S., (2014), Unilever opens up Sterling green bonds with 4 yr, £250m sustainability bond for CO2 & water improvements in manufacturing plants: 3x over-subscribed!, Climate Bonds Initiative, https://www.climatebonds.net/2014/05/unilever-opens-sterling-green-bonds-4-yr-%C2%A3250m-411m-sustainability-bond-co2-water

67. Bloomberg L.P. (2015), GlaxoSmith Kline Plc, Bloomberg Business, http://www.bloomberg.com/quote/GSK:US

68. World Health Organisation, Climate change and infectious diseases, Climate change and human health, http://www.who.int/globalchange/climate/summary/en/index5.html

69. 69 KfW Development Bank, (2015), Growing optimism is overcoming weak investment trend, KfW SME Panel 2015, https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-KfW-Mittelstandspanel/PDF-Dateien-Mittelstandspanel-%28EN%29/KfW-SME-Panel-2015.pdf

70. IGCC, (2015), Climate finance for developing and emerging countries: Five recommendations to catalyse institutional investment, http://www.iigcc.org/files/publication-files/IIGCC_2015_Climate_Finance_for_Developing_and_Emerging_Economies.pdf

71. GE Healthcare, (2016), Public & Private Partnerships, http://www3.gehealthcare.co.uk/en-gb/services/public_and_private_partnerships_in_healthcare#tabs/tab47F88F0033EA46669FB6D355AFF9C5A3

72. Frankfurt School of Finance and Management, (2016), Basics of SME Finance, Certified Expert in SME Finance Online Course

73. Agrawala, S., er atl., (2011), Private Sector Engagement in Adaptation to Climate Change: Approaches to Managing Climate Risks, OECD Environment Working Papers, No. 39, OECD Publishing. http://dx.doi.org/10.1787/5kg221jkf1g7-en

74. PWC, (2015-2016), What is the future for infrastructure financing?, Capital projects & infrastructure, http://www.pwc.com/gx/en/industries/capital-projects-infrastructure/financing.html

75. Investopedia LLC, (2016), Build-Operate-Transfer Contract, http://www.investopedia.com/terms/b/botcontract.asp

76. World Bank, (2015), What is the PPP Spectrum of Private Sector Participation in Infrastructure and Development Projects, https://ppp.gov.ph/wp-content/uploads/2015/01/What-is-PPP_Spectrum-of-Private-Sector-Participation-in-Infrastructure-and-Development-Projects.jpg

77. Ehlers, T., (2014), Understanding the challenges for infrastructure finance, BIS Working Papers No 454,, http://www.bis.org/publ/work454.pdf

78. The Economist, (2014), A Long and Winding Road: The world needs more infrastructure. How will it pay for it?, Infrastructure financing, http://www.economist.com/news/finance-and-economics/21599394-world-needs-more-infrastructure-how-will-it-pay-it-long-and-winding

79. PWC, (2015-2016), What is the future for infrastructure financing?, Capital projects & infrastructure, http://www.pwc.com/gx/en/industries/capital-projects-infrastructure/financing.html

80. World Economic Forum, (2015), Global Risks 2015, 10th Edition, Insight Report, http://www3.weforum.org/docs/WEF_Global_Risks_2015_Report15.pdf

81. United Nations Environment Programme (UNEP), (2016), The Adaptation Gap Report 2016, United Nations Environment Programme (UNEP), Nairobi, http://web.unep.org/adaptationgapreport/sites/unep.org.adaptationgapreport/files/documents/agr2016.pdf/

82. Smith, A., (1976), An Inquiry into the Nature and Causes of the Wealth of Nations. General editors: R. H. Campbell and A. S. Skinner. Textual editor: W. B. Todd. Oxford: Oxford University Press.

