GLOBAL
COMMISSION ON
ADAPTATION

#AdaptOurWorld

# **ADAPT NOW:** A GLOBAL CALL FOR LEADERSHIP ON CLIMATE RESILIENCE

## THE GLOBAL COMMISSION ON ADAPTATION

The Global Commission on Adaptation seeks to accelerate adaptation by elevating the political visibility of adaptation and focusing on concrete solutions.

The Commission is led by Ban Ki-moon, 8th Secretary-General of the United Nations, Bill Gates, Co-chair of the Bill & Melinda Gates Foundation, and Kristalina Georgieva, CEO, World Bank. It is guided by 34 Commissioners, consisting of leaders from political, business, multilateral, and scientific worlds; and it is convened by 20 countries. A global network of research partners and advisors support the Commission. The Commission is co-managed by World Resources Institute and the Global Center on Adaptation.

## ABOUT THIS REPORT

This report focuses on making the case for climate adaptation, providing specific insights and recommendations in key sectors: food security, the natural environment, water, cities and urban areas, infrastructure, disaster risk management, and finance. It is designed to inspire action among decision-makers, including heads of state and government officials, mayors, business executives, investors, and community leaders.

GLOBAL CENTER ON ADAPTATION

WORLD RESOURCES INSTITUTE

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*This report and its Action Tracks were produced on behalf of the Global Commission on Adaptation. Commissioners serve in their personal capacity, contributing to the report's content, based on their individual expertise. As such, the report does not necessarily reflect all views of each Commissioner's respective organization, institution, or government. Further, Commissioners' support for the report does not imply their full engagement in all of the proposed Action Tracks.*

## CONVENING COUNTRIES

Established initially by the Netherlands, the Commission is now co-convened by 19 other countries. This growing movement of countries supports the Commission in its mission to forge a bold strategic vision for accelerating adaptation; it shares the Commission's goal of catalyzing global adaptation solutions around the world. These national governments have not been asked to formally endorse this report.

**Argentina**

**Bangladesh**

**Canada**

**China**

**Costa Rica**

**Denmark**

**Ethiopia**

**Germany**

**Grenada**

**India**

**Indonesia**

**Marshall Islands**

**Mexico**

**Netherlands**

**Senegal**

**South Africa**

**United Arab Emirates**

**United Kingdom**

**Uzbekistan**

**Vietnam**

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# FOREWORD

A young woman in Bangladesh hears a siren of an incoming typhoon and moves her family to safety. A farmer in Zimbabwe uses a new variety of maize that is more resistant to drought. In Denmark, engineers redesign city streets to make them less prone to flooding. A business executive in Indonesia uses data and maps on water risk to inform his investments. An urban planner in Colombia paints roofs white to deflect dangerous heat.

This is what climate adaptation looks like. Examples like these are taking root and beginning to spread. Of course, not all communities have the same capacity to adapt, and those in fragile areas and living in poverty are most vulnerable.

The world has a moral responsibility to respond in a way that improves lives and livelihoods for all. To end poverty and achieve the Sustainable Development Goals, the world must drastically cut emissions and adapt to a warming world. The sooner we act, the better off we will be.

Adaptation is an economic imperative as well. This report finds that investing in adaptation, and in the innovation that comes with it, can unlock new opportunities and spur change across the globe. Adaptation can provide a triple dividend: it avoids economic losses, brings positive gains, and delivers additional social and environmental benefits.

There are bright spots, but so far the response has been gravely insufficient. Meanwhile, the climate crisis is here, now: wildfires ravage fragile habitats, city taps run dry, droughts scorch the land, and floods destroy people's homes and livelihoods.

**What will it take to meet the challenge?**

Government officials and business leaders need to radically rethink how they make decisions. We need a revolution in understanding, planning, and finance that makes climate risks visible, incorporates these risks into all decisions, and releases public and private financial flows.

Adaptation can bring out bold ideas and inspire innovation beyond what people currently think is possible. Most of all, we need political leadership that shakes people out of their collective slumber.

This Commission was formed to raise the visibility of climate adaptation on the global agenda and inspire action. It brings together over 30 Commissioners and 20 convening countries, from nearly every sector and every region of the world. We are united by a collective determination to accelerate adaptation.

We are working with many partners to support a Year of Action, starting in September 2019, that will jump-start the necessary transitions for change. Together, these actions form a comprehensive platform for urgent, bold, and equitable adaptation.

We have reason for hope. Throughout history, people have adapted to change. In turbulent times, they have found ways to reduce risks and create new opportunities. With ingenuity and resourcefulness, people have overcome the most extraordinary challenges—from eradicating disease to rebounding from the devastation of war. We need this courageous spirit today.

We call for global leadership on climate adaptation to create safer, stronger, and thriving communities around the world.

Our work is just beginning. ***We hope you will join us to adapt our world.***

**Ban Ki-moon**
*Chair*

**Kristalina Georgieva**
*Co-chair*

**Bill Gates**
*Co-chair*

## *We face a crisis.*

*Climate change is upon us, and its impacts are getting more severe with each passing year.*

*Global actions to slow climate change are promising but insufficient. We must invest in a massive effort to adapt to conditions that are now inevitable: higher temperatures, rising seas, fiercer storms, more unpredictable rainfall, and more acidic oceans.*

*We are not starting from a standstill. There are many bright spots where adaptation efforts have begun—but we need more urgency, innovation, and scale.*

*Adaptation is not an alternative to a redoubled effort to stop climate change, but an essential complement to it. Failing to lead and act on adaptation will result in a huge economic and human toll, causing widespread increases in poverty and severely undermining long-term global economic prospects.*

*The good news is that adaptation, done right, will lead to better growth and development. It will also save lives, protect nature, reduce inequalities, and create opportunities.*

*We can do it.*

# EXECUTIVE SUMMARY
# ADAPT NOW: THE URGENCY OF ACTION

Climate change is one of the greatest threats facing humanity, with far-reaching and devastating impacts on people, the environment, and the economy. Climate impacts affect all regions of the world and cut across all sectors of society. People who did the least to cause the problem—especially those living in poverty and fragile areas—are most at risk.

Consider:

- Without adaptation, climate change may depress growth in global agriculture yields up to 30 percent by 2050. The 500 million small farms around the world will be most affected.
- The number of people who may lack sufficient water, at least one month per year, will soar from 3.6 billion today to more than 5 billion by 2050.
- Rising seas and greater storm surges could force hundreds of millions of people in coastal cities from their homes, with a total cost to coastal urban areas of more than $1 trillion each year by 2050.
- Climate change could push more than 100 million people within developing countries below the poverty line by 2030.

The costs of climate change on people and the economy are clear. The toll on human life is irrefutable. The question is how will the world respond: Will we delay and pay more or plan ahead and prosper?

## The Imperatives for Accelerating Adaptation

Accelerating climate change adaptation is a human, environmental, and economic imperative:

### THE HUMAN IMPERATIVE

Climate change exacerbates existing inequities by widening the gap between people with wealth and people living in poverty. It has a disproportionate impact on women and girls, who, in most of the world, have little voice in decisions that affect their lives. It also puts an unfair burden on future generations. Solutions to these climate-related inequities must address underlying power structures and dynamics. We will not accept a world where only some can adapt, and others cannot.

### THE ENVIRONMENTAL IMPERATIVE

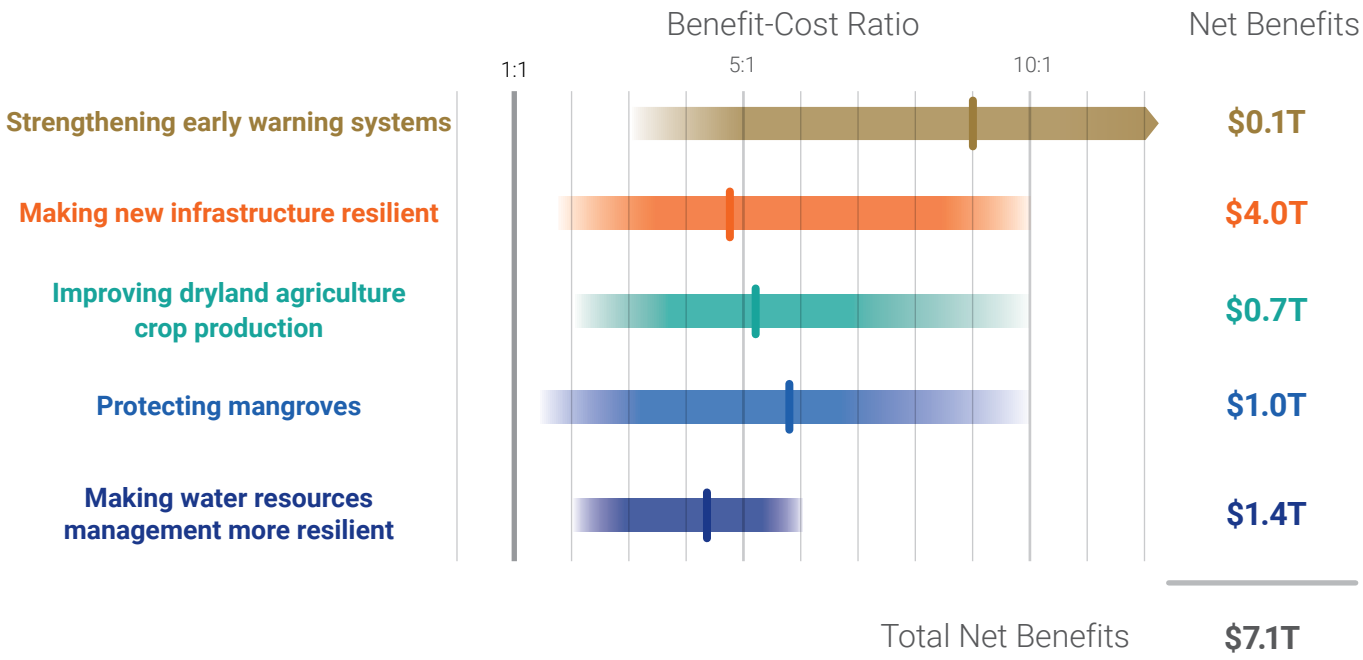
The natural environment is humanity's first line of defense against floods, droughts, heat waves, and hurricanes. A thriving natural environment is fundamental to adaptation in every human enterprise. Yet, one in four species is facing extinction, about a quarter of all ice-free land is now subject to degradation, ocean temperatures and acidity are rising, and climate change is accelerating the loss of natural assets everywhere. There is still time to protect and work with nature to build resilience and reduce climate risks at all scales, but the window is closing.

### THE ECONOMIC IMPERATIVE

Adapting now is in our strong economic self-interest. The Commission found that the overall rate of return on investments in improved resilience is very high, with benefit-cost ratios ranging from 2:1 to 10:1, and in some cases even higher (see Figure ES.1).

**Specifically, our research finds that investing $1.8 trillion globally in five areas from 2020 to 2030 could generate $7.1 trillion in total net benefits.** In other words, failing to seize the economic benefits of climate adaptation with high-return investments would undermine trillions of dollars in potential growth and prosperity. The five areas we considered for this estimate are early warning systems, climate-resilient infrastructure, improved dryland agriculture crop production, global mangrove protection, and investments in making water resources more resilient. These areas are illustrative, based on available data on economic returns: the full report has broader recommendations across seven systems that go beyond these five areas.

**FIGURE ES.1** Benefits and Costs of Illustrative Investments in Adaptation




*Note*: This graph is meant to illustrate the broad economic case for investment in a range of adaptation approaches. The net benefits illustrate the approximate global net benefits to be gained by 2030 from an illustrative investment of $1.8 trillion in five areas (the total does not equal the sum of the rows due to rounding). Actual returns depend on many factors, such as economic growth and demand, policy context, institutional capacities, and condition of assets. Also, these investments neither address all that may be needed within sectors (for example, adaptation in the agricultural sector will consist of much more than dryland crop production) nor include all sectors (as health, education, and industry sectors are not included). Due to data and methodological limitations, this graph does not imply full comparability of investments across sectors or countries.
*Source*: World Resources Institute.

**We find that adaptation actions bring multiple benefits, which we call the triple dividend.** The first dividend is avoided losses, that is, the ability of the investment to reduce future losses. The second is positive economic benefits through reducing risk, increasing productivity, and driving innovation through the need for adaptation; the third is social and environmental benefits. In Figure ES.1, all five areas have avoided loss benefits, and the last three—improved dryland crop production, mangrove protection, and water resources management—have further economic, and social and environmental benefits.

While avoiding losses is the most common motivation for investing in resilience, taken alone such losses underestimate the total benefits to society. Many adaptation actions generate significant additional economic, social, and environmental benefits, which accrue on an ongoing basis starting at the time of investment and are not dependent on the future state of the climate. In other words, they are both more certain and more immediate.

Better awareness of and evidence for all three dividends will make the economic imperative case for adaptation ever stronger. We expand on the triple dividends in the Box ES.1.

## Three Revolutions for a Better Future

**The case for ambitious adaptation is clear, but it's not happening at nearly the pace and scale required.** This is because climate impacts and risks are not yet adequately factored into decisions by those who make choices about the future. Achieving the change needed requires revolutions in three areas:

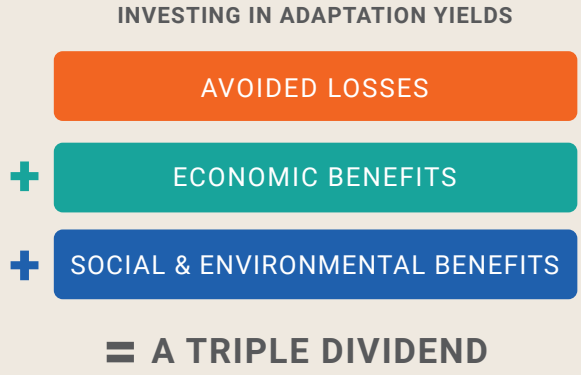
**A Revolution in Understanding** to ensure that the risks societies and economies face are fully understood—and reflected in the decisions that public and private actors make. A key element is the need to make risk visible, requiring more

BOX ES.1

## The Triple Dividend in Action

**Avoided losses:**

- Early warning systems save lives and assets worth at least ten times their cost. Just 24 hours warning of a coming storm or heat wave can cut the ensuing damage by 30 percent, and spending $800 million on such systems in developing countries would avoid losses of $3–16 billion per year.
- Making infrastructure more climate-resilient can add about 3 percent to the upfront costs but has benefit-cost ratios of about 4:1. With $60 trillion in projected infrastructure investments between 2020 and 2030, the potential benefits of early adaptation are enormous.




**Economic benefits:**

- Reducing flood risks in urban areas lowers financial costs, increases security, and makes investments that would otherwise be too vulnerable to climate risks more viable. London's Canary Wharf and other developments in East London would have been impossible without flood protection from the Thames Barrier.
- Drip irrigation technologies, first developed to address severe water scarcity, are spreading because they lead to higher crop productivity than traditional irrigation systems.

**Social and environmental benefits:**

- Mangrove forests provide more than $80 billion per year in avoided losses from coastal flooding—and protect 18 million people. They also contribute almost as much ($40–50 billion per year) in non market benefits associated with fisheries, forestry, and recreation. Combined, the benefits from mangrove preservation and restoration are up to 10 times the costs.

precise characterization of who and what is at risk—and why. As part of making risk visible, the public and private sectors can work together to more explicitly price risk in both economic and financial decision-making. Equally important is to understand what works and what options to prioritize by supporting experiential learning, stimulating innovations in science and technology, sharing solutions, and piloting new business models and financial services. It is important to consider all forms of knowledge, recognizing that valuable local knowledge rests with communities and indigenous populations.

**A Revolution in Planning** to improve how we make policy and investment decisions and how we implement solutions. The climate challenge is both urgent and pervasive across virtually all economic sectors. Mainstreaming in the public sector begins with upstream macroeconomic analysis and extends through risk screening, environmental and social impact assessments, budgeting, permitting, and project design. Since many climate impacts are local, devolving planning and even financial responsibility to those most affected is critical. In the private sector, companies worldwide are starting to improve planning to protect their operations and assets from climate risks, but current levels of physical risk disclosure remain low. Both the public and private sectors need to learn to better incorporate high levels of uncertainty in their decision-making, as choices will need to be made soon between radically different options—long before we know if the world will actually be on a 1.5°C or a 4°C pathway.

**A Revolution in Finance** to mobilize the funds and resources necessary to accelerate adaptation. Even though the imperative for action is clear, money is not flowing at the

pace or scale needed. The public sector, first, is an essential provider of finance to protect people and livelihoods across communities and sectors; and second, is an enabler of increased private sector finance through disclosure requirements, metrics, and incentives, like buying down the risk of providing financial services to small-holder producers. The private sector will increase investments on its own account, but it should also increasingly complement the public sector in sharing the costs and benefits of adaptation investments, such as for infrastructure, contingency finance, and insurance. Finally, there is a critical need for higher levels of international financial support for adaptation in developing countries.

Fully implemented, these three revolutions will protect lives, livelihoods, homes, and jobs in the face of climate change.

# Accelerating Adaptation in Key Economic Systems

**We must apply these revolutions to the key economic systems affected by climate change: systems that produce food, protect and manage water and the natural environment, plan and build our cities and infrastructure, protect people from disasters, and provide financing for a more resilient future.** The report shows how the climate crisis is disrupting these systems and offers specific, actionable recommendations for how to respond.

**Food**: Global demand for food will increase by 50 percent and yields may decline by up to 30 percent by 2050 in the absence of ambitious climate action. A more resilient food future will rely on sharp increases in agricultural R&D, which has demonstrated benefit-cost ratios between 2:1 and 17:1; better alignment of government finance and incentives for farmers with long-term, sustainable, climate-smart production; and a step change in access to information, innovative technologies, and finance to enhance the resilience of 500 million small-scale farming households whose livelihoods are most critically impacted by climate change.

**Natural Environment**: Nature-based solutions regulate water flows, protect shorelines, cool cities, and complement built infrastructure. Despite underpinning the resilience of communities and economies, nature is rapidly being degraded. Large-scale protection and restoration of nature will require accelerating progress to meet existing political commitments, such as through the Convention on Biological Diversity; appropriately valuing natural assets in land use and investment decisions; and increasing the scale of public and private resources to safeguard nature. Many nature-based adaptation solutions are also beneficial for mitigation and can provide one-third of the climate mitigation needed between now and 2030 to keep global warming below 2°C.

**Water**: Climate change is integrally connected to water systems and resources. Successful adaptation will require scaled-up investments in healthy watersheds and water infrastructure, dramatic improvements in efficiency of water use, and the integration of new climate risks, such as floods and droughts, at every level of planning and operation. More efficient water allocation and use will be vital to economic growth in the face of climate change: without such approaches, the GDPs of India, China and Central Asia would be from 7 to 12 percent lower, and much of Africa would be about 6 percent lower by 2050. Countries that make water management a top national priority, backed up by major governance changes and investments, are more likely to adapt and prosper; those that do not will experience serious challenges.

**Cities**: Urban areas are home to more than half the global population and are centers of opportunity and innovation. Adaptation efforts, if designed well, can take advantage of this transformative energy and generate high economic returns. In coastal cities, for instance, the cost of good adaptation is one-tenth the cost of no action. To plan and deliver more resilient urban services, cities everywhere need to invest in better climate risk information and technical capacity, drawing on credible topographic and community-level data. They should also invest in nature-based solutions to tackle water and heat risks, and in upgrading the living conditions of the 880 million people living in informal settlements that are highly vulnerable to climate change.

**Infrastructure**: Ports, roads, power, sanitation, sewer, and communications systems are all examples of infrastructure assets at risk from climate change. Climate-proofing existing infrastructure and building new infrastructure that is more climate resilient makes sound economic sense—on average, the benefits outweigh costs by 4:1. Investments in infrastructure need to directly build resilience, whether for storm-water drainage in cities or protecting coastal communities against sea-level rise. This will require developing blended public-private approaches that share the costs and benefits of investing in resilient infrastructure. Finally, we need to go beyond protecting individual assets to ensuring that whole systems are more resilient by making the right choices about where and what to build, which existing assets to upgrade, prioritizing green infrastructure wherever possible, and ensuring infrastructure continues to function even as damages occur.

**Disaster Risk Management**: Climate change is often most visible when seen through changes in the intensity and frequency of disasters: hurricanes, floods, heat waves, and wildfires. In the face of more common extreme weather events and climate-related disasters, we need to prevent, protect and recover. We need to proactively yet voluntarily move people and assets out of harm's way through better planning and investment decisions. At the same time, we need to scale up efforts to warn and prepare people ahead of disasters, actions that can dramatically reduce the loss of life, and exhibit very high returns on investment. Finally, social safety nets and improvements in forecast-based planning can help hasten recovery from disasters when they do strike.

# The Way Forward: The Year of Action

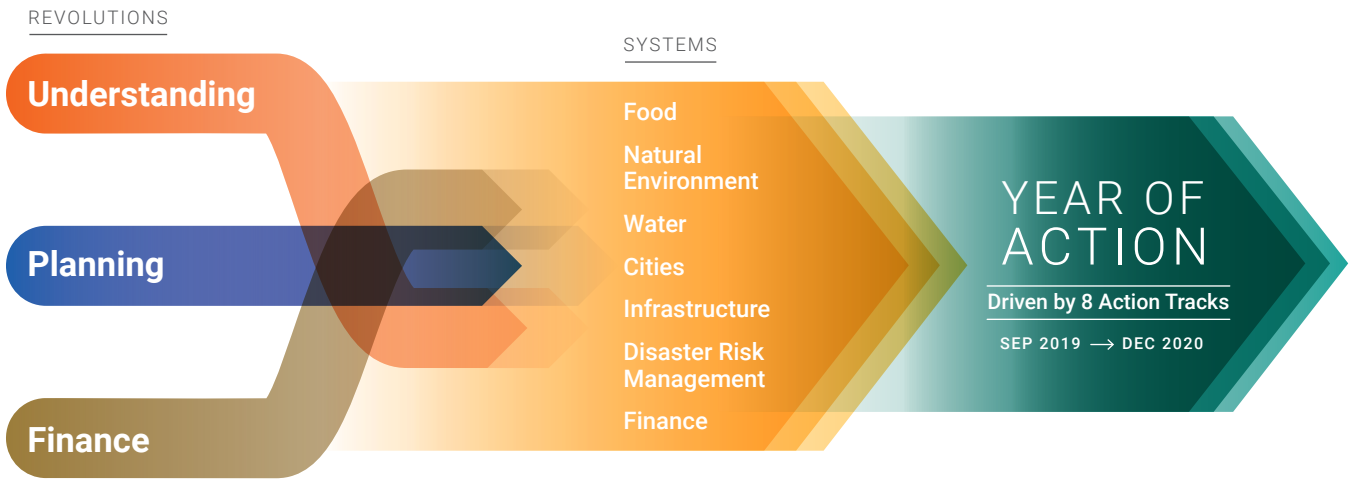
While the major transitions proposed in this report will take time to fully implement, it is essential that they start right away and with great urgency. For this reason, the Commission*—through Commissioner commitments and in partnership with others—will devote the coming 15 months to driving a set of Action Tracks that are essential to jump-start the needed transitions. In some cases, these actions will involve mobilizing political, technical, and financial support to existing initiatives; in other cases, they will entail forging new coalitions for change.

We will support efforts to integrate climate risk into all aspects of national financial planning and decision-making, while also calling for significant increases in the volume of devolved and decentralized funding available to local governments, cities, and community-based organizations. We will marshal a doubling of the scale of agricultural research for climate resilience. We will seek to transform how infrastructure investment decisions are made. We will call for scaled-up investment to improve people's ability to act ahead of extreme weather events, reduce deaths and human suffering, and lessen economic impacts. We will galvanize national, local, and private sector leadership for nature-based solutions. And we will seek to strengthen the resilience of natural freshwater and critical human water systems to reduce risks for billions of people facing high water stress and for those whose lives are impacted by floods and droughts.

The next 15 months are critical to mobilizing action on climate change and support global development. The Commission will champion the Action Tracks at the UN Climate Action Summit in September 2019 and throughout the coming year, including importantly at the Climate Adaptation Summit in the Netherlands in October 2020. The Commission will also aim to encourage countries to raise the level of ambition on adaptation in the lead up to the international climate summit, COP26, in December 2020.

**We invite collaboration from all segments of society—governments, the private sector, civil society, and citizens around the global—to join us in urgently taking this agenda forward.**

**FIGURE ES.2** Adapt Now: The Way Forward




* In the following paragraphs we use the pronoun "we" to refer to individual or groups of Commissioners, Action Track partners, and Managing Partners as the ones carrying forward commitments to action—not all members of the Commission or the Commission as whole.

PART I

# A Call to Action

# CHAPTER 1: ADAPT NOW

## Introduction

Climate adaptation is a human, environmental, and economic imperative. People who did the least to cause the problem—especially those in developing countries and those living in relative poverty everywhere—are most at risk. But as recent events have revealed, no one and no place will be spared. Fortunately, throughout history, people have shown the resourcefulness to overcome great challenges. People want to shape their future, not be victim to it. The climate crisis is already generating demands for change, including from young people around the world.

We need leadership at all levels to accelerate climate adaptation. This Commission—consisting of 34 Commissioners and convened by 20 countries—was formed to raise adaptation on the global agenda and inspire courageous action.

In the following pages, we make the case for bold adaptation action, provide specific insights and recommendations by key sectors, and introduce major initiatives to jump-start a Year of Action. What brings us together is a common desire to unleash a wave of adaptation at local, national, and global levels that creates safer, stronger, and more thriving communities for all.

**People want to shape their future, not be victim to it.**

## The Climate Crisis

The warming climate is already causing profound impacts. Climate risks manifest themselves in many ways—from the slow and inexorable rise in sea level to the erratic behavior of monsoons, and the strengthening of storms and heat waves. It does not matter if you're a coffee farmer in Colombia, an autoworker in Bangkok, or an elderly person in Paris—your health, well-being, and livelihood are at risk.

The tell-tale fingerprint of climate change is increasingly seen in disasters: the intense rainfall during Hurricane Harvey in Houston,[1] the devastating 2017 floods and mudslides in Peru,[2] the deadly 2018 heat wave in Japan,[3] and unprecedented wildfires in 2017 in Canada.[4] It can also be seen in the steady but relentless warming taking place, with the last five years being the hottest ever recorded.[5]

Coupled with the increasing hazards are the rapid increase in exposure due to population growth and the expansion of cities and industry that place more people and assets at risk, particularly along coastlines. In addition, 500 million small farms around the world are exposed to increasing changes in temperature and precipitation.[6] Even worse, few of these smallholder farmers have access to the resilient crops, drought-proof water supplies, and financing needed to pull through when the rains fail.

The effects of climate change will only increase over the next few decades, given the unavoidable changes that are already locked in because of current and near-term emissions. Even if the world were to successfully meet the Paris Agreement target of limiting the global average temperature increase to well below 2°Celsius (°C), impacts would be much larger in some regions. Land warms roughly twice as fast as the planet overall. Therefore, when scientists discuss preventing "1.5°C of global warming," they are really talking about forestalling 3°C—or 5.1 degrees Fahrenheit—of higher land temperatures.[7]

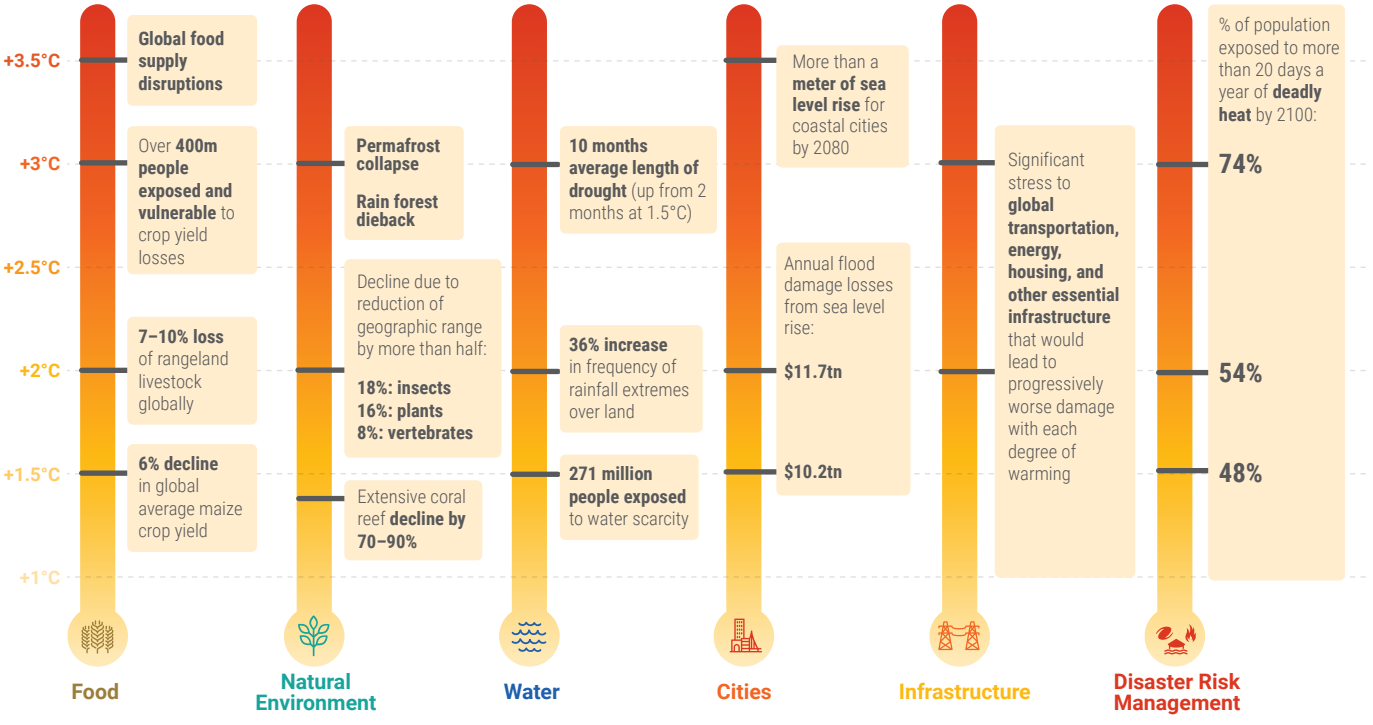
Moreover, temperatures may climb even higher, because the world is not yet on a path to meet the Paris climate targets. Current commitments do not support the rapid and deep emissions reductions—a halving[8] of current levels within the next decade—needed to achieve these targets. On the current path, global average temperatures are likely to climb to more than 1.5°C above pre-industrial levels before midcentury, and would exceed 3°C by the end of the century.[9]

Highly damaging scenarios are plausible, not just putting the Sustainable Development Goals (SDGs) out of reach but eroding hard-won gains from the past, and threatening the existence and livelihoods of many communities and societies—from subsistence farmers to agribusiness, and from low-lying atolls to cities like Lagos, Miami, and Shanghai. Every tenth of a degree rise in temperature matters as impacts scale quickly, even exponentially. At higher temperature increases such as 3–4°C, it becomes almost certain that we will cross tipping points, or irreversible changes in ecosystems or climate patterns, which will limit our ability to adapt.[10] Figure 1.1 describes the magnitude and severity of consequences in key systems that are at risk—and where this report puts forward an ambitious agenda to build resilience.

The challenge of responding to climate impacts is compounded by uncertainty about how the future climate will unfold. To a certain point, incremental approaches will suffice, such as continued improvements in water management or conventional approaches for flood protection and land use. But that may not always be the case: with more uncertain and dramatic impacts of higher temperatures, incremental adaptation will be insufficient and transformative approaches will be needed. For example, protecting against or accommodating sea-level rise in low-lying areas may no longer be possible—and coastal residents may need to systematically retreat. Many farmers will need to consider if they can continue farming at all on their current land. While uncertainty can be managed, tough choices will become inevitable with higher temperature increases.

Even with the most ambitious adaptation actions, we will face residual climate impacts. For this reason, ambitious mitigation is the best form of adaptation. Emissions reductions minimize the scale of the problem to be addressed and reduce future uncertainties. Choosing between adaptation and mitigation is a false choice—we must do both.

**FIGURE 1.1** The Risk of Catastrophic Events Increases with Temperature




*Source*: World Resources Institute, adapted from the IPCC and others.[11]

# A Human Imperative

We believe that adaptation is a human, environmental, and economic imperative. Climate change will exacerbate existing inequities by widening the gap between people with wealth and people living in poverty, adding to gender inequities, and increasing the already unfair burden on future generations. Globally, tropical and subtropical countries face greater climate impacts and have less capacity to withstand them than countries in temperate zones.[12] Within developing countries, climate change could push more than 100 million people below the poverty line by 2030.[13] Atoll nations may become unlivable this century, with human, social, and psychological costs that cannot be overstated (see Box 1).

Climate change has disproportionate impacts on women and girls. Climate impacts on women are compounded by existing biases within many of the institutions tasked with providing development and adaptation support.[14] Agricultural institutions underinvest in seeds, climate services, and insurance packages that are for crops predominantly tended by women; financial institutions design lending packages that are inaccessible to women despite a plethora of evidence that women are more reliable borrowers; and urban planners ignore women's needs for access to services, educational institutions, and employment opportunities. Political leadership will be essential, since climate adaptation interventions that ignore gender inequalities only deepen existing vulnerabilities and encourage new types of exclusion.

**BOX 1**

## The Urgency of Action for Atoll Nations

Low-lying atoll nations are especially threatened by climate change, with many islands mere meters above sea level and subject to more frequent and intense extreme events. Mitigation is critical for the survivability of atoll nations. At the same time, ambitious adaptation actions are needed to prevent them from becoming uninhabitable. Several atoll nations, like the Republic of the Marshall Islands, Kiribati, and the Maldives, are protecting their coastal areas by planting mangroves, restoring wetlands, and improving water systems.[15] However, higher temperature scenarios will limit the viability of these actions. Some may follow the lead of Kiribati, which purchased land in Fiji as a way to proactively plan for managed retreat.[16] Others, like the Marshall Islands, may commit to remain and look for ways to build higher islands.[17]

Aerial photo of the Marshall Islands

Furthermore, the effects of climate change and associated environmental degradation, if not better managed now, will cripple opportunities for today's youth and future generations. Acknowledging intergenerational inequalities is a central feature of the growing youth-led social movements around the world.[18] As inheritors of the effects of climate change, youth are also integral to generating political momentum, addressing inequalities, and advancing solutions.

In recognition that climate change is a common concern of humankind, the Paris Agreement calls for Parties to "respect, promote, and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities, and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women, and intergenerational equity."[19] The Paris Agreement also emphasizes that adaptation action should be gender-responsive and follow country-driven, participatory, and transparent approaches. These principles are embedded in the approach to the planning adaptation actions described below.

We do not accept a world where only some can adapt while others cannot, and where decisions taken today undermine the adaptive capacity of future generations. A recent report from the United Nations Special Rapporteur on Extreme Poverty and Human Rights said, "We risk a 'climate apartheid' scenario where the wealthy pay to escape overheating, hunger, and conflict while the rest of the world is left to suffer."[20] Preventing this from occurring is a strong imperative for action.

# An Environmental Imperative

Natural ecosystems are humanity's first line of defense against floods, droughts, heat waves, hurricanes, and the other mounting impacts of climate change. Beyond this, the natural environment underpins economies and societies on many levels, by providing food, fuel, and water; supporting livelihoods; and removing carbon from the atmosphere to mitigate climate change. A thriving natural environment is fundamental to adaptation in every human enterprise.

Yet nature and the ecological foundations of our existence are at a critical juncture. One in four species is facing extinction,[21] about a quarter of all ice-free land is now subject to degradation,[22] ocean temperatures and acidity are rising, and climate change is accelerating the loss of natural assets everywhere.[23] The planet is approaching thresholds beyond which ecosystem recovery may not be possible.[24] The extent of change is so great that nature could transition from being a buffer against climate impacts to contributing to greenhouse gas emissions through permafrost collapse, ice-free Arctic summers, large replacement of rainforests by savannah and grasslands, and significant dieback of the boreal forests.[25]

Environmental degradation increases everyone's vulnerability to climate change, but it most acutely affects indigenous peoples, rural communities, and others who depend directly on healthy ecosystems for their livelihoods.[26] There is still time to work with nature to build resilience and reduce climate risks at all scales, such as by restoring forests to regulate water flows and sequester carbon, and by creating green spaces in cities to help control temperatures. But the window of opportunity is closing quickly.

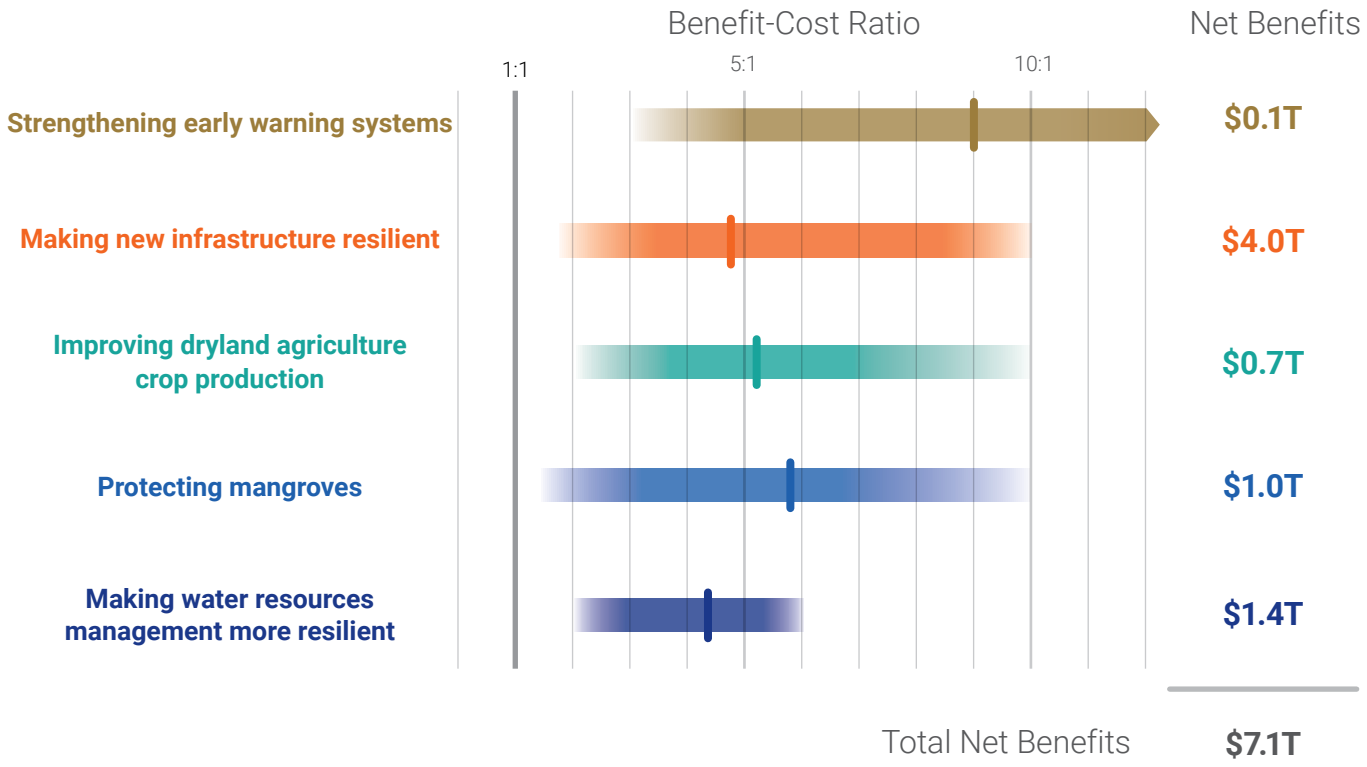
# An Economic Imperative

Adapting now is in our economic self-interest: it is typically much cheaper than recovery and rebuilding. The Commission found that the overall rate of return on investments in improved resilience is very high, with benefit-cost ratios ranging from 2:1 to 10:1, and in some cases even higher.[27] This means that every $1 invested in adaptation could result in $2–$10 in net economic benefits (Figure 1.2). Adaptation actions, done right, are some of the most cost-effective investments a country, city, or company can make.

The Commission also estimated that investing $1.8 trillion globally in five areas from 2020 to 2030 could generate $7.1 trillion in total net benefits (Figure 1.2). With sensitivity analysis, the range of total net benefits is from just under $5 trillion to over $10 trillion, with benefit-cost ratios that are still very high—from 2.5 to 5.5.[28] Put another way, failing to secure these economic benefits through climate adaptation investments would undermine trillions of dollars in potential growth and prosperity. The level of adaptation investment required is a very small share of projected total global investment: $1.8 trillion corresponds to less than 1% of projected total gross fixed capital formation over those years.[29]

The five areas we considered are early warning systems, climate-resilient infrastructure, improved dryland agriculture, global mangrove protection, and investments in making water resources more resilient. The average benefit-cost ratio of these investments is almost 4—and investing in

**FIGURE 1.2** Benefits and Costs of Illustrative Investments in Adaptation




*Note*: This graph is meant to illustrate the broad economic case for investment in a range of adaptation approaches. The net benefits illustrate the approximate global net benefits to be gained by 2030 from an illustrative investment of $1.8 trillion in five areas (the total does not equal the sum of the rows due to rounding). Actual returns depend on many factors, such as economic growth and demand, policy context, institutional capacities, and condition of assets. Also, these investments neither address all that may be needed within sectors (for example, adaptation in the agricultural sector will consist of much more than dryland crop production) nor include all sectors (as health, education, and industry sectors are not included). Due to data and methodological limitations, this graph does not imply full comparability of investments across sectors or countries.
*Source*: World Resources Institute.

areas with extremely high benefit-cost ratios like disaster risk management systems is an obvious priority. However, it is important to emphasize that any well-considered adaptation strategy should not rely on investment alone but also must address policy and institutional weaknesses.

Also, investments in these five areas do not represent total global investment requirements for adaptation, which will be higher (and would have correspondingly higher net benefits). They neither address all that may be needed within sectors (for example, adaptation in the agricultural sector will consist of much more than dryland cereal agriculture), nor include all sectors (such as health, education, and industry sectors are not included). Rather, they are illustrative, based on available data on economic returns—and Part 2 of this report has broader recommendations across seven systems that go beyond these five areas.

Adaptation actions can generate triple dividends. The first dividend is avoided losses—that is, the ability of the investment to reduce future losses from climate hazards.

While avoiding losses is the most common motivation for investing in resilience, taken alone it underestimates the total benefits to society. Many adaptation actions generate significant additional economic, social and environmental benefits, which accrue on an ongoing basis starting at the time of investment, and are not dependent on the future state of the climate. In other words, they are both more certain and more immediate. In Figure 1.2, all five areas have avoided loss benefits, and the last three—improved dryland agriculture crop production, mangrove protection, and water resources management—have further economic, and social and environmental benefits..

**Avoided losses:** The net benefits shown in Figure 1.2 are primarily due to avoided losses. For example, early warning systems save lives and assets worth at least ten times their cost. Just 24 hours warning of a coming storm or heat wave can cut the ensuing damage by 30 percent, and spending $800 million on such systems in developing countries would avoid $3–16 billion per year in losses. For its part, making infrastructure more climate-resilient adds about 3 percent to the upfront costs but has benefit-cost ratios of about 4:1. The World Bank found that investing $1 trillion in the incremental cost of making infrastructure more resilient in developing countries would generate $4.2 trillion in benefits.