83. Moser, S., and Ekstrom, J., (2010), A framework to diagnose barriers to climate change adaptation, Proceedings of the National Academy of Sciences of the United States of America, vol. 107 no. 51

84. Trabacchi, C., Mazza, F., (2015), Emerging solutions to drive private investment in climate resilience, CPI, http://passthrough.fw-notify.net/download/145039/http://climatepolicyinitiative.org/wp-content/uploads/2015/06/Finance-for-Climate-Resilience.pdf

85. Islam, M., Sallu , S., Hubacek, K., Paavola, J., (2014) Limits and barriers to adaptation to climate variability and change in Bangladeshi coastal fishing communities. Marine Policy Journal 2014 (43) 208-216

86. Antwi-Agyei, P., Dougill, A., Stringer, L., (2013), Barriers to climate change adaptation in SubSaharan Africa: evidence from northeast Ghana & systematic literature review, Centre for Climate Change Economics and Policy, Working Paper No. 154

87. Barnett, J., Evans, L., Gross, C., Kiem, A., et al, (2015), From barriers to limits to climate change adaptation: path dependency and the speed of change. Ecology and Society, Vol. 20, No. 3

88. Jones, L., (2010), Overcoming Social Barriers to Adaptation, Background Note, ODI, https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/6048.pdf

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

90. PCIR, (2012), Barriers to Effective Climate Change Adaptation, Productivity Commission Inquiry Report, No. 59, Commonwealth of Australia

91. Stenek, V., Amado, J.C., (2013), Enabling Environment for Private Sector Adaptation, IFC, http://passthrough.fw-notify.net/download/205949/http://www.ifc.org/wps/wcm/connect/6060670042bd92b6b297be0dc33b630b/Enabling%20Environment%20for%20Private%20Sector%20Adaptation%20-%20Stenek,%20Amado,%20Greenall.pdf?MOD=AJPERES

92. Jones (2010) describes three areas of social barriers: (1) Cognitive, such as the belief that uncertainty is too large to justify acting on adaptation, (2) normative, such as cultural norms discouraging change and (3) institutional, depicting social discrimination and inequality restricting access.

93. Grüning, C. and Moslener, U., (2016 forthcoming), Barriers to Climate Friendly Investment, Working paper, Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance

94. Barriers to capital flow in the capital market literature as "factors that constrain the efficient the capital flow movements across national boundaries and hinder move to the location with the highest return" where the "removal of barriers to trade in capital may improve overall welfare". Espinosa, Bruce & Yip (2000), Mezziani (2003), National Institute of Economic & Social Research (2006)

95. Ekholm, T., Ghoddusi, H., Krey, V. & Riah, K. (2013), The effect of financial constraints on energy-climate scenario, Energy Policy, Vol. 59, 562–572. Ekholm et al. (2013) have also used this in the context of clean energy investment: "Various frictions in the energy sector, government regulations, and financial markets may lead to under-investment—the level of investment being lower than the economically efficient level."

96. Ekholm, T., Ghoddusi, H., Krey, V. & Riah, K., (2013), The effect of financial constraints on energy-climate scenario, Energy Policy, Vol. 59, 562–572.

97. Pierro and Desai, (2011), The potential role of disaster insurance for disaster risk reduction and climate change adaptation, Climate and Disaster Governance, http://www.preventionweb.net/english/professional/publications/v.php?id=18210

98. GIZ, (2014), Final Evaluation: Adaptation to Climate Change and Insurance (ACCI), Kenya, Main Report

99. Olhoff, A., et al., (2016), The Adaptation Finance Gap Update, UNEP, http://web.unep.org/sites/default/files/gapreport/UNEP_Adaptation_Finance_Gap_Update.pdf

100. Stenek, V., et al, (2011), Climate Risk and Business: PORTS, Terminal Marítimo Muelles el Bosque, Cartagena, Colombia, IFC, http://www.ifc.org/wps/wcm/connect/98f63a804a830f878649ff551f5e606b/ClimateRisk_Ports_Colombia_Full.pdf?MOD=AJPERES

101. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

102. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

103. A to Z Textile Mills Ltd, (2015), Company profile, http://www.azpfl.com/index.php/en/profile/company-profile

104. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

105. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

106. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

107. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

108. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

109. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

110. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

111. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

112. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

113. GE Healthcare, (2016), Public & Private Partnerships, http://www3.gehealthcare.co.uk/en-gb/services/public_and_private_partnerships_in_healthcare#tabs/tab47F88F0033EA46669FB6D355AFF9C5A3

114. GSK, Accenture and the Smith School of Enterprise and the Environment, University of Oxford, (2011), Climate change and health: Framing the issue

115. GSK, Accenture and the Smith School of Enterprise and the Environment, University of Oxford, (2011), Climate change and health: Framing the issue

116. Bill & Melinda Gates Foundation, (1999-2015), Neglected Tropical Diseases: Strategy Overview, What We Do, http://www.gates-foundation.org/What-We-Do/Global-Health/Neglected-Infectious-Diseases

117. Wellcome Trust, About Us, http://www.wellcome.ac.uk/index.htm

118. Intec Capital Ltd, (2012), About Us, http://www.inteccapital.com/about.php

119. Buijs, S., and J. Streng, J., (2013), Rotterdamse adaptatiestrategie. Themarapport stadsklimaat, Rotterdam Climate Initiative, Rotterdam

120. ICLEI, (2011), Financing the Resilient City: A demand driven approach to development, disaster risk reduction and climate adaptation - An ICLEI White Paper, ICLEI Global Report

121. ICLEI, (2011), Financing the Resilient City: A demand driven approach to development, disaster risk reduction and climate adaptation - An ICLEI White Paper, ICLEI Global Report

122. GIZ, (2014), Final Evaluation: Adaptation to Climate Change and Insurance (ACCI), Kenya, Main Report

123. Biagini, B., and Miller, A., (2013), Engaging the private sector in adaptation to climate change in developing countries: importance, status, and challenges, Climate and Development, Vol. 5, Issue 3

124. GEF and IFC, (2012), Private Sector Engagement in Climate Change Adaptation, Prepared by the GEF Secretariat in Collaboration with the International Finance Corporation, GEF/LDCF.SCCF.12/Inf.06

125. Government of Bangladesh National Water Policy (1999).

126. DBL Group, (2013), DBL Sustainability Report 2013, http://www.dbl-group.com/data/frontImages/DBL_Sustainability_Report_2013.pdf

127. Yee, A., (2013), Conservation Pays Off for Bangladeshi Factories, New York Times, http://www.nytimes.com/2013/03/22/business/energy-environment/conservation-pays-off-for-bangladeshi-factories.html?_r=0

128. Bangladesh PaCT, (2016), PaCT's Investment Support, http://www.textilepact.net/focus-areas/supporting-factories/investment-facilitation/pacts-investment-support.html

129. Ministry of Water Resources, (1999), National Water Policy, Government of Bangladesh, http://faolex.fao.org/docs/pdf/bgd146075.pdf

130. Bangladesh PaCT, (2016), Implementing Change, PaCT Focus Areas, http://www.textilepact.net/focus-areas/supporting-factories/implementing-change.html

131. Bangladesh PaCT, (2016), Implementing Change, PaCT Focus Areas, http://www.textilepact.net/focus-areas/supporting-factories/implementing-change.html

132. Caribbean Development Bank, (2016), CDB grant to further develop Vieux Fort St Lucia water supply systems, http://www.caribank.org/news/cdb-grant-to-further-develop-vieux-fort-st-lucia-water-supply-systems

133. World Bank, (2012), Implementation Completion and Result Report To Commonwealth of The Commonwealth of Dominica, St. Lucia and St. Vincent and the Grenadines: Implementation of Adaptation Measures for Coastal Zones Projects, Washington, D.C., World Bank

134. King-Joseph, A., (2011), Environmental Management Plan (EMP) for the construction of Rainwater Harvesting and Waste Water Recycling Facility at the Coconut Bay Beach Resort and Spa in Vieux Fort, Saint Lucia, Technical Report 5C/SPACC-11-07-01, Caribbean Community Climate Change Centre

135. World Bank, (2012), Implementation Completion and Result Report To Commonwealth of The Commonwealth of Dominica, St. Lucia and St. Vincent and the Grenadines: Implementation of Adaptation Measures for Coastal Zones Projects, Washington, D.C., World Bank

136. Interview with CEO of Company (remaining anonymous), interview conducted November 2015

137. Stenek, V., et al, (2011), Climate Risk and Business: PORTS, Terminal Marítimo Muelles el Bosque, Cartagena, Colombia, IFC, http://www.ifc.org/wps/wcm/connect/98f63a804a830f878649ff551f5e606b/ClimateRisk_Ports_Colombia_Full.pdf?MOD=AJPERES

138. Stenek, V., et al., (2011), Climate Risk and Business Ports: Terminal Marítimo Muelles el Bosque, Cartagena, Colombia

139. Stenek, V., et al., (2011), Climate Risk and Business Ports: Terminal Marítimo Muelles el Bosque, Cartagena, Colombia