**Economic benefits:** Adaptation actions bring about economic benefits in three distinct ways. First, by reducing risk, adaptation actions lower financial costs, increase security, and make investments more appealing in regions, cities, or industries where those investments would otherwise appear too vulnerable. London's Canary Wharf and other developments in East London would not have been possible without the protection from the Thames Barrier. Second, by improving the productivity of resources and people, adaptation actions boost incomes. Investing $250–500 per hectare in better dryland farming practices could increase cereal yields by 70–140 percent, bringing net economic benefits of billions of dollars. For example, flood-resistant varieties of rice in Orissa, India, not only reduced losses during times of floods, but they also boosted farm yields during normal years.[30] And third, through the challenge of finding solutions, driving innovation and creating new technologies and unforeseen market opportunities. Drip irrigation technologies, first developed to address severe water scarcity, are spreading because they are also better and more efficient.

**Social and environmental benefits**—also called non-market benefits—are the third category of benefits that result from adaptation actions. These benefits are typically hard to quantify but are no less important. For example, many nature-based actions that reduce flooding also increase biodiversity and make the air and water cleaner.[31] Restoring coastal mangrove forests does not just protect coastal communities from more dangerous storm surges, it also provides critical habitat to sustain local fisheries. While mangrove forests provide more than $80 billion per year in avoided losses from coastal flooding—and protect 18 million people—they also contribute almost as much ($40–50 billion per year) in non-market benefits associated with fisheries, forestry, and recreation. Combined, the benefits of mangrove preservation and restoration are up to 10 times the costs.[32] Rotterdam enjoys social benefits, in the form of improved community cohesion and quality of life, from green spaces that are designed to slow floodwaters.

To date, the second and third dividends have been largely overlooked. Better awareness of and evidence for all three dividends will make the economic imperative case for adaptation ever stronger.

## Barriers to Action

The case for adaptation is irrefutably strong, so why isn't more being done? There are several fundamental reasons, starting with the fact that most decisions do not internalize climate change. Decisions by a city official undertaking land-use planning, a utility deciding where (and whether) to build a new power plant, or a farmer planning the next cropping season, should all consider the many ways climate puts expected outcomes at risk. Even when risks are understood, knowledge is often lacking on appropriate solutions—what works, what does not, and the costs and benefits of specific options to reduce vulnerability.

Human behavior does not favor taking the initiative when the location and timing of hazards are uncertain, when benefits of action may be years away, or when more immediate priorities take precedence. Households, companies, and governments all have short-term planning biases and succumb to what has been called the tragedy of the horizon.[33] Short-term planning horizons lead to both underallocation and misallocation of resources. Underallocation occurs because future losses appear much lower than today's costs (due to discounting); misallocation occurs because successful short-term solutions may be maladaptive in the future.

In addition to knowledge gaps and short-term biases, fragmented responsibilities, poor institutional cooperation, and lack of resources hinder action. Governments lack incentives and funding for agencies to grapple with knowledge gaps, collaborate across silos, and implement innovative solutions. In most governments, few incentives exist to foster collaboration across sectors—between ministries, between governments and affected communities, between the public and private sectors, and even between nations. While resources are needed, so are policy responses that remove current incentives that undercut climate resilience. It is often cheaper to anticipate and reduce risk than to protect against it, or compensate for losses.

CREDIT: M. YOUSUF TUSHAR/THE WORLDFISH CENTER

Maherunness and her husband growing chilies at her climate-smart house in Satkhira, Bangladesh.

Finally, a fundamental barrier to action is that the people most affected by climate change have little power. Power typically rests with those least affected, most insured, and most able to protect themselves from the impacts of climate change. Major disparities in power also exist between countries. For the rich, climate change can seem like a problem easily overcome, not a lifelong sentence to poverty and suffering as it may mean for vulnerable and marginalized people. Those most at risk are often have limited ability to shape key decisions that affect them. Without their voice, the urgency of adaptation is muted.

# A Call to Action

Addressing these broad and entrenched barriers requires an ambitious response. Our Call to Action calls for revolutions in

- how we analyze, learn about, and understand climate risks and solutions;
- how we plan, make policy and investment decisions, and implement solutions; and
- how we finance required actions.

All three are essential, as they are mutually supportive and interlinked. All three involve both the public and private sectors. All three must be undertaken in a way that respects, promotes, and considers each country's respective human rights obligations, and is gender-responsive, participatory, and transparent. And all three need to start now, since change takes time, and time is not on our side.

## A Revolution in Understanding

**We need a revolution in understanding to ensure that the nature and magnitude of risks societies and economies face is fully understood—and effectively reflected in the decisions that public and private actors make**. Simple information is often lacking: many developing-country cities don't even have up-to-date flood maps and digital elevation models to properly assess flood risks. Moreover, decision-makers may not fully understand climate impacts and trends—not only because they have never experienced those impacts (such as the emergence of new diseases like dengue fever in the United States),[34] but also because there

BOX 2

## Pricing Risk: Revealing the True Cost of Climate Impacts

Pricing risk can be a catalyst for driving adaptation actions. The true costs from the impacts of climate change should be included in all economic analysis and decision making. Pricing risk can change behaviors through policy incentives as well as shape better investments—for example, when water is priced to reflect availability, or when rising insurance premiums deflect investments in flood-prone lowlands.

Putting an explicit price on risk in practice, however, is difficult. There is no single metric, like a price on carbon for climate mitigation, that applies to all sectors and countries. Many climate risks are local, so perils and prices will differ by location. So far, the skills, approaches, and tools most developed for pricing risk are those used by and for the insurance and catastrophe risk transfer markets. We urgently need better global data on hazards and exposures, calculations of probabilities, and knowledge of local conditions and vulnerabilities in order to successfully price risk. Given the limited depth and breadth of current markets, governments will have to lead in the creation of new risk management products. It will also be necessary for public and private actors, together, to find ways to pool risks across countries, given that the most vulnerable countries are also typically those least able to bear the costs of high-priced risk.

are new impacts that we are just becoming aware of (such as climate change reducing the nutritional quality of major cereal crops).[35]

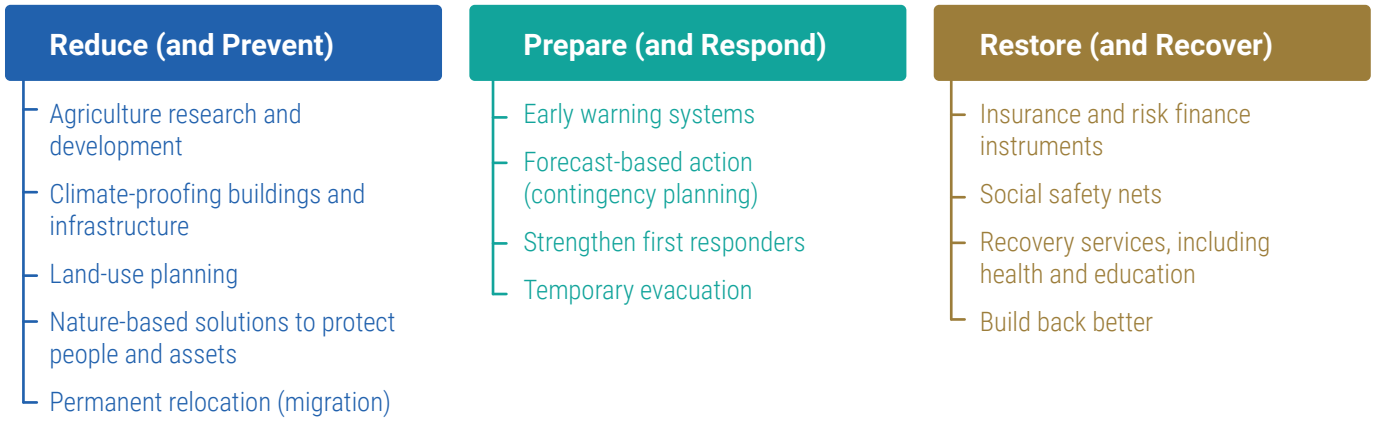
**A key element of this revolution is the need to make risk visible**. We need to more precisely characterize who and what is at risk, and why. Making risk visible starts with modeling how future climate hazards such as sea-level rise and heat waves lead to adverse outcomes, like the loss of coastal land and increased sickness or death. Making risk visible helps integrate climate impacts into all planning decisions. For example, a new highway bridge, 3 meters higher than the existing one, would have a larger upfront cost, but it would be less likely to be destroyed in the event of higher flood waters. In this case, factoring in climate risks is likely to steer the decision to the better option.

Policymakers have various tools to make risk visible, ranging from engineering design standards to approaches that implicitly or explicitly price risk. Design standards, by tightening flood level and wind stress requirements, reflect social preferences to better manage climate stresses. Policy incentives can steer decisions in directions that help reduce risk—for example when compensation funds are offered to help households move out of floodplains. Land-use planning and zoning regulations make risk visible by explicitly directing development toward areas less vulnerable to flooding. Finally, in both financial markets and economic analysis, pricing risks helps make more explicit the impacts of climate change in investment and policy decisions. Momentum is building in both the private and public sectors to develop tools to explicitly price risk (see Box 2).

**Equally important is to understand what works and what options to prioritize.** This is done by supporting experiential learning, sharing solutions, stimulating innovations in science and technology, and replicating promising business models and financial services. All forms of knowledge are important, recognizing that valuable local knowledge rests with communities and indigenous populations. Platforms that connect researchers and practitioners across communities and countries are critical. For example, the LDC University Consortium on Climate Change is an initiative that seeks to build knowledge and practice networks across some of the most vulnerable countries in the world.[36]

It is important to consider all forms of knowledge, including that of local communities and indigenous populations. For example, the Hani people in China's Ailao Mountain region have bred drought-resistant crop varieties and developed unique irrigation technologies to successfully cope with water shortfalls in their rice terrace agriculture system.[37] Combining traditional knowledge with modern scientific and technological tools can pay extra dividends, as when Inuit hunters combine their knowledge of wildlife and sea ice with weather station and GPS data to adapt to changing conditions.[38]

**FIGURE 1.3** Basic Elements of Climate Change Adaptation




*Source:* Authors, drawing on disaster risk management frameworks developed by the Global Facility for Disaster Reduction and Recovery, World Bank, and others.

The Commission strongly supports the full range of actions required by the revolution in understanding, from investments in basic and applied R&D, on the one hand, to peer-to-peer learning about solutions, on the other. The direct investment costs are relatively low, and the benefits of making knowledge systems more responsive to the needs of end users are high. Germany's Adaptation Strategy and Action Plan and Climate Preparedness Portal are good examples of national action that strengthens local capacity and provides climate services in a demand-responsive way.

## A Revolution in Planning

**We need a revolution in planning to improve how we make policy and investment decisions, and implement solutions.** The climate challenge is not only urgent—it is also pervasive across virtually all sectors of the economy. The Commission recommends the following four changes in how decisions are made for cities, infrastructure, agriculture, health, education, water, and protecting the natural environment to make those decisions climate-informed.

**The required change starts by mainstreaming climate risk.**[39] This means looking across the full spectrum of potential solutions—that is, from reducing exposure and vulnerability to preparing for and recovering from climate impacts (Figure 1.3). It also means integrating climate risk into all standard government and corporate processes, from strategy development to budget formulation and investment decisions. For countries, there are important United Nations Framework Convention on Climate Change (UNFCCC) processes that focus on climate change, such as nationally determined contributions (NDCs) and national adaptation plans (NAPs). These processes are important to help countries identify priority climate actions and mainstream these actions into economic and sector development plans and budgets. Finally, it means using explicit criteria, such as unmet needs, potential for impact, and benefit-cost ratios for prioritizing interventions.

Mainstreaming is closely tied to the first revolution in understanding. Mainstreaming in the public sector begins with upstream macroeconomic analysis and extends through risk screening, environmental and social impact assessments, permitting, and project design. It guides how governments assess policies, institutions, and investments to ensure that they are building resilience not only at the level of individual projects but system-wide. Mainstreaming in the private sector is similar. Companies worldwide are embarking on the same cycle of improving their planning related to climate risks to their operations and assets. The private sector is well aware of climate risks at one level—the World Economic Forum's Global Risks Perception Survey rates extreme weather as the most severe threat over a 10-year horizon[40]—but this awareness has not yet led to more detailed planning or action. Only 15 percent of roughly 2,500 companies cite physical risks in their disclosure documents to the Climate Disclosure

CASE STUDY 1

## Designing Amid Uncertainty: The Thames Barrier

The Thames Barrier is an iconic example of building robustness and flexibility in the face of uncertainty. By holding back storm surges and high tides, it helps protect 1.3 million people, £275bn in property and infrastructure, and places of high historical and cultural value from flooding. When it was opened in 1982, the Thames Barrier had a design life until 2030. However, studies show that based on current sea-level rise projections and the ability to raise embankments, it can now protect London until 2070. The Thames Estuary 2100 Plan sets out a long-term approach to managing this change and what should be done for different rates of sea-level rise and social change to 2100 and beyond. The plan accommodates multiple objectives, including flood protection, river access, species habitat, and quality of life.


The Thames Barrier works to hold back storm surges and high tides protecting 1.3 millon people.

Project,[41] and reporting on norms developed by the Task Force on Climate-Related Financial Disclosures (TCFD) remains low. Mainstreaming in both the public and private sectors requires more awareness, capacity, and accepted planning methodologies.

**Second, we must improve how we make decisions in the face of uncertainty**. New methods in decision science allow us to identify choices that are robust across a range of future outcomes—choices that guide our immediate decisions and allow flexibility as the future unfolds. A well-known example of adaptive decision-making in practice is the Thames Barrier (see Case Study 1). Taking a longer-term perspective allows planners to reduce the risk of maladaptation. At some point, transformational actions representing a complete change in direction may be needed. Switching to drought-resilient crops may be of no use if the site is not fit for farming anymore. More resilient infrastructure may be wasted if a city needs to be relocated. Not everything is "no regrets." Sometimes tough decisions will need to be made today that effectively have to choose between planning for a 1.5°C versus a 4°C world.

**Third, we must strengthen the role of vulnerable groups and local actors in planning processes that affect their own lives.** Planning and decision-making should be devolved as closely as possible to where people are most affected. Unfortunately, in most countries, participatory planning with local populations is uncommon, even though it helps develop shared goals, coordinate action, and build on local knowledge. Local communities—whether they are slum dwellers in Lagos, coffee farmers in Guatemala, or coastal communities in Australia—need adequate capacity and resources to help make and implement decisions that affect them. Community-driven development (CDD) approaches adopted by many governments and supported by the World Bank and other development finance institutions provide a rich set of lessons.

BOX 3

### Recognizing the Rights of Indigenous Peoples

Climate change threatens the land, livelihoods, and cultures of indigenous peoples. Climate impacts are often exacerbated by legal and institutional barriers and historic marginalization. As a result, adaptation actions should be designed in ways that reinforce and support increased indigenous rights, agency, and governance systems.[42] Examples include water management and irrigation solutions that uphold water and land rights; prioritizing local knowledge and technologies that preserve culture and indigenous knowledge systems; and planning processes that preserve their right to self-determination, including rights to free, prior, and informed consent.[43,44,45]

Particularly important in this regard are indigenous peoples, who are often on the front lines of climate impacts and yet face constraints in responding due to political and social marginalization (see Box 3).

In many instances, the locus of adaptation action is not local but at subnational, national, or even regional scales. An agriculture ministry setting farm policies, a water ministry investing in watershed development, or a public works department strengthening a national grid—all go beyond local implementation. The Rio Declaration and the Paris Agreement cite the importance of access to information and public participation, and the Paris Agreement further emphasizes that adaptation action should be gender-responsive and follow country-driven, participatory, and transparent approaches. Creating channels to share fiduciary responsibility of projects can also improve project implementation by enhancing transparency and accountability. The case of Bangladesh illustrates these lessons—and shows its dramatic success in saving lives through improved early warning systems, civic awareness, cyclone shelters, reinforced buildings, and recovery services (Figure 1.4).

**Lastly, governments need to promote ways to work better across boundaries, whether these be sectoral or jurisdictional.** Climate risks are cross-cutting, and adaptation solutions must be as well. For example, improved watershed management requires collaboration from agriculture, infrastructure, and social development actors. Resilient cities require municipalities, water utilities, and energy companies to work together. Addressing climate-induced health risks also requires cross-sectoral planning. In Bhutan, the Health National Adaptation Plan (H-NAP) identifies opportunities to prepare for and respond to health risks of climate change associated with increases in vector-borne diseases, and impacts on water quality, sanitation, hygiene, and food security. Working across sectors requires political will at the highest levels, as well as demands for effective results from civil society.[46]

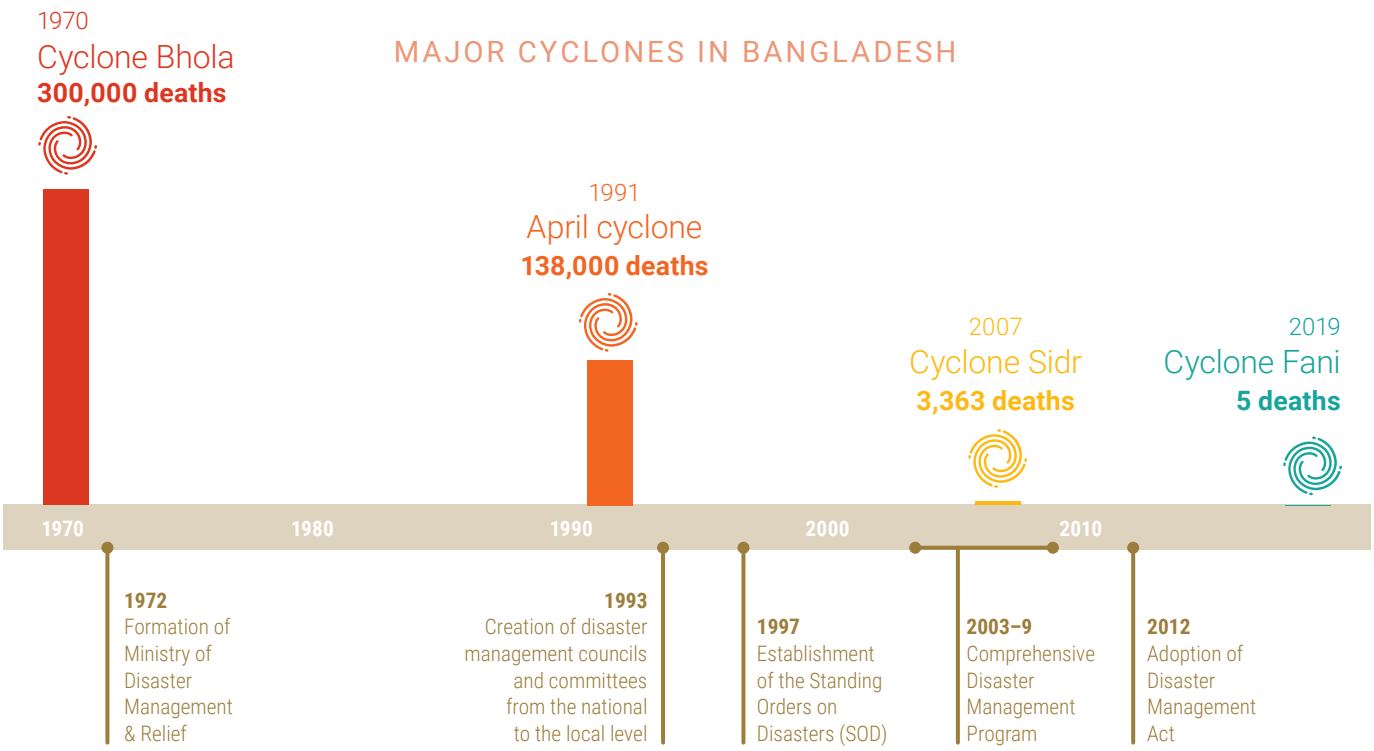
Climate change also requires action across national boundaries. Climate risks—both slow-onset and more extreme events—are already displacing people both within countries and across borders, and require planned relocation efforts. Other transboundary climate issues relate to natural resource use, such as watersheds, and trade. Institutional models exist to improve planning, reduce tensions, learn from others, and use science and technology in finding solutions. A few examples are (a) the West Africa Coastal Areas Management Program (WACA), a World Bank-financed multicountry program that addresses problems with cross-border climate impacts; (b) the Seeds without Borders initiative, which supports how neighboring countries improve agricultural productivity and resilience in the face of increasing natural disasters;[47] and (c) the North-East Asia Clean Air Partnership (NEACAP), set up in 2018 by China, North and South Korea, Japan, Mongolia, and Russia to promote science-based, policy cooperation to protect the environment and human health.

## The Revolution in Finance

**The economic case for resilience is strong, and the need for resources is clear. Yet, money is not flowing at the scale needed.** Climate risk has been and continues to be ignored in most investment decisions. Therefore, to better finance the required adaptation actions, a revolution in finance is needed to mobilize funding into more climate-resilient and cost-effective solutions. The Commission believes this revolution consists of four main parts:

**FIGURE 1.4** Key Policy Interventions in Bangladesh Contributed to Reduced Deaths from Climate Disasters

BANGLADESH IS A STRIKING EXAMPLE OF THE POWER OF EFFECTIVE ADAPTATION:
Starting with **early warning systems**, scaled-up disaster response has included **cyclone shelters**, **building civic awareness**, **strengthening buildings**, and improving **post-disaster recovery**




*Source*: Asian Disaster Reduction Center (ADRC).[48]

**First, as part of a broader transition toward sustainable finance, adaptation and climate resilience need to be built into all investment and financing decisions from the beginning.** The world will require trillions of dollars in annual infrastructure investment over the coming decades. If done right, these investments will lead to the kind of growth and development that is systemically resilient. Resilience needs to be built into investment and financing decisions from the beginning, and not considered as a climate finance add-on after other financing decisions have been made.