140. Stenek, V., et al., (2011), Climate Risk and Business Ports: Terminal Marítimo Muelles el Bosque, Cartagena, Colombia

141. Stenek, V., et al., (2011), Climate Risk and Business Ports: Terminal Marítimo Muelles el Bosque, Cartagena, Colombia

142. Becker, A., et al., (2013), A Note on Climate Change Adaptation for Seaports: A Challenge for Global Ports, a Challenge for Global Society, University of Rhode Island, http://digitalcommons.uri.edu/cgi/viewcontent.cgi?article=1002&context=maf_facpubs

143. Stenek, V., et al, (2011), Climate Risk and Business: PORTS, Terminal Marítimo Muelles el Bosque, Cartagena, Colombia

144. National Capital Integrated Coastal Development program (NCICD), (2015), Changing threats into opportunities: Overview, http://en.ncicd.com/ncicd/

145. National Capital Integrated Coastal Development program (NCICD), (2015), Changing threats into opportunities: Overview

146. Dutch Water Sector, (2014), Groundbreaking event starts work on Jakarta's ambitious 40 billion coastal development NCICD project, http://www.dutchwatersector.com/news-events/news/11974-groundbreaking-event-starts-work-on-jakarta-s-ambitious-40-billion-coastal.html

147. National Capital Integrated Coastal Development program (NCICD), (2015), Changing threats into opportunities: Overview

148. Van der Schaar Investments B.V. Delft, The Netherlands, (2014), Jakarta's Giant Sea Wall & National Capital Integrated Coastal Development, http://www.indonesia-investments.com/business/business-columns/jakartas-giant-sea-wall-national-capital-integrated-coastal-development/item1834

149. Van der Schaar Investments B.V. Delft, The Netherlands, (2014), Jakarta's Giant Sea Wall & National Capital Integrated Coastal Development

150. Although research concluded that climate change was not responsible for the 2011 Thailand floods, it might have a role in future precipitation events and flooding, and measures taken after the 2011 flood, including the dikes mentioned in this report, will have an effect on climate change vulnerability.

151. Komori, Daisuke, Shinichirou Nakamura, Masashi Kiguchi, Asako Nishijima, Dai Yamazaki, Satoshi Suzuki, Akiyuki Kawasaki, Kazuo Oki, and Taikan Oki., (2012), Characteristics of the 2011 Chao Phraya River flood in central Thailand, Hydrological Research Letters 6, no. 0, pp. 41-46

152. Van Oldenborgh, G. J., Van Urk, A., and Allen, M., (2012), The absence of a role of climate change in the 2011 Thailand floods. Bulletin of the American Meteorological Society, Vol. 93(7), pp. 1047-1049

153. Wall Street Journal, (2015). As Rainy Season Approaches, Thailand Focuses on Floods, http://blogs.wsj.com/indonesiarealtime/2012/02/09/as-rainy-season-approaches-thailand-focuses-on-floods/ (accessed on 08.10.15)

154. Bangkok Post, (2011), Floods: Factories reopening, Bangkok Post, http://www.bangkokpost.com/learning/learning-from-news/268958/floods-factories-reopening (accessed on 08.10.15)

155. Pattaya Today, (2015), Massive utility hike to pay for new dyke, http://pattayatoday.net/news/thailand-news/hi-tech-partially-reopens-early/ (accessed on 08.10.15)

156. Bangkok Post, (2012), Feud pits eco-activists against industrial parks, Bangkok Post, http://www.bangkokpost.com/business/economics/283040/feud-pits-eco-activists-against-industrial-parks (accessed on 08.10.15)

157. Pattaya Mail, (2011), Hi-Tech Industrial Estate kickstarts operations, http://www.pattayamail.com/business/hi-tech-industrial-estate-kickstarts-operations-8338

158. The Nation, (2012), IEAT seeks anti-flooding financing, Business, http://www.nationmultimedia.com/business/IEAT-seeks-anti-flooding-financing-30175799.html

159. Bangkok Post, (2012), Feud pits eco-activists against industrial parks. Bangkok Post, http://www.bangkokpost.com/business/economics/283040/feud-pits-eco-activists-against-industrial-parks (accessed on 08.10.15)