**Second, the public sector needs to recognize its role as an essential provider and enabler of finance for adaptation actions for the foreseeable future**. While some investments in resilience will generate bankable financial cash flows, many will not. Greater public resources will be required, whether for resilient economic systems such as agriculture and infrastructure, or social safety nets and risk-pooling mechanisms. In parallel, governments must take many other kinds of actions such as introducing policy incentives to improve planning and land use; strengthening climate services; building public sector capacity; and strengthening the functioning of the financial sector itself to better disclose risk, manage risk, and expand into new risk-pooling markets.

**Third, the private sector has a critical role to play, not only on its own account but to complement the public sector.** Firms in agriculture, industry, and commerce can make their own operations and supply chains more resilient and profitable by investing in adaptation.[49] Data and finance companies can provide climate adaptation services to respond to market needs and can develop and scale up insurance products that will provide contingent finance and create incentives for greater resilience. Members of the private sector can step up as active advocates to help shape and amplify the pressure for change.

More ambitious actions by the private sector will require a higher level of collaboration between the public and private sectors than seen today. Based on improved data and physical risk assessments, the two sectors should work on better pricing of risk and blended financing models that share costs and benefits (such as in infrastructure, supply chains, agriculture, and resilient cities). As risk becomes better understood and priced, the private sector can design risk finance instruments in an increasing number of countries—while governments continue to finance social safety nets and other services for vulnerable groups. The Africa Disaster Risks Financing (ADRiFi) program is one strong example of public and private risk-pooling (see Case Study 2). Moreover, public-private models for financing public infrastructure can create private value such as land value capture and reduced supply chain risks.

**CASE STUDY 2**

### Risk Pooling in Africa

The Africa Disaster Risks Financing (ADRiFi) program enables African countries to have access to market-based solutions for transferring some of their climate risks and to benefit from a payout in the event of a disaster. The program supports early stage financing that could be the impetus that gets countries to finance insurance premiums from their own budgets. This support complements the capacity-building support that Africa Risk Capacity (ARC) Insurance provides to African countries to help them better understand their disaster risk layers and establish the appropriate financing mechanisms for each layer of risk. These will prepare African countries to best address climate-disaster events when they occur.

**Fourth, there is a critical need for higher levels of international financial support for adaptation in developing countries**. Concessional climate finance (including grants) is particularly important, as many countries will be unable to borrow at market rates to invest in climate resilience. While international flows of adaptation finance to developing countries have steadily increased, they remain modest relative to the need and urgency of the challenge. Ambitious replenishments of the Green Climate Fund, the International Development Association, and regional development funds, such as the African Development Fund, will be essential to finance adaptation on a larger scale. Donors should push to ensure increased flows of adaptation finance and an improved balance between adaptation and mitigation finance, similar to recent commitments by the World Bank.[50]

# The Way Forward

It is clear: Scaling up adaptation is a human, environmental, and economic imperative. Our three revolutions—designed to address these imperatives—all put people first. Our priorities are to protect livelihoods, homes, jobs, and access to infrastructure services for the world's population.

The three revolutions provide the elements of how to adapt. Part II of this report drills down into greater detail about how these revolutions can be implemented in seven different economic systems: food, the natural environment, water, cities, infrastructure, disaster risk management, and finance. While each system is unique, all have common needs to improve their understanding, planning, and financing of adaptation actions. Furthermore, the chapters in Part II show that none of these economic systems operate in isolation. All are interconnected, and recognizing those interconnections is fundamental to achieving systemic resilience, growth, and prosperity.

All of this requires political leadership. Communities, activists, and business people can push, but the massive public goods that flow from adaptation actions ultimately rely on governments to create incentives and facilitate investments. This Commission is dedicated to strengthening political leadership on adaptation and proposes to do so through a bold set of Action Tracks as detailed in Part III. Each Action Track will build on sector-specific goals to contribute to the larger revolutions required.

Human beings have adapted to climate variability for thousands of years. What is different now is the unprecedented magnitude and pace of change, the level of uncertainty, the size of vulnerable populations, the scale of assets at risk, and the rapidly declining quality of ecosystem health. All of these factors are changing, and fast. Adapting will require human resourcefulness, innovation, and courage at a global scale rarely seen.

PART II

# Accelerating Adaptation in Key Systems

# CHAPTER 2: FOOD SECURITY AND LIVELIHOODS OF SMALL-SCALE PRODUCERS

## The Challenge: Growing Threats to Agriculture

Climate change stresses the global food system.[51] Climate change is already making food insecurity worse;[52] it has reduced the global yield growth of wheat and maize[53] as well as the yields of many other crops in Africa and elsewhere.[54] Developing countries are experiencing 20 percent more extreme heat than in the late 1990s.[55] And the number of undernourished or food-insecure people grew by between 37 million and 122 million to more than 800 million between 2014 and 2017,[56] partly because of climate shocks.[57]

Additional climate change will exacerbate great challenges already faced by the global food system. These challenges include a likely 50 percent increase in global demand for food between 2010 and 2050 and even larger increases in the world's most food-insecure regions—about a threefold increase in sub-Saharan Africa and almost twofold in South Asia.[58] Demand for meat, dairy, and fish—which people in developing countries today typically consume at only one-third or less the rate of those in developed countries—is on track to grow by 70 percent or more.[59]

Agriculture also contributes to the climate challenge. Greenhouse gas emissions from agriculture and associated land use change, now about 25 percent of global emissions, are likely to grow to 70 percent of allowable emissions from all human sources by 2050 and must be greatly reduced to meet climate targets.[60]

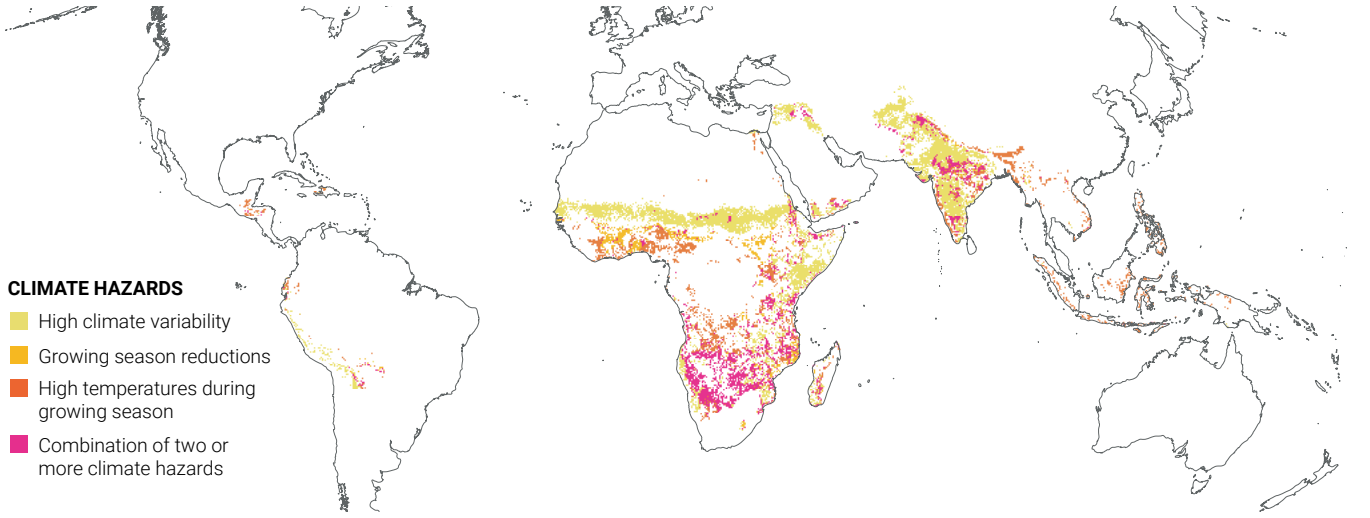
Climate change has adverse physiological effects on crops and livestock. Higher temperatures reduce water available for crops by drying out air and soils, while they increase pest and disease pressures, directly stress livestock, reduce labor productivity, and increase parasites and diseases for both livestock and crops.[61]

Absent adaptation, researchers now estimate that climate change will depress growth in global yields by 5–30 percent by 2050.[62] Although higher carbon dioxide concentrations could benefit plant growth and offset some of these effects, such carbon dioxide fertilization effects are uncertain and could be offset by negative effects from increased ground-level ozone and by reductions in the nutritional quality of many crops (which would also make malnutrition worse).[63]

Increased variability and extremes in temperature and rainfall will lead to production shocks that will worsen food insecurity. Even in years of average rainfall, rain is likely to fall in more concentrated bursts, increasing periods of inadequate soil moisture. Extreme droughts and floods, including more intense monsoons and El Niño events that cause both droughts and floods, will also become more common,[64] and the areas exposed to serious droughts and floods will increase by 15 percent to 44 percent by 2050.[65] With 4°C of warming, crop seasons in most of sub-Saharan Africa could shrink by 20 percent or more.[66] Droughts particularly threaten livestock producers, who must sell off livestock when prices are low. These effects together could impair the growth and development of children.[67]

Climate change is expected to increase food prices, reduce food availability, and reduce the incomes and food production of smallholder farmers. Although some causes of higher prices can benefit some farmers, both consumers and farmers lose when climate or other challenges increase prices by harming production. Particularly hurt will be people living in poverty and the food-insecure, who already spend more than half of their incomes on food,[68] and who include large numbers of landless rural people and smallholder farmers, who are net purchasers of food.[69] Climate change is likely to raise food prices by 20 percent[70] for billions of low-income people. With high global economic growth, the

**FIGURE 2.1** Areas of High Agricultural Risk for Different Climate Hazards in Vulnerable Areas




*Source*: Prepared by Philip Thornton, CCAFS, for the Global Commission on Adaptation.[71]

absolute number of food-insecure people may still decline, but according to modeling done for the Commission by International Food Policy Institute (IFPRI), higher average food prices alone, and ignoring the effects of variability, may make 50 million more people food-insecure in a warmer world.[72]

The physical harm to food production and the consequences for people will be greatest in the most food-insecure regions, particularly in sub-Saharan Africa and South Asia (Figure 2.1),[73] where tens of millions of hectares of agricultural lands will become substantially drier. Populations in these regions already experience high rates of undernutrition (seen, for example, as child stunting), have limited social insurance, receive less government support than farmers in developed countries, and are most likely to experience direct health threats from extreme temperatures.[74]

## The Way Forward: Support Small-Scale Food Producers

Adapting to climate change while also achieving healthy food for all, mitigating climate change, protecting ecosystems, and achieving the SDGs will require systemic changes to the global food system and global land use. Multiple publications have now cited the need for healthier, less resource-intensive diets and reducing food loss and waste, increasing the output per hectare of cropland and pasture, linking those gains to preservation and restoration of forests and their carbon, addressing widespread micronutrient deficiencies, promoting innovation throughout the food system, more balanced food distribution, and the important underlying role of greater equity in the control over land and other resources.[75]

Our recommendations here focus on the particular challenges climate change poses to the livelihoods of small-scale food producers, whom climate change will adversely affect both as consumers and producers. Globally, around 500 million farms are two hectares or smaller,[76] and two-thirds of adults working in poverty make a living in part through agriculture.[77] People in rural areas also have higher rates of food insecurity and extreme poverty.[78]

Smallholder farmers face many challenges even without climate change, and fully addressing them requires improvements to education, health, gender-equity more broadly, and the political economy of food systems. Our recommendations focus on a high-priority subset of potential interventions for agricultural improvement that can both address existing agronomic and livelihood challenges and help smallholder farmers adapt to a changing climate. We recommend some long-standing interventions based on firm evidence that similar interventions have achieved positive outcomes, while recommendations for newer ideas are based on their potential and a compelling rationale. We also considered environmental sustainability, the ability to manage trade-offs where they exist, evidence that risks are acceptable, and likely co-benefits for mitigation or society (Table 2.1). The following categories of action, and specific steps, are vital:

## 1) Improve smallholder productivity

The world's farmers could achieve greater crop and livestock yields with improved management,[79] and some interventions can disproportionately help respond to climate change (even in the difficult context of dryland agriculture, interventions are likely to yield large economic returns).[80]

**Governments, development agencies, and the private sector to boost funding for demand-driven research and development**. R&D is crucial to address climate stresses on crops from increasing heat, drought, and disease. For example, extreme heat has highly adverse effects on the yields of staples such as maize, wheat, and rice,[81] as well as on important cash crops such as arabica coffee and cocoa. Research is needed not just to test more heat-tolerant varieties but also to find physiological and genetic drivers. In Zimbabwe, farmers using drought-tolerant maize were able to harvest up to 600 kilograms more maize per hectare than farmers using conventional maize.[82] Investments in basic and applied research in both national and internationally oriented research agencies as well as extension services have high rates of return, with 75 percent of studies finding at least a 22 percent rate of return and 25 percent finding at least a 62 percent rate of return in one recent meta-analysis.[83] Another study of research by the CGIAR system (formerly called the Consultative Group on International Agricultural Research) found benefit-cost ratios ranging from 2:1 to 17:1.[84] Consistent funding streams for long-term projects, particularly on less-researched orphan crops, such as sorghum, cassava, and pulses, are important for food security in low-income regions,[85] and those crops can benefit from modern molecular techniques.[86] Farmer-driven research, including participatory plant-breeding and last-mile adoption of technologies from researchers to the farm level, also have produced many successes.

**Agriculture agencies to improve the distribution of seeds, the protection of genetic crop diversity, and the rate of development of new crop varieties.** Crop modeling studies suggest that existing crop varieties could withstand much of the direct heat effects (but less of the precipitation effects) of 2°C of warming if they were adapted to become locally available and if farmers adopted them.[87] Yet in much of the world, including Africa and India, it takes far longer for new crop varieties to become available than in developed countries. It is thus important to more rapidly develop improved crop varieties for farmers, reduce barriers to the sale of improved seeds, and increase market access, particularly in Africa.[88]

**Agriculture agencies and private companies to exploit digital technology, better weather information, and farmer-to-farmer education to improve technical assistance**. Good agricultural extension is critical to realizing the benefits of R&D.[89] The use of digital communication and farmer-to-farmer education can both amplify traditional extension and provide critical weather information for farmers to make planting and harvesting decisions.[90] Data and analytics can also be used to improve disease surveillance and the development of early warning systems. Digital soil maps are critical for farmers to understand their local soil health and respond accordingly.

**In Zimbabwe, farmers using drought-tolerant maize were able to harvest up to 600 kilograms more maize per hectare than farmers using conventional maize.**

## 2) Help small-scale producers manage risks from increased variability and climate shocks

A substantial literature shows that small-scale producers manage risk by underinvesting in agricultural production.[91] This strategy may increase incomes on average, but it means that many will be forced to sell assets during times of hardship and then never recover from severe climate shocks.[92] As a result, finding ways to reduce risk and avoid the need to sell off productive assets is highly valuable.[93]

**Governments, development agencies, and private companies to help smallholders diversify their incomes**. Diverse income streams help smallholder farmers boost food security and increase investment in productive management. One strategy can be production diversity. Studies have found that more diversified farms in Africa, which are correlated with somewhat larger size and greater market access, have greater food security. Another is increasing off-farm income by providing more off-farm job opportunities.[94]

**Governments to create and strengthen social security systems**. Basic social security systems improve food security and help farmers avoid poverty traps that lead to long-term reductions in productivity and income.[95] In developing countries, only a small percentage of the population is covered by social security systems sufficient to guarantee food security.[96]

**Governments and the private sector to explore weather-based agricultural insurance for smallholders**. Crop insurance based on indices of bad weather that requires no direct information from the farm can lower administrative costs. Pilot efforts have had both successes and failures, which are linked to administrative costs and to the fairness and honesty of reporting and payments when a policy is triggered. With continued experimentation to lower administrative costs and to ensure that farmers are reimbursed for real losses, this approach may help stabilize incomes.[97]

**Private and public financial institutions to improve access to finance**. Private investments provide the majority of funds used for agricultural improvements,[98] yet limited access to finance poses major barriers for small-scale producers. Setting lending targets and developing specific models for private finance that works for small-scale producers and cooperatives, including microfinance, will be necessary to mobilize adequate finance for adaptation.

## 3) Address the challenges of the most climate-affected and vulnerable

**Governments and development agencies to improve rights and resources for women farmers**. Women make up more than 40 percent of the agricultural workforce and tend to have substantially less access to land rights, fertilizers, education, technical assistance, weather information, and water.[99] Women are likely to play even larger roles going forward, because farms are getting smaller, pushing more men to move to cities for jobs and leaving women to run farms.[100] Climate change will likely accelerate this trend.[101] Tenure reforms that provide equal property rights for women and targeting financing and extension services at women would help advance gender justice. It would also likely result in promising yield improvements.[102] For example, the Food and Agriculture Organization of the United Nations (FAO) estimates that if women had the same access to productive resources as men, they could increase yields on their farms on average by 20–30 percent and reduce the number of hungry people in the world by 12–17 percent.[103]

**Governments to develop transition funds to help those farmers most affected by climate change**. Some farmers will face such large stresses that they will need to transition to alternative farming systems, such as alternative crops, or even leave farming altogether. Direct government financial support, supportive R&D, and assistance in establishing new marketing networks can play important roles in successful transitions.[104] Because the precise farms that will need these funds are uncertain but are likely to grow in number over time, farmer transition funds should be based on transparent and equitable criteria.

**Governments to assist pastoralists**. Many pastoralists in Africa are already under great stress because of migration barriers, encroachment by crop farmers, often-discriminatory governance, and high population growth.[105] Now they are facing more frequent and severe droughts and the other impacts of climate change. About 268 million pastoralists already have high rates of food insecurity, according to FAO, and climate stresses contribute to damaging social conflict. It will be critical to protect pastoralists' rights to pasture, to assist in altering the destocking and restocking process as rainfall varies, and to find alternative income sources.[106]

## 4) Achieve policy coherence by making agriculture interventions climate-smart

Policies should support all the multiple goals of the food system. Climate-smart intervention means not a specific set of measures but increased focus on yield and income stability rather than on yield alone. It also means greater focus on efficiency in the use of inputs, such as water and fertilizer, and more focus on long-term sustainability by properly caring for soil and water resources. Such a climate-smart approach requires packages of measures tailored to local conditions, rather than single steps, extending from the farm to the overall value chain.

**Governments to redirect public support to facilitate climate-smart decision-making.** The Organisation for Economic Co-operation and Development (OECD) has estimated that governments provided $568 billion per year for agriculture in 2014–16, but few of those dollars were directed at measures—such as limiting excessive use of water and fertilizer or the wrong mix of fertilizer[107]—that help farmers adapt to climate change.[108] In some cases, these subsidies have been counterproductive, encouraging farmers to produce foods in locations or ways that are increasing environmental harm. Public finance and incentives for farmers thus need to be better aligned with long-term sustainable, climate-mitigating, and climate-resilient production.

**Governments to support synergies and avoid tensions between adaptation and mitigation.** The same agricultural systems that must adapt to climate change and produce more food must also reduce emissions. There are many opportunities to do both, such as increasing the output of crops, meat, or milk per hectare; per liter of water; per kilogram of fertilizer; and per animal unit. More gains would come from switching to foods that offer more protein per unit of feed and per hectare while also generating far fewer emissions; from reducing demand for animal products by the world's affluent while also promoting alternative proteins; from reducing food loss and waste; and from avoiding competing demands for agricultural land. In addition, successfully adapting to climate change reduces the need to convert more forest to fields, which releases carbon. At the same time, tensions between mitigation and adaptation should be avoided to the extent possible and will require developing and following integrated land use plans. Examples include avoiding agricultural production in wetlands and not building or improving roads in locations that will encourage the clearing of forests.

**Governments to adopt measures to conserve land and water resources at the landscape scale, including agroecological approaches**. Climate change is likely to increase soil erosion and losses of soil carbon, among other threats to soil quality.[109] These threats can potentially be addressed with agroecological approaches, such as enhanced use of agroforestry, increased retention of crop residues, and larger numbers and types of crops used in rotations, particularly more use of legumes. Various forms of integrated pest management will also be necessary to address the likely increase in pest pressures from a warming world. Improving the evidence-base for the effectiveness of adopting different agroecological approaches are a necessary step.[110]

Climate-smart interventions include agroecological approaches that work to conserve land and water resources at the landscape scale.

**TABLE 2.1** Recommendations Categorized for Different Actions, Climate Risks Addressed, Type and Potential Breadth of Impact, and Justification

*Note:* Evaluations are based on knowledge of the literature and experience, derived from a variety of potential recommendations originally identified by Commission members and the evaluation criteria indicated in the text.

| Specific interventions | Action domain | Primary climate risks addressed | Primary impact | Breadth of impact | Justification & strength of evidence |
|---|---|---|---|---|---|
| **1) IMPROVED SMALLHOLDER PRODUCTIVITY** | | | | | |
| Increase research & development spending | ★★ **Research & development** | **+ Heat & water stress**<br>**+ Volatility & stress**<br>**+ Climate shocks**<br>**Shifting suitability** | Production, income | Applicable to all farming | Strong evidence from previous experience<br>HIGH CONFIDENCE |
| Extension including digital farmer services, weather & seasonal forecasts, and farmer-to-farmer | ★★ **Knowledge dissemination** | **+ Heat & water stress**<br>**+ Volatility & stress**<br>**+ Climate shocks**<br>**Shifting suitability** | Production, resilience | Broad applicability | Strong evidence for extension; promising examples of digital services and farmer-to-farmer education<br>HIGH CONFIDENCE |
| More rapid variety & breed development and faster, better distribution to smallholders | ★ **Research & development**<br>★ **Policy & markets** | **+ Heat & water stress**<br>**+ Volatility & stress**<br>**Shifting suitability** | Production, resilience | High adoption potential, if speed can be increased & barriers overcome | Strong evidence around performance of improved seeds / breeds and of potential of alternative varieties to address changing weather patterns<br>HIGH CONFIDENCE |
| **2) HELP FARMERS MANAGE INCREASED VARIABILITY AND CLIMATE SHOCKS** | | | | | |
| Income diversification including farm diversification, increased market access, and increased off-farm diversification | **Research & development**<br>**Policy & markets**<br>**Finance**<br>**Knowledge dissemination** | **+ Heat & water stress**<br>**+ Volatility & stress**<br>**+ Climate shocks**<br>**Shifting suitability** | Production, livelihoods, mitigation co-benefits | Broad: farm production diversity where feasible, off-farm activities in other places | Strong evidence that income diversification increases food security for smallholder farmers<br>HIGH CONFIDENCE |
| Stronger social security systems | ★★ **Policy & markets** | **+ Climate shocks** | Livelihoods | Target vulnerable populations | Strong evidence for effects on food insecurity; mixed evidence for preserving production systems<br>HIGH CONFIDENCE |
| Bundled crop and/or livestock insurance | **Research & development**<br>**Policy & markets**<br>**Finance**<br>**Knowledge dissemination** | **+ Volatility & stress**<br>**+ Climate shocks** | Livelihoods, production | Target vulnerable populations | Strong rationale; technical challenges remain; evidence mixed<br>MEDIUM CONFIDENCE |

**TABLE 2.1** Recommendations Categorized for Different Actions, Climate Risks Addressed, Type and Potential Breadth of Impact, and Justification (continued)

*Note:* Evaluations are based on knowledge of the literature and experience, derived from a variety of potential recommendations originally identified by Commission members and the evaluation criteria indicated in the text.

| Specific interventions | Action domain | Primary climate risks addressed | Primary impact | Breadth of impact | Justification & strength of evidence |
|---|---|---|---|---|---|
| **3) ADDRESS THE CHALLENGES OF THE MOST AFFECTED AND MOST VULNERABLE FARMERS** | | | | | |
| Improve the rights and resource access of women farmers | **Research & development**<br>**★ Policy & markets**<br>**★ Knowledge dissemination** | **+ Heat & water stress**<br>**+ Volatility & stress**<br>**+ Climate shocks**<br>**Shifting suitability** | Livelihoods, equity, nutrition | Broad applicability | Strong rationale; strong evidence of benefits of increasing access; some evidence of positive nutritional outcomes<br>MEDIUM CONFIDENCE |
| Help pastoralists adapt via flexible combinations of policies and practices | **Research & development**<br>**★ Policy & markets**<br>**Finance**<br>**Knowledge dissemination** | **+ Heat & water stress**<br>**+ Volatility & stress**<br>**+ Climate shocks**<br>**Shifting suitability** | Livelihoods, political empowerment, nutrition, conflict resolution | Target pastoralist populations | Strong rationale, including links between CC and conflict; mixed evidence on effectiveness of interventions<br>MEDIUM CONFIDENCE |
| Implement transition funds | **Research & development**<br>**★★ Finance** | **Shifting suitability** | Livelihoods | Highly targeted vulnerable populations | Strong rationale based on equity and likely need; some positive examples of transition support<br>NEW CONCEPT |
| **4) ACHIEVE POLICY COHERENCE AMONG FOOD SYSTEM GOALS** | | | | | |
| Redirect public support to promote & facilitate climate smart agriculture | **★ Policy & markets**<br>**★ Finance** | **+ Heat & water stress**<br>**+ Volatility & stress**<br>**+ Climate shocks**<br>**Shifting suitability** | Productivity, livelihoods, equity, resilience | Broad applicability | Strong rationale; strong evidence of the efficiency & effectiveness of some types of support<br>MEDIUM CONFIDENCE BECAUSE OF MEDIUM EXPERIENCE |
| Support synergies and minimize trade-offs between adaptation & mitigation | **Research & development**<br>**★ Policy & markets**<br>**Finance**<br>**Knowledge dissemination** | **+ Heat & water stress**<br>**+ Volatility & stress**<br>**Shifting suitability** | Resilience, mitigation co-benefits | Targeted production systems | Strong rationale based on need to achieve multiple goals; strong evidence of both potential synergies and trade-offs<br>HIGH CONFIDENCE |
| Conserve land & water resources at the landscape scale via improved agronomic practices and eco-agricultural approaches | **Research & development**<br>**★ Policy & markets**<br>**Finance**<br>**Knowledge dissemination** | **+ Volatility & stress** | Resilience, mitigation co-benefits | Targeted production systems, to overcome scaling challenges | Strong rationale based on need to achieve multiple goals. Strong evidence of effectiveness in some situations, though scaling challenges remain<br>MEDIUM CONFIDENCE |

★ = Highly applicable ★★ = Very higly applicable

Confidence levels (high, medium, low) refer to confidence in the estimate of the intervention's contribution to small-scale farmer adaptation.

# CHAPTER 3: NATURAL ENVIRONMENT

## The Challenge: Critical Ecosystems Are at Breaking Point

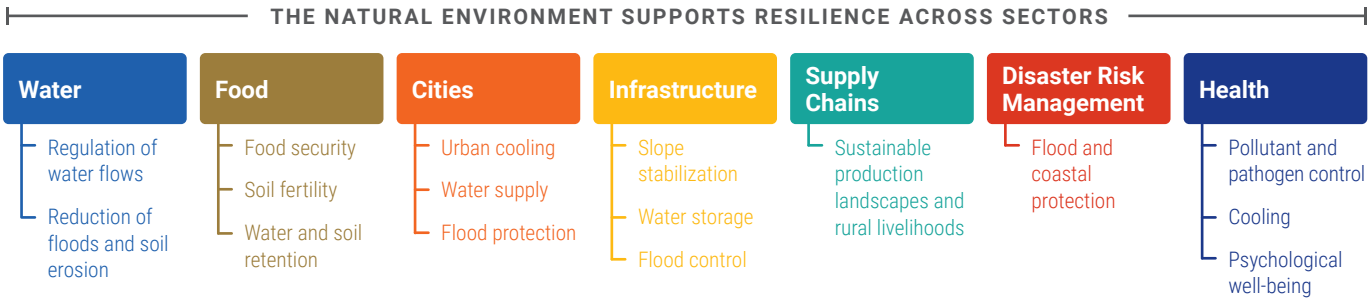
Nature gives protection against the mounting impacts of climate change that is of incalculable value and irreplaceable. Forests store and regulate water—services that will become even more important as rainfall becomes more unpredictable. Wetlands soak up potentially deadly floods and ensure supplies of life-giving water to farmers and cities in times of drought. Mangroves tame the powerful storm surges that might otherwise destroy coastal communities. These crucial ecosystems, and many others, underpin whole economies and societies, providing food and fuel, supporting livelihoods, and fighting climate change itself by capturing carbon from the atmosphere. A thriving natural environment is thus a cornerstone of building resilience across all sectors (Figure 3.1).

Yet the alarming truth is that the trends are moving rapidly in the wrong direction. One in four species is facing extinction,[111] about a quarter of all ice-free land is now subject to degradation[112]—with 3.6 million hectares of old-growth forest destroyed in 2018 alone[113]—and a third of all marine fish stocks are fished unsustainably.[114] Climate change is everywhere accelerating the loss of natural assets,[115] and the planet is approaching thresholds beyond which ecosystem recovery may not be possible.[116] Coral reefs and polar ecosystems are particularly vulnerable, with reefs projected to decline by up to 99 percent at 2°C of warming.[117]

This level of ecosystem damage most acutely affects indigenous peoples, rural communities, and others who depend directly on healthy ecosystems for their livelihoods.[118] Capacity to adapt may be especially limited for those with insecure land tenure and for women, who often lack a voice in how natural resources are managed.

There is still time to work with nature, not against it, but the window of opportunity is closing quickly. Nature's services will become even more valuable as global temperatures climb. But beyond rises of 1.5°C or 2°C, tipping points may be reached. Nature's services will then be lost, making it impossible for many parts of the world to adapt effectively. The option of enlisting nature to help mitigate and adapt to climate change remains on the table—but only just.

**FIGURE 3.1** Relationships between the Natural Environment and Climate Change Adaptation by Sector




*Source:* Authors.

# The Way Forward: Harnessing the Power of Nature

The extensive study done for this Commission underscores the many advantages—and major benefits—of working with nature.[119] First, nature-based solutions work for both adaptation and mitigation, since nearly all interventions that reduce climate impacts also increase carbon uptake and storage. Natural solutions like forest restoration and avoiding deforestation could provide a surprising one-third of the climate mitigation needed between now and 2030 to keep warming below 2°C.[120]

There are many other benefits, such as better water quality, more productive natural resources, job creation, improved health, cultural benefits, and biodiversity conservation. Nature-based solutions often work well at a broad scale, such as in whole watershed restorations or along coastlines. They can be more cost-effective than engineered approaches, like seawalls, and can also work well in tandem with those engineering approaches to control floods, protect coasts, and reduce urban heat. For example, combining "green" and engineered approaches in New York City would lower the costs of flood protection by $1.5 billion (22 percent) compared to hard infrastructure alone.[121]

**Restoring the mangrove forests that protect from sea-level rise and storm surges is 2 to 5 times cheaper than building engineered structures.**

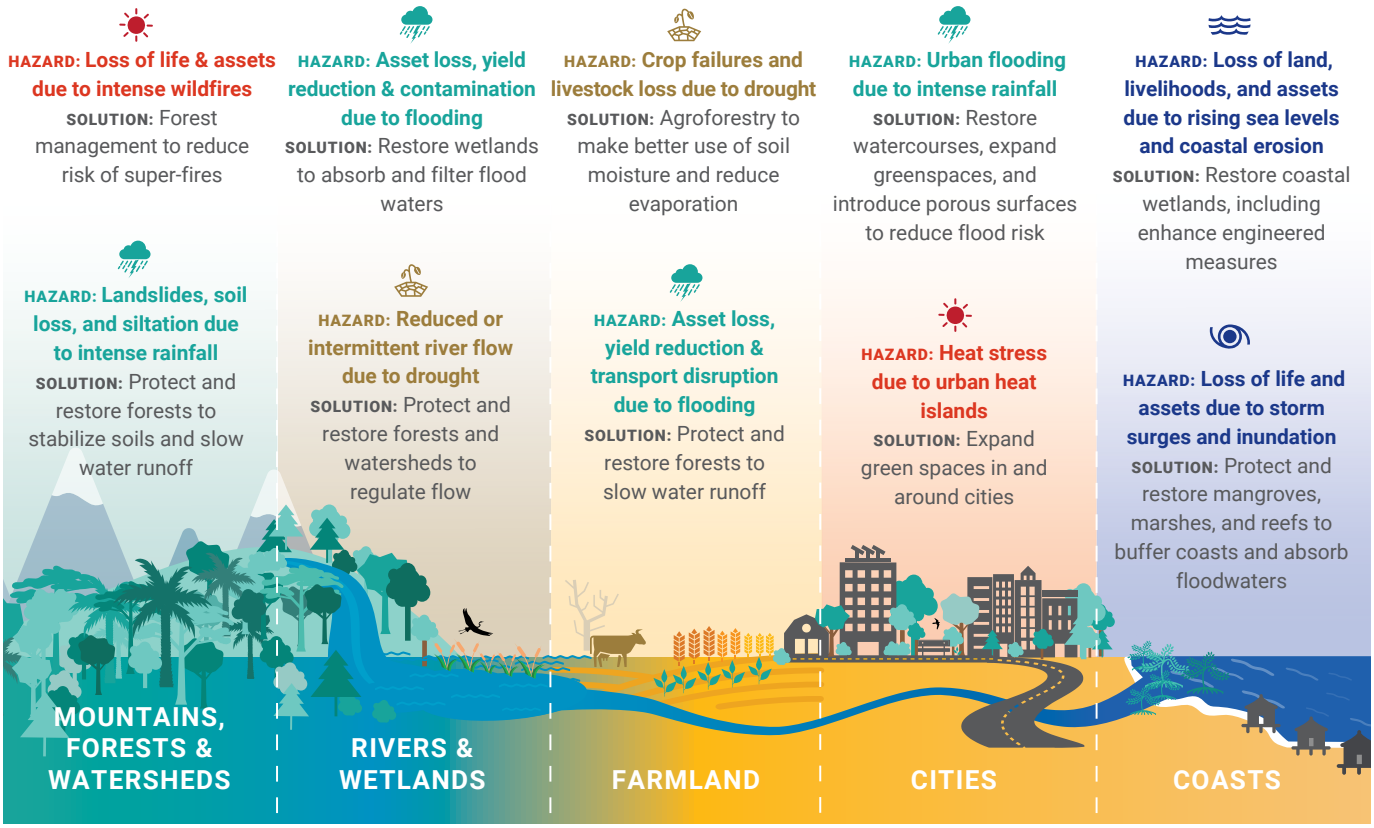
We can already see the immense opportunity of using nature to increase societal resilience in landscapes ranging from uplands to the ocean (Figure 3.2). Restoring upland forests and watersheds could save water utilities in the world's 534 largest cities an estimated $890 million each year and is critical for regulating water flows and managing the future's more extreme floods.[122] Meanwhile, lakes, marshes, and river floodplains both slow the release of floodwater and filter out sediment. The Netherlands has harnessed these capabilities with a Room for the River strategy that increases capacity of rivers and their floodplains to hold floodwaters, reducing damage and loss of life (see Case Study 6 in the next chapter).

Ecosystem restoration also is a powerful tool for feeding the hungry, cooling sweltering cities, and protecting communities. One striking example is farmer-led reforestation in the Maradi and Zinder regions of Niger, which has boosted crop yields, improved soil fertility, and lifted communities out of poverty. Tree cover has soared ten-fold and the daily time spent gathering firewood—a task that mainly falls to women—has dropped from 3 hours to 30 minutes.[123] For cities, an annual investment of $100 million in urban tree planting could create enough shade to cut average temperatures by 1°C for 77 million people around the world.[124] Restoring the mangrove forests that offer protections from rising seas and storm surges is two to five times cheaper than building engineered structures like underwater breakwaters,[125] while also storing carbon and improving water quality and local fisheries.[126,127]

Yet despite the powerful case for working with nature to reduce climate risks, the world has barely begun to realize this potential. Few governments have adopted these approaches widely, even though many cite natural solutions in their NDCs. And only 3 percent of nearly 2,000 companies reported using natural ecosystems as part of their climate adaptation strategies.[128] The barriers include lack of awareness of the critical role of natural assets in underpinning social and economic resilience and lack of accessible funds to invest in nature-based solutions. In addition, the piecemeal way adaptation is often planned and executed undervalues or ignores the many benefits of working with nature.

Humanity faces a stark choice: We can harness nature-based solutions to mitigate climate change and to better adapt—or we can continue with business as usual and lose the essential and myriad services nature provides.

**FIGURE 3.2** How Different Nature-Based Solutions Can Work Together across Landscapes to Build Resilience




*Source*: Authors.

## Accelerate Existing Action

We can start by moving faster to meet existing commitments to protect and enhance natural assets at scale, most of which are not on track. These include international commitments through the United Nations Convention on Biological Diversity (CBD), especially its emerging ambitious post-2020 global biodiversity framework. Other international commitments in need of full implementation include the United Nations Convention to Combat Desertification (UNCCD), the UNFCCC, and the SDGs; the Bonn Challenge of restoring 350 million hectares of degraded land by 2030; the Tropical Forest Alliance goal of net-zero deforestation by 2020; and the Global Mangrove Alliance's target to increase global mangrove habitat by 20 percent by 2030.

That's just a beginning, though. To take real advantage of the power of nature, we must take the following three critical steps:

## 1) Raise understanding of the value of nature for climate adaptation

**Governments and companies to identify, assess, and value natural assets for their potential to support adaptation and resilience**. Natural capital methodologies are powerful tools to help value nature's benefits, raise understanding, and inform planning processes. Expanding the evidence of what works and what does not, sharing experiences and technical know-how across sectors and professional disciplines, and considering both indigenous and scientific knowledge is also important to increase understanding.

## 2) Embed nature-based solutions into adaptation planning and policy

**Governments and companies to develop high-level spatial plans to identify strategic opportunities at larger scales and to create shared visions for climate-resilient landscapes.** Nature-based solutions often have more substantial and lasting benefits if deployed at landscape, ecosystem, or citywide scales. Broad perspectives also make it easier to plan for multiple objectives (see Case Study 3).

**Governments to adopt participatory planning processes.** As flagged in Chapter 1, participatory planning processes make it possible to develop shared goals, to coordinate action, and to build on traditional and local knowledge. For nature-based solutions, local knowledge is particularly important, especially from indigenous communities that have adaptive capacity embedded in their traditional knowledge systems. Participatory planning also helps ensure that interventions do not undermine land and resource rights of rural populations (see Case Study 4).

CASE STUDY 3

### Planning with Ecosystems

China's Ecological Redlining Policy uses a rigorous science-based process to identify priority areas for biodiversity conservation, ecosystem services management, and disaster risk reduction.[129, 130] About a quarter of the country is to be put under a high degree of protection to build the resilience of critical natural assets.

Mexico has identified and designated water reserves in more than one-third of its river basins, covering nearly 50 million hectares. A mix of protected areas and wetlands, these reserves can help maintain adequate downstream flows and protect the water supply for 45 million people in a changing climate.[131]

The Great Green Wall Initiative in the Sahel and West Africa, with catalytic funding from the GEF, applies a landscape approach to improve sustainable land and water management—such as restoring 15 million hectares in Ethiopia and planting 11.4 million trees in Senegal—across 21 African countries.[132]

CASE STUDY 4

### Participatory Planning in Indonesia

The benefits of participatory planning are well illustrated on the coast of northern Java, Indonesia. In Demak district, by planning and working together, diverse stakeholders have restored a 20-km belt of coastal mangroves, introduced sustainable aquaculture, and reduced groundwater extraction. The resulting increased protection from coastal flooding and improved aquaculture productivity have increased resilience for 70,000 people, with additional carbon storage, biodiversity, and fisheries benefits.[133]

**Nature-based solutions often have more substantial and lasting benefits if deployed at landscape, ecosystem, or citywide scales.**

## 3) Increase investment in nature-based solutions

**National and local governments to reorient policies, subsidies and investments, including developing programs to better mobilize private sector support.** Only the public sector can align land-use regulations, infrastructure investments, and fiscal policies around natural environment objectives. The example from Canada (see Case Study 5) illustrates types of public-sector interventions. Private sector businesses should also be brought in as partners when investments can bring returns. Examples include payments for ecosystem services (PES), green bonds, resilience bonds, insurance schemes, and water user fees. Costa Rica has successfully deployed PES schemes to conserve natural assets, while Washington, DC, has attracted private capital to reduce flooding by restoring wetlands.[134]

**Developed countries and development agencies to increase resources and technical assistance for developing countries to support nature-based adaptation measures at scale.** Access to such funding should not be limited to national-level authorities but should also be devolved to local communities in ways that minimize any gender-based barriers to access.

CASE STUDY 5

### Financing Nature-Based Solutions

Canada's CAN$2 billion (US$1.6 billion) Disaster Mitigation and Adaptation Fund (DMAF) enables communities to better manage risks from natural hazards like floods, wildfires, and droughts through investment in natural and constructed infrastructure. One CAN$25 million (US$20 million) investment is restoring saltmarshes and improving dykes along the Bay of Fundy in Nova Scotia. The project will reduce coastal flooding for tens of thousands of residents and businesses, world heritage sites, indigenous communities, and more than 20,000 hectares of farmland.

Saltmarshes along the Bay of Fundy in Nova Scotia, Canada.

# CHAPTER 4: WATER

## The Challenge: Increasing Floods, Droughts, and Water Scarcity

The world is already facing daunting challenges managing this precious resource and ensuring that people, crops, and the environment have the water they need. Crucial water supplies, like aquifers and lakes, are shrinking or increasingly polluted. Floods and droughts cause damages in the billions of dollars and take a huge human toll, in particular on women and girls.[135] Nor does it help that water is now grossly mismanaged in many areas—wasted in inefficient irrigation systems, poorly allocated, and lost in aging, leaky water mains.

On top of all of these issues come the potentially devastating impacts of climate change, which will largely be felt through their effects on water. By 2050, the number of people who lack sufficient water at least one month per year will soar to more than 5 billion, from 3.6 billion today,[136] causing unprecedented competition for water. This competition will in turn fuel regional conflicts and migrations, tearing the already frayed fabric of society, especially in developing countries.[137]

At the same time, climate change has already begun increasing the number and severity of storms. Tomorrow's storms will overwhelm stormwater systems, send rivers spilling over their banks, trigger landslides, and wash away entire communities, increasing flood risks for fully half of the planet's population.[138] Coastal cities and communities—home to one-tenth of the world's population—and small island states are particularly vulnerable, facing the triple threat of more floods, rising seas, and higher storm surges.

We are woefully unprepared for this new reality. Everything from levees and irrigation systems to water management plans and allocations is based on yesterday's climate. But the future will be very different from the past. Successful adaptation requires a fundamental transformation in how water is managed, just as successful mitigation demands a complete transformation of the energy system. Without such a transformation, violence, civil war, and mass displacements could increase—and people in poverty now, who are more likely to rely on rainfed agriculture and to live on the most marginal lands, will suffer the most.