160. Oxfam NZ, (2014), Planting the fetau tree, http://www.oxfam.org.nz/what-we-do/where-we-work/samoa/improving-livelihoods/planting-the-fetau-tree

161. Caring for Climate, (2012), Business and Climate Change Adaptation: Towards resilient companies and communities, UN Global Compact and UN Environment Programme, http://caringforclimate.org/wp-content/uploads/Business_and_Climate_Change_Adaptation.pdf

162. Guy Carpenter, (2011), Guy Carpenter to Develop Agriculture Microinsurance Market, http://www.gccapitalideas.com/2011/03/22/guy-carpenter-to-develop-agriculture-microinsurance-market/

163. ILO Impact Insurance Facility, (2015), Using meso-level distribution to achieve scale and control cost, Agriculture, Mozambique-GIIF, https://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0ahUKEwjfiLDbkb7MAhUqB8AKHT_dCr8QFggzMAI&url=http%3A%2F%2Fwww.impactinsurance.org%2Fprintpdf%2F3757&usg=AFQjCNHbvDXa8ZuGI1B_9u3-a6Z6K1D-TQ&cad=rja

164. IFC, (2016), Guy Carpenter & Co LLC (Mozambique – regional), Financial Institutions, http://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/industries/financial+markets/retail+finance/insurance/guy+carpenter

165. Sompo Japan Insurance (Thailand) Co Ltd, (2011), Sales area expansion of Weather Index Insurance, http://www.sjnk.co.jp/english/news/download/20110222_2.pdf

166. Eco-CSR Japan (2016). Insurance in climate change. Sompo Japan – Weather Index Insurance against Drought Risk in Northeast Thailand. Interview with Satoshi Hirooka from Sompo Japan Insurance. https://www.env.go.jp/earth/coop/eco-csrjapan/en/insurance-in-climate-change.html

167. CAPSA-ASCAP, (2015), Climate Insurance for Crops: Case Study of Weather Index Insurance for Agriculture in Thailand, Palawija Newsletter, Vol. 32, No. 3, http://www.uncapsa.org/palawija-articles/climate-insurance-crops-case-study-weather-index-insurance-agriculture-thailand

168. CAPSA-ASCAP, (2015), Climate Insurance for Crops: Case Study of Weather Index Insurance for Agriculture in Thailand, Palawija Newsletter, Vol. 32, No. 3, http://www.uncapsa.org/palawija-articles/climate-insurance-crops-case-study-weather-index-insurance-agriculture-thailand

169. CAPSA-ASCAP, (2015), Climate Insurance for Crops: Case Study of Weather Index Insurance for Agriculture in Thailand, Palawija Newsletter, Vol. 32, No. 3, http://www.uncapsa.org/palawija-articles/climate-insurance-crops-case-study-weather-index-insurance-agriculture-thailand

170. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

171. SC Johnson, (2012), GreenChoices, SC Johnson 2012 Public Sustainability Report

172. SC Johnson, (2010), SC Johnson and Bill & Melinda Gates Foundation, http://www.scjohnson.com/en/press-room/press-releases/03-17-2010/SC-Johnson-and-Bill-Melinda-Gates-Foundation.aspx

173. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

174. Vestergaard Frandsen, (2016), About Us, http://www.vestergaard.com/about-us

175. Field, C., et al., (2014), Technical Summary, 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-TS_FINAL.pdf

176. Vestergaard Frandsen, (2016), About Us, http://www.vestergaard.com/about-us

177. A to Z Textile Mills Ltd, (2015) Company profile, http://www.azpfl.com/index.php/en/profile/company-profile

178. Harvard Medical School and Brigham and Women's Hospital, (2011), Building Local Capacity for Health Commodity Manufacturing: A to Z Texile Mills Ltd., https://ghca.jp/files/fm/5153d4461pgs-j94abgbq_0_10.pdf

179. Harvard Medical School and Brigham and Women's Hospital, (2011), Building Local Capacity for Health Commodity Manufacturing: A to Z Texile Mills Ltd., https://ghca.jp/files/fm/5153d4461pgs-j94abgbq_0_10.pdf

180. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

181. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

182. Center for Health Market Innovations, (2016), Primedic, http://healthmarketinnovations.org/program/primedic

183. PR Newswire, (2008), IGNIA Fund I Co-leads USD 6.0 Million Investment in Primedic, Mexican Healthcare Provider to the Base of the Pyramid, http://www.prnewswire.com/news-releases/ignia-fund-i-co-leads-us60-million-investment-in-primedic-mexican-healthcare-provider-to-the-base-of-the-pyramid-65033277.html

184. Latin America Private Equity & Venture Capital Association, (2009), An Interview with Dr. Paulino Decanini, Primedic, http://lavca.org/2009/11/06/an-interview-with-dr-paulino-decanini-primedic/

185. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

186. Siemens, (2014), Vision 2020: We Make Real What Matters, http://www.siemens.com/about/pool/strategy/siemens-strategy-overview.pdf

187. Field, C., et al., (2014), Technical Summary, 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-TS_FINAL.pdf

188. Siemens, (1996-2016), Sanjeevan Mobile Clinic, Siemens India, http://www.siemens.co.in/about-us/sustainability/corporate-citizenship/social/sanjeevan-mobile-clinic.htm

189. Siemens, (2012), A mobile clinic for kids in Korea, News Archive, http://www.health-care.siemens.com/news-and-events/news/healthcare-news-2012-10-08-2

190. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

191. Field, C., et al., (2014), Technical Summary, 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, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-TS_FINAL.pdf

192. Piramal Enterprises Limited, (2014), eSwasthya, http://www.piramalswasthya.com/what-we-do/eswasthya/

193. Intellecap, (2010), Opportunities for Private Sector Engagement in Urban Climate Change Resilience Building, The Rockefeller Foundation, ACCCRN

194. GE Healthcare, (2016), Public & Private Partnerships, http://www3.gehealthcare.co.uk/en-gb/services/public_and_private_partnerships_in_healthcare#tabs/tab47F88F0033EA46669FB6D355AFF9C5A3

195. GE Healthcare, (2016), Public & Private Partnerships, http://www3.gehealthcare.co.uk/en-gb/services/public_and_private_partnerships_in_healthcare#tabs/tab47F88F0033EA46669FB6D355AFF9C5A3

196. Abraham, N., (2013), GE Healthcare to make India hub for low-cost devices; products will be up to 40% cheaper, The Economic Times http://economictimes.indiatimes.com/industry/healthcare/biotech/healthcare/ge-healthcare-to-make-india-hub-for-low-cost-devices-products-will-be-up-to-40-cheaper/articleshow/25282416.cms

197. Trefis Team, (2012), GE Healthcare Looks to Low-Cost Solutions for Emerging Markets, http://www.trefis.com/stock/ge/articles/106396/ge-healthcare-looks-to-low-cost-solutions-for-emerging-markets/2012-03-05

198. GlaxoSmithKline, (2015), Our commitment to fighting malaria, http://www.gsk.com/media/712055/our-commitment-to-fighting-malaria.pdf

199. Devex Impact, (2000-2016), GlaxoSmithKline's Tres Cantos Open Lab for DDW R&D, https://www.devex.com/impact/partnerships/glaxosmithkline-s-tres-cantos-open-lab-for-ddw-r-d-530

200. World Health Organisation, Climate change and infectious diseases, Climate change and human health, http://www.who.int/globalchange/climate/summary/en/index5.html

201. GlaxoSmithKline, (2015), Our commitment to fighting malaria, https://www.gsk.com/media/281064/malaria-factsheet.pdf

202. Hunter, J. (2011), Challenges for pharmaceutical industry: new partnerships for sustainable human health, Philosophical Transactions of the Royal Society A. v369, 817–1825, http://rsta.royalsocietypublishing.org/content/369/1942/1817

203. GlaxoSmithKline, (2010), Corporate Responsibility Review 2010, https://www.gsk.com/media/280034/cr-review-2010.pdf

204. GlaxoSmithKline, (2013), New Partnership between GSK and the Bill & Melinda Gates Foundation to accelerate research into vaccines for global health needs, Press Releases, https://us.gsk.com/en-us/media/press-releases/2013/new-partnership-between-gsk-and-the-bill-andamp-melinda-gates-foundation-to-accelerate-research-into-vaccines-for-global-health-needs/

205. Wu, X., et al., (2016), Impact of climate change on human infectious diseases: Empirical evidence and human adaptation, Environment International, Vol. 86, pp. 14-23