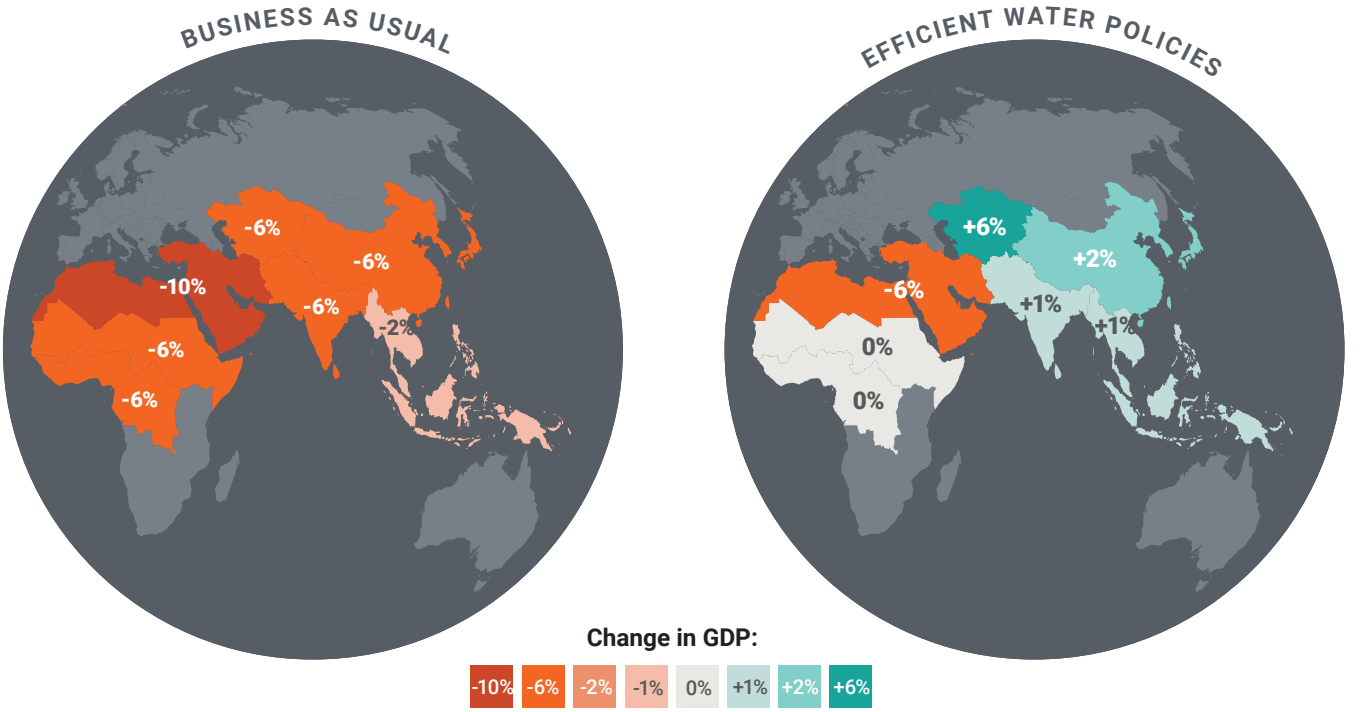
## The Way Forward: Manage Water Better

Adapting the planet's water resources and systems to the new climate reality is a formidable task. But it also offers opportunities—to improve ecosystems, grow economies, boost agricultural efficiencies, and tackle huge problems, like inequity. To adapt right and to realize those opportunities, the following four key actions, and specific steps under each action, are critical:

### 1) Harness the power of nature and expand water infrastructure

**Governments to invest in healthy watersheds.** Wetlands, upland forests, and other crucial ecosystems, including 90 percent of the watersheds for large cities, are in serious trouble.[139] That is compromising water security, increasing pollution, and raising the cost of water. A vital first step, therefore, is reversing the current degradation of these areas through new investments and better policies. Such actions would bring major ecosystem benefits, including more reliable water supplies and reduced flood risks. In Chile, the Santiago Water Fund is an innovative public-private partnership working to protect 80 percent of the city's freshwater by securing new investments in conservation, natural infrastructure, and restoration in the Maipo River basin.

**FIGURE 4.1** Effects of Water Allocation Policies on GDP in 2050, Taking Climate Change into Account




*Note*: The left map shows change in GDP in 2050 assuming current water allocations remain unchanged. The right map shows change in GDP in 2050 assuming 25 percent of the water is reallocated to higher uses. Both maps take climate change into account, using a combination of optimistic (SSP1) and pessimistic (SSP3) scenarios used by the IPPC.
*Source*: Authors, adapted from World Bank, *High and Dry* (2016).

**Governments to enhance and expand water infrastructure.** To ensure that people have the water they need in an uncertain world, water resource agencies and utilities should consider building or improving multipurpose reservoirs, creating interconnected regional water systems, and enhancing groundwater recharge.[140] They may need to explore new sources of water like wastewater reclamation or desalination plants. And to better protect communities, governments may need to invest in new and upgraded flood infrastructure, such as embankments, drainage canals, stormwater systems, and retention facilities. The Republic of the Marshall Islands, with support from the Green Climate Fund, is investing in water infrastructure to secure year-round access to safe freshwater. This follows a severe 2015–16 drought that cost the country roughly 4.5 percent of its GDP.[141]

## 2) Cope with water scarcity by using water more productively

Vast amounts of water around the world are wasted through inefficiencies, with some of the worst problems in countries that are the most water-scarce.[142] Taking advantage of opportunities to save water and use it more productively promises quick and major gains and is essential to address the increasing stress that climate change will impose. Figure 4.1 illustrates the improvement in GDP in 2050 assuming 25 percent of water is reallocated to higher uses.[143]

**Government agencies to reallocate water to society's highest priorities.** Water-resource agencies must develop fair and transparent mechanisms to guide reallocation to higher-value uses and provide the flexibility to deal with climate uncertainties. Such reallocation can be accomplished through

administrative decrees or economic instruments such as tradable water rights. Safeguards are required to ensure that people—especially people living in poverty, women, and girls—and ecosystems have the water they need to thrive.

**Cities to become water-smart.** Already, 14 of the world's 20 megacities face severe water shortages that threaten economic productivity and quality of life.[144] Water utilities and their regulators can make the available water go further by reducing demand through appropriate pricing and incentives for conservation. They also can increase the effective supply by fixing leaky water mains, by reclaiming wastewater and stormwater, or by desalinating seawater using renewable energy. Wastewater treatment also helps protect public health and protect scare water resources by improving water quality. (See Case Study 6 for an example of water-smart planning in action.)

**Farmers, with the help of agricultural ministries, to use water more efficiently**. Irrigation modernization, including using new techniques such as just-in-time irrigation, coupled with climate-appropriate agricultural policies, can slash the amount of water needed in agriculture, which now accounts for about 70 percent of global water use. This can be done while also increasing yields.

CASE STUDY 6

## Room for the River in the Netherlands

Instead of building higher and higher levees, the Netherlands adopted a "Room for the River" strategy, founded on the principles of water safety and spatial quality. The idea is to live with the water instead of fighting it: The strategy gives water more space to spread out when floods occur, reducing damage and loss of life. The country moved dikes inland, widened rivers, raised bridges, dug flood channels, and added river catchment areas. New parks, public infrastructure, and recreational spaces were also created. Now the Rhine River can safely carry 1,000 cubic meters of water per second more than it could before.[145] "Working with nature is getting more and more support these days and I think rightly so," said Willem Jan Goossen of the Dutch Ministry of Infrastructure and Water Management in a 2018 interview. "If you keep your floodplains and protect them as they are, you can still maintain your economic development while being flexible and resilient in dealing with the risks."[146]

CREDIT: ROBERTO MALDENO/FLICKR

Nijmegen River Park in the Netherlands, part of the country's Room for the River project.

## 3) Prepare for a changing climate by planning for floods and droughts

**Since the future will not be like the past, water resource agencies to take new climate risks into account at every level of planning and operations**. Planning can be improved via closer collaboration with meteorological and disaster-management agencies. Water agencies have roles to play during emergencies as well: They can retain floodwaters in reservoirs to the extent possible to both minimize downstream damage and prepare for future droughts, and they can increase their ability to tap into groundwater in the case of drought emergencies.

**Government agencies to build better water-monitoring systems.** Managing water effectively requires enormous amounts of information and analysis. Meteorological, water resource and environmental agencies thus should develop ground- and satellite-based monitoring systems, coupled with advanced hydro-informatics, to provide enhanced weather, flood, and drought forecasting, to monitor environmental conditions and improve water management. They should also strengthen collaboration with civil society actors to ensure community-level action in response to emergency warnings.

Detail of a drip irrigation system in an agricultural training center in Kenya. Drip irrigation is an example of a more water-efficient farming practice.

## 4) Improve water governance and scale up financing

Countries that take seriously water management in the face of climate change make it a top national priority, backed up by major investments.

**Countries to improve water governance**. Political leaders are responsible for creating policies and organizations that embody three key elements. The first is collaboration among government agencies and active participation by the private sector, civil society, and the public. The second is capacity to develop and implement good planning and regulatory regimes. The third is supporting water security in transboundary waters through cooperation among states based upon agreements and joint management bodies.

**Governments to boost financing**. Current investments fall far short of what's needed. The OECD estimates that spending must climb threefold just to meet sustainable development water supply and sanitation goals.[147] Governments should arrange for major increases in financing. Investments in stormwater management, infrastructure to reduce flood and drought risk, and ecosystem protection should be primarily borne by governments, since healthy watersheds and flood control are essential public goods. Investments in better water delivery systems should be borne primarily by users, albeit with some government support or the use of social tariffs to help ensure access by people in poverty.

The adaptation recommendations in this chapter show that our water systems can be transformed to ensure water security and meet our SDG goals; however, this is only possible with good governance and the right kinds of investments.

# CHAPTER 5: CITIES AND URBAN AREAS

## The Challenge: Cities and Vulnerable Populations at Grave Risk

Climate change is already bringing more damage, stresses, and suffering to the world's cities,[148] home to more than half the global population.[149] Droughts are causing the water taps in Mexico City to run dry, forcing millions of people to pay many times more for tanker truck water deliveries. Heat waves have struck cities from India to Europe. Torrential rains have triggered killer landslides in La Paz and Durban, while fierce storms and floods have destroyed factories in the Chinese cities of Guangzhou and Dongguan and brought New York City subways to a halt.

Without a determined effort to adapt to these impacts, the economic toll and human pain in cities will inevitably climb—sometimes dramatically. The double threat of rising seas and greater storm surges alone could force hundreds of millions of people from their homes in coastal cities (Figure 5.1), with a total cost to coastal urban areas of more than $1 trillion each year by midcentury.[150]

These impacts imperil people's quality of life and the economic vibrancy of cities, which produce more than 80 percent of global GDP. And they make it even harder to tackle the persistent issues that cities already face, such as poverty, homelessness, and social inequality. More than 880 million people now live in informal settlements where opportunities are few and access to basic services like electricity, basic healthcare, sanitation, education, and clean water is scarce to nonexistent.[151] The needs of women, especially women in poverty, tend to go unrecognized, leaving them increasingly vulnerable and further behind educationally, economically, and politically.

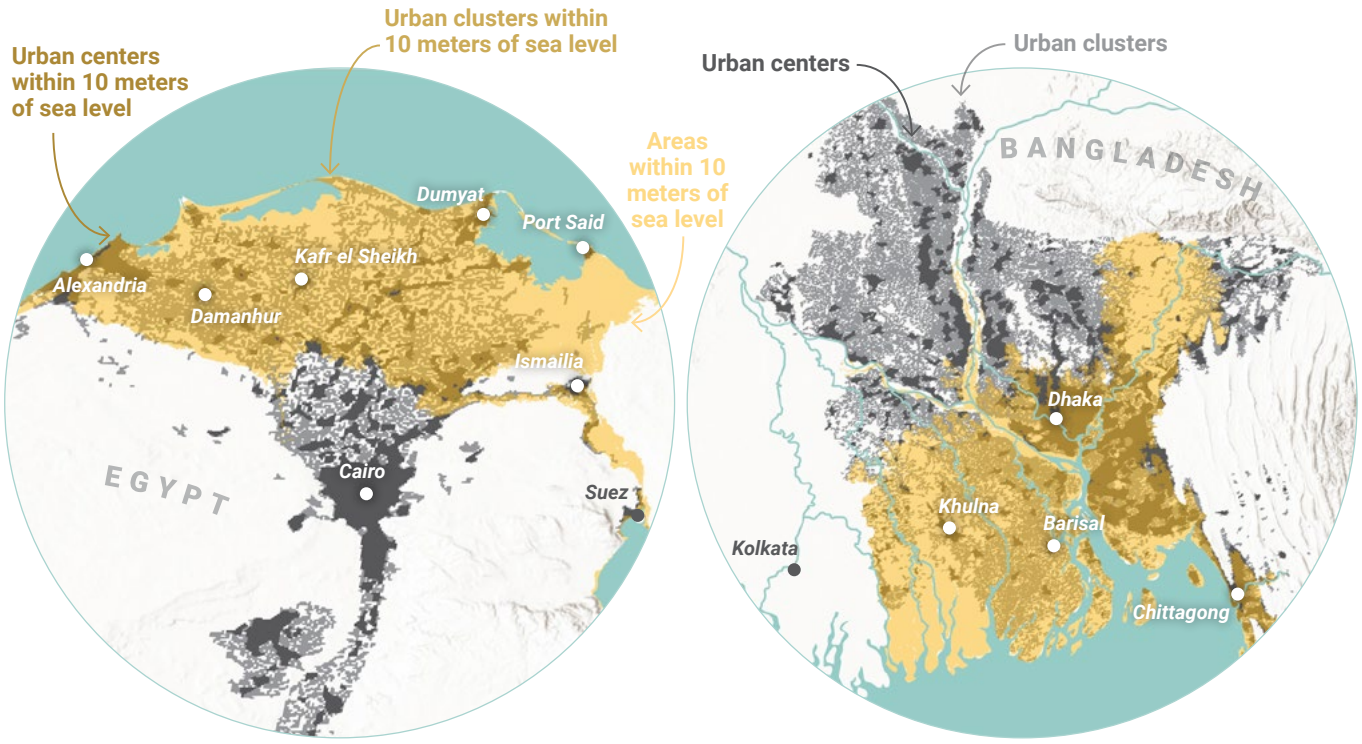
Moreover, in their rush to grow, many cities have been relentlessly stripping away or building over floodplains, forests, and wetlands that could have absorbed stormwater or offered respite and precious water during heat waves and droughts. In several coastal U.S. states, for example, the highest rates of home construction since 2010 have occurred in flood-prone areas.[152] As a result, more and more people are in harm's way all over the world, especially in rapidly growing, under-resourced cities in developing countries that have limited capacity to adapt to climate change.[153]

The challenges are enormous, but cities have no choice but to innovate and adapt if they are to continue to thrive in a warming world.

## The Way Forward: Building More Resilient and Equitable Cities

Cities are places of constant change and renewal, with action at all levels, from grassroots community groups and private actors to city planning departments, regional, and national agencies. Adaptation efforts can take advantage of this transformative energy. Done carefully, through mobilizing resources, harnessing synergies between climate adaptation and mitigation, and simultaneously tackling persistent problems like poverty, inequality, and basic infrastructure deficits, adaptation efforts can put cities on a stronger, safer path that offers economic opportunities and higher quality of life for all. We recommend the following four crucial steps, each with detailed actions, to make cities more inclusive and climate-resilient:

**FIGURE 5.1** Large Portions of Major Urban Areas Are in Low-Elevation Coastal Zones



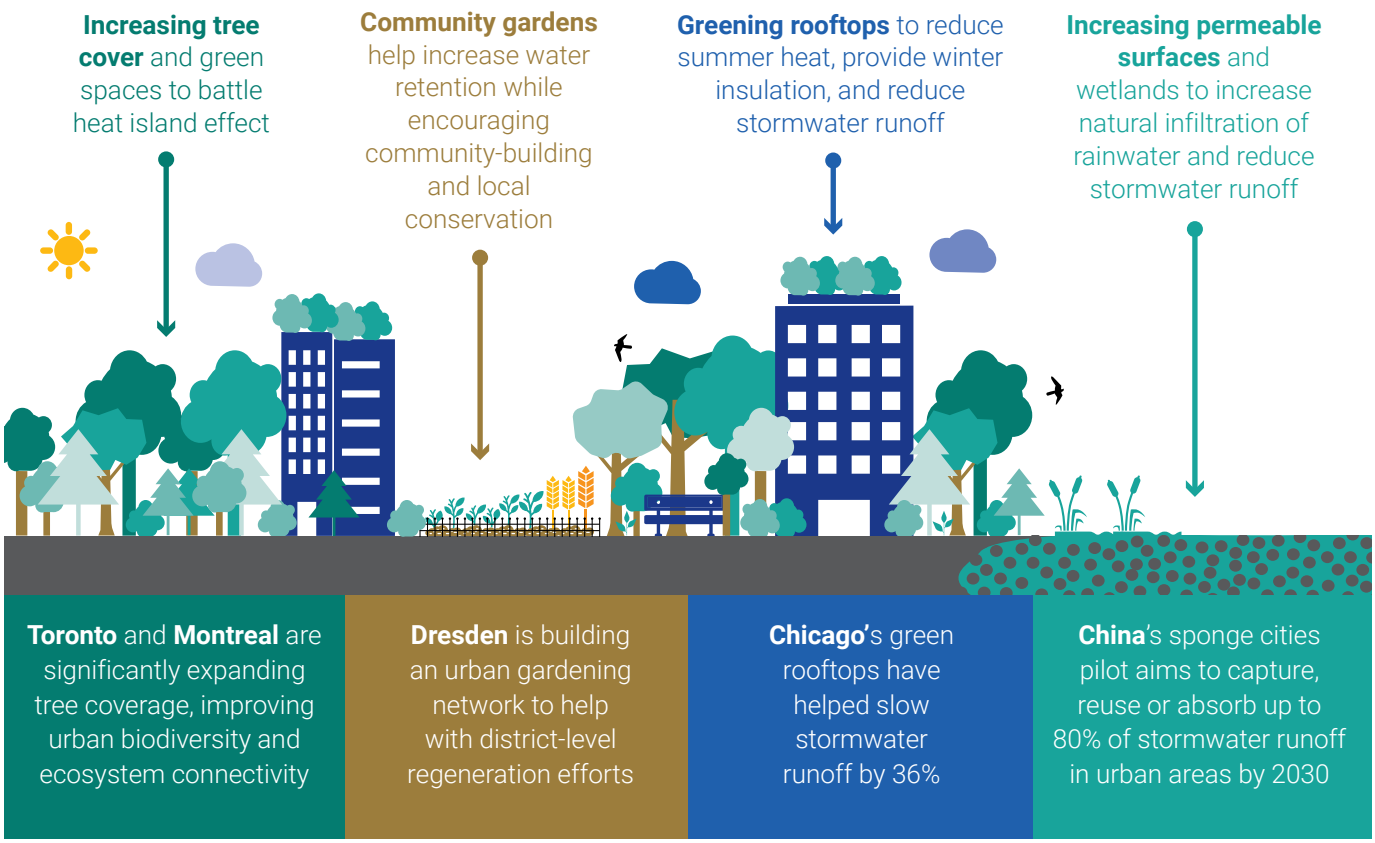

*Note*: "Urban centers" are cities and large urban areas; "urban clusters" are towns and suburbs or small urban areas.
*Source*: Center for International Earth Science Information Network (Columbia University), CUNY Institute for Demographic Research (City University of New York), and the Institute of Development Studies. 2019. For the Coalition for Urban Transitions and the Global Commission on Adaptation.

## 1) Mainstream information on climate risks in the planning and delivery of urban services, while strengthening local capacity

**Knowledge providers to make the latest modeling technologies and credible data on climate risks available to cities and communities.** Many cities in the developing world currently lack even basic floodplain maps that are crucial to adaptation efforts. All cities urgently need updated topographic maps, along with weather and climate information, satellite, and remote sensing data; models that reveal risks of climate impacts to local areas; and assessments of the vulnerabilities for specific population groups, such as women and people living in poverty.

**City governments and private actors to build capacity to use this information in order to drive integrated urban planning, investments, and operations and reduce climate risks.** Cities can select safer ground for neighborhoods or factories, for instance, as Surat, India, did by relocating key industry clusters away from flood-prone zones.[154] They must also ensure that new buildings and other infrastructure are designed—and existing infrastructure is retrofit—to better withstand predicted climate impacts. Docks and wharfs can be raised to stay above rising seas, for instance. More powerful pumps can be installed in underground public transit stations and tunnels, pavements and open space can be designed to soak up more stormwater. Disaster preparedness and response systems can be made an essential part of designs and operations. All these actions typically require more resources, and too many

**FIGURE 5.2** Urban Planning with Nature-Based Solutions for Adaptation




*Source*: Authors, based on Chu, E., Brown, A., Michael, K., Du, J., Lwasa, S., and Mahendra, A. 2019. "Unlocking the Potential for Transformative Climate Adaptation in Cities." Washington, DC: Global Commission on Adaptation and World Resources Institute.

city governments have very limited investment and technical capacity. None of these steps are easy, but they offer major payoffs in future losses avoided, greater economic returns, lower infrastructure maintenance costs, and longer building and infrastructure lifetimes. In coastal cities, for instance, the annual cost of global adaptation is one-tenth the total cost of no action.[155] Adaptation action in cities can even mitigate climate change. Better public transit infrastructure can both improve resilience and cut carbon emissions, for example, and make it possible to connect low-income urban dwellers—who increasingly live in women-headed and minority households[156]—to better jobs.