206. MMV, (2016), Our History, About Us, http://www.mmv.org/about-us/our-history

207. IFPMA, (2015), Developing World Health Partnerships Directory: Medicines for Malaria Venture (MMV), http://partnerships.ifpma.org/partnership/medicines-for-malaria-venture-mmv

208. DevPolicyBlog, (2015), Malaria R&D in a time of global partnerships, http://devpolicy.org/events/event/malaria-rd-in-a-time-of-global-partnerships/

209. Hunter, J. (2011), Challenges for pharmaceutical industry: new partnerships for sustainable human health, Philosophical Transactions of the Royal Society A. v369, 817–1825, http://rsta.royalsocietypublishing.org/content/369/1942/1817

210. Hunter, J. (2011), Challenges for pharmaceutical industry: new partnerships for sustainable human health, Philosophical Transactions of the Royal Society A. v369, 817–1825, http://rsta.royalsocietypublishing.org/content/369/1942/1817

211. Independent Evaluation Group, (2008), The Medicines for Malaria Venture, World Bank, http://ieg.worldbank.org/Data/reports/gpr_mmv.pdf

212. IFPMA, (2015), Developing World Health Partnerships Directory: Medicines for Malaria Venture (MMV), http://partnerships.ifpma.org/partnership/medicines-for-malaria-venture-mmv

213. D&B, Emerging SMEs of India, Pharmaceutical, http://www.dnb.co.in/pharmaceutical/overview.asp

214. D&B, Emerging SMEs of India, Pharmaceutical, http://www.dnb.co.in/pharmaceutical/overview.asp

215. GlaxoSmithKline, (2014), Response to CDP Climate Change 2014 Information Request

216. GlaxoSmithKline, (2015), Our commitment to fighting malaria, https://www.gsk.com/media/281064/malaria-factsheet.pdf

217. GlaxoSmithKline, (2015), Our commitment to fighting malaria

218. Toronto Environment Office et al., (2008), Ahead of the Storm: Preparing Toronto for Climate Change, Development of a Climate Change Adaptation Strategy

219. Toronto Environment Office et al., (2008), Ahead of the Storm: Preparing Toronto for Climate Change, Development of a Climate Change Adaptation Strategy

220. Toronto Environment Office et al., (2015), Grants for green and cool roofs, http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=3a0b506ec20f7410VgnVCM10000071d60f89RCRD

221. Toronto Environment Office et al., (2008), Ahead of the Storm: Preparing Toronto for Climate Change, Development of a Climate Change Adaptation Strategy

222. Buijs, S., and J. Streng, J., (2013), Rotterdamse adaptatiestrategie. Themarapport stadsklimaat, Rotterdam Climate Initiative, Rotterdam

223. Buijs, S., and J. Streng, J., (2013), Rotterdamse adaptatiestrategie. Themarapport stadsklimaat, Rotterdam Climate Initiative, Rotterdam

224. Yamamoto, Y., (2006), Measures to Mitigate Urban Heat Islands, Quaterly Review, No. 18, National Institute of Science and Technology Policy, Japan

225. Tokyo Metropolitan Government, (2011), The Environment of Tokyo, https://www.kankyo.metro.tokyo.jp/en/attachement/full-version.pdf

226. Telvent, (2010), Smart Information for a Sustainable World, Sustainability Report 2010, http://digital.telventdtn.com/i/40633-telvent

227. UN Global Compact and UN Environment Programme, (2012), Business and Climate Change Adaptation: Towards resilient companies and communities, Caring for Climate, http://caringforclimate.org/wp-content/uploads/Business_and_Climate_Change_Adaptation.pdf

228. The Guardian, (2014), Empowering farmers through mobile communication in West Africa, http://www.theguardian.com/sustainable-business/2014/oct/22/empowering-farmers-through-mobile-communication-in-west-africa

229. Indigo Trust, (2012), Grant Awarded to Farmerline, http://indigotrust.org.uk/2012/12/06/grant-awarded-to-farmerline/

230. Africa Capital Digest, (2015), Village Capital backs Farmerline and Atikus with $ 50,000, http://africacapitaldigest.com/village-capital-backs-farmerline-and-atikus-with-50000/

231. Ashoka Changemakers, (2015), Farmerline Ltd: Improving the Livelihoods of Smallholder Farmers through ICT, Elevator Pitch, https://www.changemakers.com/discussions/entries/farmerline-ltd