**City officials to coordinate across agencies, sectors, and levels of government.** Cross-sectoral approaches are the best way to enhance resilience in cities. For example, against a backdrop of decreasing water availability and predictability in many cities, integrated planning of water use across residential, industrial, energy, agricultural, and other sectors is essential. A single extreme event can lead to cascading hazards and a breakdown of a city's infrastructure. Climate adaptation and disaster risk reduction in urban areas requires providing weather, climate, hydrological, and related environmental services and information in an integrated way, tailored for each city. The Surat Climate Change Trust in Surat, India, for example, was born out of the realization that more than a dozen different agencies and institutions had a share of the overall flood-management responsibility for the city—and that successful adaptation required city officials, natural resource authorities, and state disaster management authorities to work together.[157]

## 2) Harness the power of nature to respond to both water and heat risks

**Cities, regional agencies, and water utilities to adopt integrated approaches that together address flood and heat management, and protection of water sources**. As Chapter 3 describes, green roofs and greater tree cover can cool cities and reduce energy use, and wetlands and forests can temper floods and increase water supplies by protecting water sources (Figure 5.2). In many cases, these and other nature-based solutions are remarkably cost-effective: In São Paulo, for instance, the reduction of sediment flow from restoring 4,000 hectares of forests near the city's watershed was estimated to be $4.5 million cheaper than the cost of dredging reservoirs to improve urban water quality.[158] But since ecosystems such as watersheds typically extend well beyond urban boundaries, cities must coordinate across jurisdictions. That's what the city of Durban, South Africa, did with a transmunicipal partnership that addresses water security problems in the Umgeni River catchment, while also improving water and sanitation access to underserved and periurban areas and experimenting with graywater reuse techniques.[159]

## 3) Build climate resilience by upgrading living conditions in vulnerable communities and informal settlements, drawing on community knowledge

**City governments to strengthen the adaptive capacity of vulnerable and informal communities.**[160] Climate risks disproportionately affect people living in poverty, many of whom live in underserved informal settlements. These communities are often at risk for flooding or landslides,[161] are susceptible to extreme heat, and have little or no political voice in cities. Improved housing, water, sanitation, drainage, and waste management can improve health and increase informal workers' productivity, while building resilience. The Asian Coalition for Community Action (ACCA) program has supported such community-led improvements in more than 2,000 informal settlements in 207 cities and 18 countries.[162] Deficits in basic infrastructure in many cities require significant investment in climate-resilient trunk infrastructure (e.g., water mains, sewerage lines, electricity grids). Ideally, community-led upgrading efforts can connect to this, but many city governments lack adequate resources and would benefit from technological innovations. Partnerships between city governments and informal communities, as seen in numerous cities across Africa and Asia, help build solutions.

**City decision-makers to tap into citizen knowledge and experience, especially from people who are marginalized, to support more inclusive climate adaptation strategies.** To redress development inequalities and reduce poverty, adaptation must tackle head-on the issues of economic, social, and political marginalization in urban areas. Because accurate information on informal settlements and climate impacts is often lacking, many actions, when taken, are ineffective or make things worse. City governments thus must do more to engage vulnerable communities in improving resilience, as in the "Know Your City" Initiative, where residents of informal settlements help gather data to understand climate risks and prioritize upgrading investments (see Case Study 7 for another example).[163]

**CASE STUDY 7**

### Building Resilient Homes in the Philippines

In 2009, when Typhoon Ondoy hit the Philippines, 40,000 people were living in informal settlements along the Manggahan Floodway. Lives and property were lost. In the aftermath, people living in the informal settlements worked with decision-makers to advocate for their rights to housing and began designing their own climate-resilient homes. After years of community-based planning and negotiation, construction began. The climate-resilient design incorporates things like disaster-resilient materials and elevated water tanks. So far, 480 families have moved in; when complete, the project is expected to have 900 units. "We believe in order to be a resilient community, the people should have the capacity to organize with government stakeholders," said Bryan Carlo R. Teodosio, an organizer with Community Organizers Multiversity who worked with informal settlements on the project. "They need to be consulted at all levels."[164]

## 4) Increase climate-resilient investments and capture value from adaptation benefits

**International financial institutions, donors, and the private sector to step up finance for urban adaptation, and to prioritize valuing and incentivizing such investments**. Less than 5 percent of global climate adaptation finance between 2010 and 2014 was spent on cities.[165] Given the limited fiscal authority of many cities, more concessional financing is needed, with greater coordination across international financial institutions to reduce the transaction costs for cities. Partnerships in technical assistance play an important role; for instance, project preparation facilities by NGOs and other agencies have helped governments design adaptation initiatives as a well-sequenced bankable portfolio of projects.[166]

**National governments and national development banks to encourage urban adaptation, because many cities depend heavily on national transfers and policies**. In Kenya, for example, the 2016 Climate Change Act required all county governments to integrate climate action into development plans that have lasting impacts on Kenyan cities.[167] The Danish government similarly required municipalities to integrate climate risk data and adaptation strategies into development plans, while also creating mechanisms for water utilities to fund investments in enhanced stormwater management infrastructure.[168] The Smart Cities Mission of India encourages climate-friendly solutions for area-based development and citywide infrastructure projects by harnessing technology in a way that encourages economic growth, improves quality of life, and reduces vulnerability to disasters.[169]

**City governments to share the value created from adaptation investments with private real estate developers and infrastructure providers, while ensuring that benefits are distributed equitably**. Public investment in adaptation can generate significant value, instead of just averting losses, and can pay for itself. A study in New York City found that a combined green-gray infrastructure approach would meet stormwater targets more cost-effectively and attract more private investment, relieving pressure on the city's budget.[170] Cities should work with the commercial development industry to ensure that governments can capture a portion of this value, which can be recycled into more adaptation investments. Cities must also find ways to generate local financing for adaptation investments. Developed cities will need more sophisticated taxation and value-capture measures with relevant insurance schemes. Developing cities must strengthen land management systems and invest strategically in resilient infrastructure for greater returns.

Given the diversity across cities, the above four steps and the actions within them need to respond to the very different levels of technical and financial capacity in cities.

CREDIT: UN PHOTO/KIBAE PARK

An informal settlement in Hanoi, Vietnam.

# CHAPTER 6: INFRASTRUCTURE

## The Challenge: Inadequate Infrastructure and Increasing Vulnerability

All around the world, much of the infrastructure[171] that we depend on is crumbling, aging, or simply missing. Chunks of concrete have fallen on cars from deteriorating bridges in Massachusetts and California, dams in Brazil have failed, and one-third of Germany's rail bridges and half of London's water mains are more than a century old.[172] Even worse, almost 1 billion people lack the lifeblood of the modern global economy—electricity—and 4.2 billion are forced to live without safely managed sanitation.[173]

Tackling these infrastructure challenges will require significant investment. Simply repairing bridges, roads, ports, sewers, runways, and other vital public works in the United States will cost an estimated $4.5 trillion.[174] Many trillions more are needed to build the new electricity grids, public transit systems, and other facilities that are crucial to raising living standards around the world, particularly in developing countries, and to upgrade existing systems—while also cutting carbon emissions to fight climate change.[175] But the costs of failing to meet these challenges are even higher. Without reliable power, water, transportation, sanitation, and other basic infrastructure services, economies will shrink, whole countries will fall behind, diseases will take a larger toll, and persistent problems like poverty and inequality will be harder to solve.

On top of all these existing problems come the growing impacts of climate change. More extreme floods are washing out bridges and overwhelming sewage treatment plants. Heat waves are buckling roads and forcing power plants to shut down, while rising seas threaten ports and coastal airports. These impacts and others already are causing $29 billion[176] per year in direct damages to transportation and power generation in developing countries. In Europe, the toll could soar 10 times by the end of the century in the absence of adaptation measures under some scenarios.[177] In Africa, declining water flows could cut revenues from hydropower generation by up to 60 percent, causing energy prices to jump threefold.[178] And in the Arctic region, 70 percent of current infrastructure (including 100 airports or airfields and 13,000 km of roads) may be threatened by permafrost thawing by 2050.[179]

Moreover, every bridge failure or power generation glitch sends ripples of indirect impacts throughout the economy that can be many times greater than the direct damages. People may be unable to get to work. Food may rot before it reaches the market. Industry supply chains may be cut, and factories may have to slow production or shut down. For example, Typhoon Mangkhut in Asia brought major logistics hubs and the ports of Hong Kong and Shenzhen to a standstill and disrupted 6,500 supplier sites; and Hurricane Florence in the United States caused an estimated $24 billion in losses in industries from aerospace to pharmaceuticals.[180, 181] The economic costs of infrastructure disruptions can far exceed those of direct flood damages. Modeling shows that if a major flood were to strike Paris, up to 85 percent of business losses would come from electricity and transport disruptions.[182] In low- and middle-income countries, infrastructure disruptions already cost households and businesses $391–$647 billion per year, much of it caused by current climate variability.[183] These impacts are not just financial: more people will suffer or die if they can't get to the hospital. As the hazards from climate change increase, so will these indirect impacts.

The greatest burden from these impacts often falls on those who are socially excluded or disadvantaged. Some groups are vulnerable because they already lack adequate flood defenses, clean water, or other vital services. Many have fewer resources to cope when disasters and disruptions do occur, have less voice in shaping infrastructure services, and often

are the last to see repairs and upgrades. When water pipes fail, for instance, it is usually women who must walk the extra distance to fetch the family's supply.

But if the twin challenges of inadequate infrastructure and growing climate impacts are formidable, they also present a major opportunity. Countries will be investing trillions of dollars a year repairing, replacing, and building infrastructure no matter what the future holds. Yet most current investments fail to take the impacts of climate change into account, even when they are made in areas highly exposed to those impacts.[184] Since bridges, sewers, and other structures will be in service for many decades, these unfortunate decisions are locking in increasing vulnerabilities and making it difficult and expensive to adapt in the future.

The much better choice is to build the new highway bridge higher and stronger and to locate assets away from exposed areas (see Figure 6.1). Improving the resilience of infrastructure systems through repairs and new construction creates safer communities and stronger economies in a warming world, and pays for itself many times over. Studies show that a slight increase in upfront costs (3 percent for transport projects)[185] can unlock benefits that are several times greater than those incremental costs.[186] Meanwhile, innovative approaches can improve access of underserved communities to electricity, water, sanitation, and communications, as well as improve network resilience (see Box 5).

**BOX 4**

### Innovative approaches to sanitation

The development and adoption of self-contained toilets and waste processing technologies—such as the reinvented toilet—that kill pathogens and do not require running water, sewers, or treatment plants are a catalytic solution to the global sanitation crisis. Conventional sewer sanitation is not likely to be the most sustainable or affordable solution for all urban, let alone rural, areas. Scaling up new technologies can help preserve water and protect human life in regions that are predicted to bear the brunt of the environmental, health, and economic effects of climate change.[187]

**FIGURE 6.1** A Systems Approach to Strengthening Asset and System Resilience


*Source:* Authors.

# The Way Forward: Integrating Climate Resilience into Infrastructure

The central message of this chapter is simple: Climate resilience needs to be integrated into all infrastructure assets and systems throughout their lifecycles. This requires the engagement of the appropriate public institutions and agencies, with national policies to support local action. Developers, operators, owners, data providers, and communities all have vital roles. Significant additional public and private investment will be required.

We recommend the following four critical steps to ensure that we have the infrastructure needed for a changing climate:

## 1) Undertake inclusive and climate-informed planning for new and existing infrastructure

**Governments, development agencies, and the private sector to collaborate to strengthen knowledge and capacity for managing climate risks**. In many countries, the data needed to understand climate hazards and exposure are lacking. Investments in data and tools provide widespread benefits, underpinning climate-informed decisions. Increased peer learning between infrastructure sectors and across countries is needed to generalize emerging good practices. Concerted capacity-building, particularly at the local level, is needed to move from improved information to better decisions.

**Infrastructure asset owners to assess and manage climate risks to those assets**. Risk assessments can reveal vulnerabilities and make the case for investments to reduce risks. This can also support reporting in line with the recommendations of the TCFD. In some cases, minor physical enhancements can be made to improve resilience to impacts like flooding, drought, fire, disease, or wind, such as moving backup generators out of easily flooded basements. Resilience can also be enhanced through operational changes, such as improved monitoring and strengthened business continuity management (see Case Study 8).

CASE STUDY 8

### Using Data to Identify Infrastructure Risks

Endeavour Energy owns, manages, and operates a distribution network supplying electricity to 2.4 million people in Australia. Endeavour Energy uses a geographic information system (GIS) that includes the location and layout of assets and other geographic features. The GIS forms part of Endeavour Energy's maps that identify those assets in bushfire-prone areas and enables more efficient and effective management of vegetation near power lines to minimize outages.

**Governments to use strategic planning to create and finance more climate-resilient infrastructure systems**. These plans should be designed to perform well across a range of future scenarios, informed by robust risk assessment. This helps to identify critical assets and prioritize investments in new or retrofit infrastructure. One example is Curaçao, which has developed a long-term infrastructure plan designed to quickly provide benefits for people and the environment, while also preparing for long-term adaptation to sea level rise.[188] Planning should reflect the different priorities for infrastructure services among communities being served and designed to overcome historical disparities in access. Planning should also be designed to provide flexibility over time (see Case Study 9). These plans should explore the range of potential public and private revenue sources, including innovative tools such as land value capture. The aim is to identify a sequenced, coherent portfolio of projects, supported by a viable financing strategy.

## 2) Mandate climate-resilient design

New infrastructure assets should be designed to withstand projected climate impacts and ensure environmental sustainability for lifespans that will often be 40 years or more. Incentives fostering design innovations should be promoted.

**Governments to develop and update national technical codes and standards to account for physical climate risks, adapting international best practices to local conditions**. So far, only 5 of the 35 OECD countries have revised at least one code to account for climate risks.[189] Developing countries face the further challenge that their standards are often taken from other countries, without being adjusted for national circumstances. Concerted efforts to develop nationally appropriate,

CASE STUDY 9

### Investing in Climate-Resilient Infrastructure

Canada's latest infrastructure investment plan emphasizes building resilience through the use of both constructed and natural infrastructure—from seawalls and roads to natural shorelines and wetlands. The Investing in Canada Plan commits CAN$22 billion (US$17 billion) for green infrastructure investments—including ones that will boost resilience to the impacts of climate change.

The Republic of the Marshall Islands, meanwhile, is working with the World Bank to improve the resilience of maritime infrastructure. Communities in the Marshall Islands depend on transport by boat for everything from education to health services: protecting docks and ports from climate impacts is vital. The project includes a contingent emergency response component (CERC) that enables funds to be quickly reallocated in response to emergency events.

climate-resilient standards, and to translate those standards into action on the ground, are needed.

**Public and private investors to screen all significant new and retrofitted infrastructure projects to ensure that they are resilient to climate change**. Canada, the European Commission, and the multilateral development banks (MDBs) have been pioneers in integrating consideration of climate risk into decision-making, but, overall, national governments and the private sector are lagging behind.

## 3) Mobilize private sector investment in resilient infrastructure

Eighty percent of private investors want to increase their infrastructure investment within the next five years,[190] but the investments will not occur without sufficient revenue streams. The recommendations in the Finance chapter (Chapter 8) underscore the need for action to mobilize finance for resilient infrastructure. In addition, policies or incentives are needed to mobilize investments in resilient infrastructure, since areas with the greatest need for such infrastructure will often be perceived by private investors as being risky. Public funding will, however, continue to play an essential role.

**Governments and public finance institutions to reduce the real or perceived risks to investing in resilient infrastructure**. Improvements to the policy environment for investment can reduce the risks faced by investors. Where suitable revenue streams can be established, public and private funding can be combined using blended finance. Public finance also can help reduce risks with concessional tranches in the capital structure of the asset. These can take the form of equity grants for project development, first-loss guarantees, credit guarantees, or capped returns. Public finance institutions, including the MDBs, can also provide technical expertise in the management of climate risks to reduce the riskiness of private investment.

**Governments to explore the use of new financing models**, such as land value capture, that can create new revenue streams for resilient investments.

**Governments to ensure that their direct procurement of infrastructure, and the economic regulation of privately owned utilities, supports resilient options**. In particular, the assessment processes should consider the likely lifecycle costs of different options, rather than focusing on the upfront costs, and should provide flexibility for innovative approaches, including the use of nature-based solutions.

## 4) Prepare financing to minimize disruption when infrastructure damage occurs

It is neither cost-effective nor technically feasible to eliminate all risks from a changing climate. It is vital, therefore, to rebuild rapidly and resiliently after extreme events. It is essential to "build back better" when replacing damaged assets, taking the opportunity to reduce hazards.

**Insurance industry, asset owners, governments, and donors to work to achieve more rapid recovery after disasters hit.** Possible strategies include combining financial reserves, providing prearranged credit, and expanding insurance. For example, Colombia has strengthened insurance coverage for new road concessions, enhancing financial protection for infrastructure.[191] Combining efforts to improve risk management in general with a specific focus on infrastructure could help increase uptake of coverage and ultimately reduce the costs resulting from related disruption. This can be facilitated by scaling up existing mechanisms, including the Global Risk Financing Facility (GRiF).

# CHAPTER 7: DISASTER RISK MANAGEMENT

## The Challenge: Preventing Hazards from Becoming Disasters

Humanity has always lived under the looming threat of nature's fury, from the floods of ancient times to dust bowl droughts and recent hurricanes. But now, an atmosphere supercharged with heat and moisture is making life even more difficult. Climate change is increasing not just the number of potentially deadly weather events but also their ferocity. As a result, existing weather records are being broken by new extremes with every passing year, like the sweltering 42.6°C July 2019 heat in Paris[192] or the staggering 1.26 meters of rain that fell in 24 hours, in April 2018, on the Hawaiian island of Kauai.[193]

And with more people in harm's way, thanks to humanity's relentlessly sprawling footprint, the loss of protective ecosystems, and myriad other factors, the potential for extreme weather to cause human disasters—loss of life and major damage—is climbing.

That's why it's so vital that the world continue to improve how it prepares for and responds to hazards, following the examples of many countries that have succeeded in reducing the toll from severe weather (as the Bangladesh example shows in Chapter 1). We know that it works to warn people about impending emergencies and to take proactive actions like moving them to higher ground in floods. These interventions for preparedness and response need to be extended and strengthened even as existing hazards such as flooding now occur in more places and with increasing intensity. But that is not enough. Such measures are also needed for hazards like heat waves and wildfires that are becoming stronger and more common. In 2003, thousands were killed in Europe during a prolonged heat wave.[194] Learning from that experience, deaths were drastically reduced in 2019 due to swift and effective preparations, even as heat records were being broken across Europe. (See Case Study 10 for more examples.)

**CASE STUDY 10**

### Protecting People from Extreme Heat

Germany and India have both responded to devastating heat waves with action plans that focus on protecting their most vulnerable citizens. After a 2010 heat wave killed more than 1,300 people, Ahmedabad, India, took quick actions: training health care staff, distributing water, painting roofs with white reflective paint (to reduce the heat in homes by as much as 5°C), and more. Thanks to this Heat Action Plan, fewer than 20 people died in a similar heat wave in May 2015.[195] Thirty other Indian cities have adopted the plan, and the Indian National Disaster Management Authority has issued guidelines based on it. In Kassel, Germany, heat warning hotlines advise elderly residents of incoming heat waves and provide recommendations to stay cool and healthy. The Hesse region even created a quality "Climate-Adapted" seal to ensure standards of "climate-fit" nursing care.[196]

But those capabilities are only a fraction of what's needed to make the world safer and stronger. Even when lives are spared, disasters such as tropical cyclones or the wildfire that incinerated the California town of Paradise are causing increasing damage to homes, businesses, and basic infrastructure like roads and power grids. Cleaning up and rebuilding in the aftermath of these disasters is an enormous and growing financial burden—a burden that may drive people into poverty.

A far more cost-effective strategy than responding after a disaster strikes is investing in adaptation measures to limit or reduce damage in the first place. Creating natural shoreline barriers or restoring wetlands can tame dangerous storm surges and floodwaters, for example. Unfortunately, prevention has received neither the attention nor the support that it urgently needs. International investment in response and reconstruction is more than 20 times larger than the support for steps to avoid damage.[197] Greater investments in effective disaster risk reduction would reduce the need for such massive investment in response and reconstruction.

Another pressing problem is the prevalence of outdated legal, regulatory, and policy frameworks. Many different government agencies may have only small pieces of the overall responsibility for preparing for and responding to severe weather events. Disaster response may not even be included in natural resource management laws and policies. Moreover, in most countries, local authorities on the front lines of disaster management lack the resources needed to carry out their vital duties.

# The Way Forward: Prevent, Protect, and Recover

These challenges point to an obvious but difficult solution: Overall, we must rapidly increase investment across the entire range of effective actions, from reducing the exposure and vulnerability of people and the natural and built environment to weather events, to recovering stronger, faster, and more inclusively after disasters occur. The starting point is to fully implement global agreements already in place—such as the Sendai Framework for Disaster Risk Reduction, which outlines the roles of governments and other public and private actors in reducing risks—while building on initiatives such as the Global Framework for Climate Services (GFCS), which seeks to make planning and policy decisions climate-informed, and the Global Facility for Disaster Risk Reduction (GFDRR), which provides knowledge, funding, and technical assistance to developing countries for reducing their vulnerability to natural hazards.

Here are the specific steps we must take:

## 1) Reduce long-term vulnerability and exposure

As the Sendai Framework recognizes—and as we outline in Chapter 1—preventing disasters by reducing multisectoral risks is the best option. Given that much of the risk arises from planning and investment decisions that shape where we live, the infrastructure we use, and the environment that surrounds us, earlier chapters in this report have outlined ways agriculture, water systems, the natural environment, cities, and infrastructure can be made stronger and more resilient in the face of climate impacts.

**Countries to develop national strategies and provide dedicated funding for disaster risk reduction**. These strategies must ensure the latest information on risk is used to guide where and how to build new communities and all other new investments in order to limit future exposure and risk. They must also make sure that no one is left behind, especially the most vulnerable.

## 2) Boost efforts to warn, respond, and protect

It is difficult in the short term to reduce the exposure of populations and assets to climate hazards. But much more can be done to improve public awareness, early warning mechanisms (including preparedness planning and last mile communications) and disaster response systems. Investments in early warning systems in developing countries have big payoffs, as noted in Chapter 1. One study estimates that modest investments of around $1 billion a year in developing countries could deliver total benefits ranging from $4 billion to $36 billion.[198]

**Governments to invest more in early warning systems and in ensuring that those warnings are heard and acted upon.** Public awareness campaigns need to better target all those who might be affected in order to improve awareness of risks and to explain what to do when disasters occur. It is also vital to invest in local capacity to act on warnings and to provide legal mandates that make it clear who has responsibility for making timely warnings and for maintaining local warning systems and equipment. Of particular importance is increasing financing for civil protection and first responders. (See Case Study 11 for an initiative that targets some of the most vulnerable populations globally.)