232. Ashoka Changemakers, (2015), Farmerline Ltd: Improving the Livelihoods of Smallholder Farmers through ICT, Elevator Pitch, https://www.changemakers.com/discussions/entries/farmerline-ltd

233. Vaswani, K., (2012), Indonesian farmers reaping social media rewards, BBC News, http://www.bbc.com/news/business-18193993

234. Pshenichnaya, N., and Clause, V., (2013), mAgri Case Study: Nokia Life Agriculture Service, http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/03/GSMAmAgri_Nokia_Case_Study.pdf

235. Pshenichnaya, N., and Clause, V., (2013), mAgri Case Study: Nokia Life Agriculture Service

236. Pshenichnaya, N., and Clause, V., (2013), mAgri Case Study: Nokia Life Agriculture Service

237. Pshenichnaya, N., and Clause, V., (2013), mAgri Case Study: Nokia Life Agriculture Service

238. WMO, Ericsson, (2011), Mobile Weather Alerts: Enabling Access to Weather and Climate Services in Africa, UN, https://business.un.org/en/documents/9302

239. Met Office, (2011), Barometer, Met Office Magazine Issue 19, http://www.metoffice.gov.uk/media/pdf/r/2/Barometer_Issue_19.pdf

240. WMO, (2012), WMO Sever Weather Forecasting Demonstration Project (SWFDR) Mission to the Rwandan Meteorological Agency (RMA), https://www.wmo.int/pages/prog/amp/pwsp/documents/Report_Final7.pdf

241. WMO, Ericsson, (2011), Mobile Weather Alerts: Enabling Access to Weather and Climate Services in Africa, UN, https://business.un.org/en/documents/9302

242. According to the WMO, some 200,000 fishermen depend on the lake for their livelihood. They estimated that changing weather conditions cause up to 5,000 casualties among fishermen every year. DBL Group, (1991-2016), About DBL Group, http://www.dbl-group.com/About-DBL-Group

243. Chamberlain, J. M., Bain, C. L., Boyd, D. F. A., McCourt, K., Butcher, T., and Palmer, S., (2014), Forecasting storms over Lake Victoria using a high resolution model, Meteorological Applications, Vol. 21, pp. 419-430

244. WMO, (2012), WMO Sever Weather Forecasting Demonstration Project (SWFDR) Mission to the Rwandan Meteorological Agency (RMA), https://www.wmo.int/pages/prog/amp/pwsp/documents/Report_Final7.pdf

245. WMO, (2012), WMO Sever Weather Forecasting Demonstration Project (SWFDR) Mission to the Rwandan Meteorological Agency (RMA), https://www.wmo.int/pages/prog/amp/pwsp/documents/Report_Final7.pdf

246. WMO, Mobile Weather Alert Services: Uganda Pilot, Lake Victoria, https://www.wmo.int/pages//prog/dra/rmo/documents/UgandaProjectHandout.pdf

247. Ayyagari, M., Beck, Th, and Demirgüç-Kunt, A., (2005), Small and Medium Enterprises across the Globe, World Bank, http://siteresources.worldbank.org/DEC/Resources/84797-1114437274304/SME_globe.pdf

For more information, contact:
UNEP Finance Initiative
Tel: +41 (0) 22 917 8178
E-mail:info@unepfi.org
www.unepfi.org

www.unep.org

United Nations Environment Programme
P.O. Box 30552 Nairobi, Kenya
Tel.: ++254-(0)20-762 1234
Fax.: ++254-(0)20-762 3927
Email: uneppub@unep.org

UNEP

Demystifying Adaptation Finance for the Private Sector seeks to shed light on the role, potential, and policy needs of private financial institutions in enabling adaptation to the unavoidable physical impacts of climate change. Using a broad sample of adaptation-related measures, it explains how private sector actors can adapt their production processes, supply chains, and marketed products to a changing climate. It explains how the required investments will be financed, and identifies the barriers currently inhibiting private financial flows for adaptation, both on the demand and supply sides of financial transactions. Importantly, the study discusses the catalytic role that national and international public actors need to play in establishing the policy and public finance regimes to mobilise private adaptation finance at scale.

ISBN No: 978-92-807-3620-5

DTI/2066/GE