CASE STUDY 11

### Generating Early Warnings

Climate Risk and Early Warning Systems (CREWS) is a partnership of several international organizations (the World Bank, World Meteorological Organization, and United Nations Office for Disaster Risk Reduction) and countries (Australia, France, Germany, Luxembourg, the Netherlands, Switzerland, and Canada) that aims to saves lives, assets, and livelihoods in least developed countries (LDCs) and small island developing states (SIDS) by increasing the capacity to generate and communicate effective, impact-based, multihazard, gender-informed early warnings.

**Governments to provide warnings and partner with civil society to ensure effective responses for new and emerging risks from climate change.** While much of the world's early warning effort has been focused on storms, floods, and droughts, other hazards like heat waves and wildfires are also becoming more common and more intense. Measures like free water distribution and cooling centers have proven effective, reducing the human toll in cities like Ahmedabad, India, and Paris. Moreover, wildfires could increase the area of burned land in Mediterranean Europe by 40–100 percent across 1.5°C, 2°C, and 3°C global warming scenarios.[199] These risks and responses must be included in longer-term risk-management systems.

## 3) Increase capacities to absorb and recover from extreme events

While an immediate crisis may be successfully managed through emergency response and recovery operations, the underlying vulnerability of people living in poverty and other marginalized groups may actually increase for years to come. Moreover, disasters can drain public finances unless plans are in place to mitigate the financial shocks. Leveraging advances in predictive capabilities, forecast-based actions can enable governments and international and civil society organizations to ensure access to predictable and rapid funding before and after disasters, and to rapidly transmit it to those most affected. Governments need to shift from reacting to disasters to proactively developing preparedness plans for extreme climate events among the relevant government ministries and stakeholders including civil society organizations.

**Governments and development agencies to scale up financial solutions that reduce disaster shocks on public finances.** This requires systems (early action protocols and dedicated funding) that enable funds to flow to communities in advance of predicted shocks, instead of after they occur (see Case Study 12). Expanding domestic insurance markets for homeowners and public assets can reduce the sovereign financial burden for reconstruction, for instance. Moreover, the right blend of financial protection measures—such as catastrophe bonds, budget lines, or contingent credit—can ensure that predictable, adequate, and timely government financing is available for response and recovery. Actions that are based on accurate forecasting could be much more cost effective, significantly lowering the cost of emergency response.[200]

CASE STUDY 12

### Responding Before Disaster Strikes

Forecast-based financing (FbF) turns the standard disaster response—act after disaster strikes—on its head. Using advanced weather forecasts and a dedicated funding mechanism, FbF funnels resources to communities before extreme events hit. "With such a timely disbursal, we hope to avoid potential catastrophe before it even happens, supporting people to continue working and going to school," said Robert Kwesiga, Secretary General of the Uganda Red Cross Society (URC).[201] Uganda is one of 16 Red Cross Red Crescent societies around the world piloting FbF. Uganda has seen more frequent flooding and more severe droughts due to climate change. In the Kapelebyong Region, FbF helped more than 2,000 people protect themselves against flooding-induced waterborne diseases, and enabled URC to proactively warn residents of potential flooding in two districts.

**Governments to expand and tailor social safety nets to support both shock-response and long-term resilience.** Greater investments are needed in social protection and safety net programs, which need to be made more inclusive and responsive to shocks. With the right data on beneficiaries, existing social protection systems can be modified to provide top-up benefits in emergencies or reach a wider group of people in need. As we pointed out in the earlier chapter on food, social safety nets can be an important element of livelihood security for smallholder farmers, and similarly for urban residents living in poverty and the informal sector, as discussed in the cities chapter.

**Governments to plan for recovery and response before disasters hit.** Too often, reconstruction strategies are only considered in the aftermath of disasters, such as whether to work under existing administrative frameworks or under new approaches, or how much to use public finances for recovery in the private sector or for rebuilding citizens' homes. As these decisions take considerable time, the lack of advanced planning can substantially delay recovery and reconstruction, adding to the economic toll and human suffering. Governments therefore should carefully prepare contingency plans that enable building back stronger, faster, and more inclusively.[202] They should also update and strengthen legal and policy frameworks to ensure prioritized, coherent action that cuts across institutional silos and guarantees the role of civil society.

CREDIT: WORLD METEOROLOGICAL ORGANIZATION.

A Global Atmosphere Watch (GAW) Global station in Barrow, Alaska. GAW stations collect weather and climate data.

# CHAPTER 8: FINANCING ADAPTATION

## The Challenge: Scaling Up Investments

As we have shown throughout this report, the economic case for resilience is strong (Chapter 1), and there are strong demands for increased resources to strengthen the resilience of our economies (Chapters 2–7). Money is not flowing at the volume needed.

While previous chapters have focused on the demand side for resources, this chapter focuses on the supply side. Financial resources for adaptation investments will have to come in a coordinated manner from across the entire financial system (see Figure 8.1). While investments in adaptation have clear economic benefits, they may require large upfront payments before reaping medium- and longer-term benefits. Furthermore, many adaptation investments do not generate sufficient short-term cash flows to attract private investors. For this reason, the public sector needs to shift its focus to include both generating finance and creating incentives to scale up private sector engagement in adaptation investments.

**Special attention needs to be given to the challenge of providing vital concessional finance to developing countries that are highly vulnerable to climate change.**

## The Way Forward: A Transformation in Finance

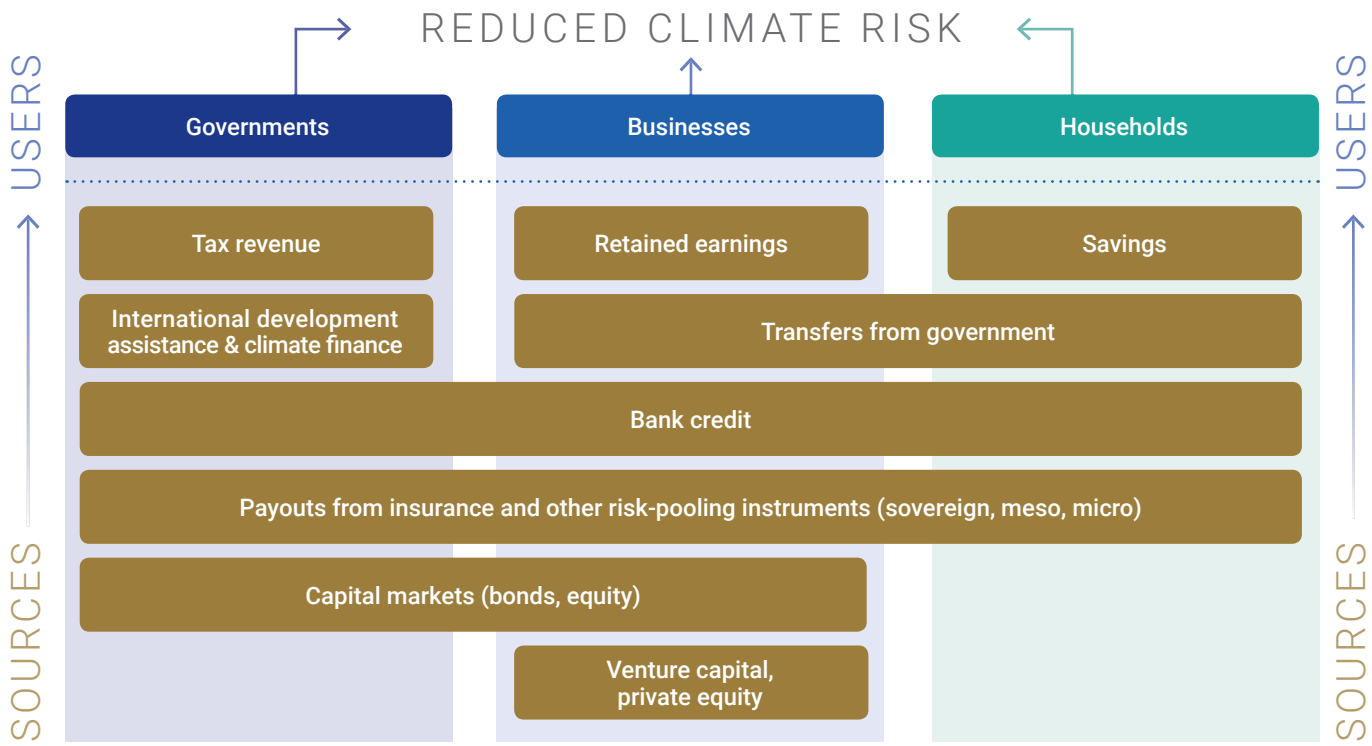
Ensuring that resources do flow will require 4 things, all of which must be undertaken simultaneously:

### 1) Shift how investment decisions get made

As we set out in earlier chapters, many improvements in adaptation and resilience will come from investments in key systems, such as water, transportation, and agriculture. However, investment decisions in both government and private markets do not yet systematically take physical climate risks into account, though they are starting to do so. As we saw in Chapter 1, efforts to take climate risk into account and to improve the pricing of climate risk will help both the public and private sectors acquire better technical and financial understanding of risk, establish priorities, shape climate-informed investments, and develop instruments to improve risk-pooling and contingency finance. Using better science and methodologies to provide information on hazards, exposure, and the vulnerabilities of people and assets can result in better investment decisions.

**Governments, corporations, business associations, and international organizations to develop and deploy tools and strategies to ensure that investment decisions are climate-informed**. Some governments, companies, and donors already systematically screen their projects for exposure to climate and natural hazards as part of standard investment appraisal in the context of a broader commitment to sustainable finance, for example.[203] This practice should become standard for all projects in both the public and the private sector. At the same time, investors should develop effective strategies to deal with emerging uncertainties associated with climate change. These include understanding "no regrets" resilience

**FIGURE 8.1** Key Sources and Users of Adaptation Finance




*Source*: Authors.

measures, decision-making under deep uncertainty,[204] physical and economic modeling, and scenario planning.[205] Promising approaches already exist and have been deployed, and these too need to be scaled up.

**The private and public sectors to improve and harmonize adaptation metrics and resilience ratings systems[206] to enable stakeholders to quantify the costs and benefits of investing in resilience and to track progress.** As we emphasized in Chapter 1, scaling up and building on efforts to take climate risk into account and to price it—including the financial, economic, and human costs of not managing that risk—will increase the supply of adaptation resources to meet the rapidly growing demand. Investments in data and downscaled information will be critical if climate is to be mainstreamed into how we make financial decisions of all kinds.

## 2) Scale up and deploy public finance more effectively

Financial authorities—typically central bank governors and finance ministers—are responsible for government financial decision-making and oversight of the financial system overall. They are beginning to show leadership in the challenging process of incorporating climate risks into both. On the public side, this responsibility extends to analyzing and managing climate risks on both the revenue and expenditure sides of national budgets. In the wider financial markets, regulators from more than 36 countries now recognize that climate change may present macroeconomic and financial-stability challenges and material risks for companies.[207] We thus make the following recommendations:

**Governments to make more effective use of their budget processes to both increase the "adaptation quality" of existing investments and to increase the amount of funding flowing to adaptation investments**. Governments should consider doing more with the resources they already have by improving the quality and impact of adaptation spending.[208] But they also should consider increasing the allocation of public resources for climate adaptation. Such efforts at increasing finance should be based on rigorous, climate-smart public investment priorities, best developed in collaboration between line ministries and finance ministries. Both traditional and innovative approaches to public finance will be needed to raise public resources for adaptation. In addition to the Fiji example of innovative fiscal policy (see Case Study 13), debt-for-climate-finance swaps have been proposed as another source of adaptation finance for national governments.[209] An example of traditional funding mechanisms involves the City of Miami, which recently borrowed $400 million by issuing new "Miami Forever" bonds for flood control and coastal protection projects.[210]

**National governments and international donors to increase the amount of devolved funding available to local actors to identify, prioritize, implement, and monitor climate adaptation solutions**. This involves enabling subnational authorities to access and deploy financing for adaptation, as well as strengthening the role that communities and households play in making investment decisions. Devolved finance should be flexible, long-term, inclusive, and transparent. Two good examples are the dedicated National Adaptation Fund on Climate Change (NAFCC) mechanism in India that has funded subnational projects[211] and Grenada's Community Climate Change Adaptation Fund, which channels small grants to community groups to implement adaptation projects.[212]

**Financial authorities, NGOs, and banks to also help improve access to financial services, especially among the estimated 1.7 billion people who still lack access**.[213] This is one of the barriers to adaptation at the household level. If structured correctly, expanded access to products such as microfinance, microinsurance, transfer and remittance facilities, and related nonfinancial support can help ensure that those most affected by climate shocks have the resources to protect themselves and recover when necessary. New innovations in digital technology are essential to expanding financial services. For example, Danish Microfinance Partners and Maj Invest are working with local communities in 15 countries to help them cope with climate impacts while increasing their access to financial services.[214]

**Developed countries and other donors to increase the amounts of international adaptation finance being provided on concessional terms**. The United Nations Environment Programme (UNEP) estimates that the annual cost of adaptation could range from $140 to 300 billion by 2030,[215] current flows of international adaptation finance fall short of the challenge. During 2015–16, global public financing for adaptation was about $22 billion per year, of which $7.4 billion was multilateral climate finance.[216] (In 2018, flows from the multilateral development banks had risen to $12.9 billion,[217] but there are no 2018 consolidated data across all flows.) Clearly, scaling up and improving access to finance for adaptation is urgent. Successful replenishments of the International Development Association (IDA), and regional contributions to multilateral climate funds such as the Adaptation Fund, the Least Developed Country Fund, and the Special Climate Change Fund, will be key. Also critical is a strong replenishment of the Green Climate Fund (GCF),[218] which would include previous contributors following the

CASE STUDY 13

## Raising Funds for Adaptation Action

In 2017, Fiji introduced its Environment and Climate Adaptation Levy (ECAL), a 10 percent tax on such items as luxury cars and yacht charters, and a 10 percent income tax on the rich. More than FJ$255 million (about US$117 million) has been collected and spent on renewable energy, reforestation, agricultural research, disaster relief, upgraded bridges, rural roads, and many other projects to protect the country's natural environment, reduce its carbon footprint, and improve its ability to adapt to the impacts of climate change. This innovative financial instrument is all the more powerful because it is used to finance an explicit, systematic, and comprehensive climate adaptation action plan.

leadership shown by Germany and Norway in doubling the pledges they made during the initial resource mobilization and new contributors committing resources on a voluntary basis. Special attention needs to be given to the challenge of providing vital concessional finance to developing countries that are highly vulnerable to climate change but have limited access to finance. This category includes several smaller, middle-income island states.[219]

**Developed countries and other donors to significantly increase adaptation-related financing and improve the balance between adaptation and mitigation finance, including through processes and mechanisms related to international negotiations**. Overall, adaptation finance has accounted for only around a quarter of total climate finance flows in recent years, falling far short of the estimated need, and the Paris Agreement call for a balance between finance for adaption and mitigation.[220] Moving forward, donors should push to ensure increased flows of adaptation finance and an improved balance between adaptation and mitigation finance, similar to recent commitments by the World Bank.[221]

**Ministries of finance, central banks, and financial regulators to strengthen their capacity to manage climate change impacts on public finance and on wider financial stability**. This will require strengthened fiscal modeling, debt sustainability analysis, public expenditure reviews, and public procurement guidelines. The new Coalition of Finance Ministers for Climate Change Action, the GCF Readiness Program, the NDC Partnership, and the Special Program for Climate Resilience are all providing technical assistance to countries in these areas and should be scaled up. The joint International Monetary Fund (IMF)/World Bank Financial Stability Assessment Programs (FSAPs)—which have started to support countries in integrating comprehensive disaster finance strategies into their macrofiscal frameworks—should be extended to more countries. Also, the IMF should gradually mainstream climate change risk into its Article IV consultations.

## 3) Scale contingent finance and insurance

Developing and implementing effective disaster risk finance strategies will be essential to enable governments and communities to respond effectively to climate change impacts. Numerous studies show the importance for recovery and poverty alleviation of ensuring that cash is available soon after, or even before, a disaster, and that mechanisms are in place to ensure that such funding reaches the most vulnerable.[222] Recent IMF analysis shows that many countries may be underinsured as they seek to balance the macroeconomic costs and benefits of investing in risk reduction financial instruments.[223] Insurance and related risk-pooling markets can have the added benefit of helping price climate risk, thus enabling governments, companies, and individuals to make better decisions. While insurance has limitations and cannot, by itself, protect resource-strapped communities and countries from the full range of climate-related risk they face,[224] there is considerable room to foster adoption of disaster risk finance packages that include insurance and other disaster risk finance tools.

**Governments to develop and implement disaster risk finance strategies that strategically deploy multiple instruments, including national disaster funds, social protection programs, contingent credit lines, and sovereign and subsovereign insurance—including insurance that is expressly targeted to cover vulnerable people and those living in poverty**.[225] For example, Kenya is already using multiple instruments. It established the National Drought Emergency Fund, acquired a $200 million contingent credit line for emergencies, and implemented the Kenya Livestock Insurance Programme (KLIP), an index-based program that is subsidized by the government.[226] Yet, recent analysis suggests that only a small minority of developing countries are implementing this risk-layering approach.[227] Many more countries should develop, with international support, strong disaster risk finance strategies.

**Central governments in developing countries to accelerate efforts to deepen markets for sovereign and private insurance and other risk finance instruments**. This can be done by strengthening regulatory and policy frameworks, improving consumer education, deploying new technologies that support broader insurance coverage, and creating publicly owned insurance programs. Initiatives such as the InsuResilience Global Partnership and the GRiF are

promoting innovation to expand insurance uptake. At the same time, for people living in poverty, insurance may be largely unaffordable and may even increase existing inequalities; other instruments such as climate-adapted social safety nets or budget allocations may be a better choice for them. Since most developing countries lack the data and market maturity in the private sector to develop risk finance instruments by themselves, the public sector will need to lead. Over time, insurance premiums that are based on sound practices and robust modeling can provide useful information to promote better decisions about vital infrastructure and property. Insurance can also create incentives for investing in resilience measures.

**To address moral hazard, the competent authorities to consider leading national dialogues to clarify and codify the conditions under which their government will and will not cover private losses from extreme climate events**. Adequate transition periods for phasing out some government backstops should be provided to give stakeholders time to invest in resilience. In all countries, the role of the government as insurer of last resort must be clarified, both to protect countries' national accounts and to incentivize climate-smart choices. While the public sector must help communities shoulder some of the risk, the perception of an unlimited government backstop disincentivizes private actors from investing in their own resilience and exposes national budgets to enormous strain. While politically difficult, the limits of the government's role as insurer need to be addressed.

## 4) Harness private capital for resilience

The world's more climate-aware companies are already using their own resources to safeguard business operations and supply chains against climate impacts (see Case Study 14)**.** For example, the shipping line Maersk is evaluating its global network of ports and undertaking modifications to make them resilient.[228] After Superstorm Sandy struck in 2012, Bloomberg LP, the global provider of financial data, moved a key data center out of Manhattan to upstate New York to protect its equipment against flooding. Decisions like this will become more common.

CASE STUDY 14

### Resilience in the Private Sector

In 2018, the African Financial Alliance on Climate Change was launched to put the financial sector at the center of Africa's climate agenda. This innovative partnership aims to mobilize both domestic and international finance for climate-resilient development in Africa, including private capital. Its goal is for Africa's financial actors to take a lead role in driving low-carbon and climate-resilient action in Africa.[229]

It's increasingly good business to safeguard supply chains against climate impacts. The Global Resource Initiative taskforce, spearheaded by the United Kingdom, brings together private and public sector leaders to find ways to make a country's international supply chains more resilient, including through ecological resilience to climate change. Upstream suppliers and downstream buyers can identify production and infrastructure vulnerabilities. Governments can also support vulnerable suppliers to build their capacity to manage supply chain risks.

Private capital is also increasingly seeking solutions to enable businesses, governments, and households to adapt to climate change. Demand will grow for climate-resilient products and services, including new materials, engineering techniques, early warning systems, information tools, and climate and weather data. According to a recent survey, half of the world's biggest companies estimated that climate adaptation solutions could result in $236 billion in increased revenue.[230]

**The private sector to recognize that its own climate resilience depends crucially on the resilience of the communities in which it is embedded**. Business depends on public infrastructure to stay resilient. Climate-proofed corporate facilities will be of little use if workers cannot reach the workplace, if suppliers cannot deliver, or if customers cannot make purchases because of breakdowns in communications or transportation. Greater incentives need to be created for the private sector to join with the public sector in investing more broadly in resilient infrastructure or nature-based solutions. There are some nascent efforts to partner with the private

sector in implementing broad, city- or region-scale resilience. For example, the Innovative Financing and Delivery of Natural Climate Solutions (IGNITION) program in Greater Manchester aims to increase the city's green infrastructure by 10 percent by 2038 through the creation of at least €10 million worth of projects that incentivize businesses and organizations to invest in nature-based climate change adaption solutions.[231]

**Financial authorities to consider requiring companies and financial institutions with potentially high exposure to climate risks to conduct routine analysis and disclosure.** Climate-risk disclosure has made important advances, thanks to initiatives such as the TFCD and the Sustainability Accounting Standards Board (SASB).[232] By disclosing risk information in a comparable and transparent way, companies can help investors understand the risks that climate impacts pose to profits and help them price assets accordingly. Over time, companies that adopt sensible risk-reduction and management strategies should face lower costs of capital.[233] Climate risk disclosure is still voluntary in most countries, with the notable exception of France,[234] where it is mandatory. In some countries, like the United Kingdom, governments have have committed to exploring mandatory disclosure.[235] Without it, few companies will disclose this information systematically.

**To better jump-start the disclosure process worldwide, the appropriate regulatory authorities in the world's largest developed economies to consider, within 5 years, requiring the disclosure of climate risks**. This requirement should be in line with the TCFD, applicable to all publicly listed entities operating in their jurisdiction, and follow a standardized reporting methodology in partnership with the private sector. Governments in smaller economies may adopt a similar approach as capacity permits. In the interim, companies should accelerate voluntary disclosure across all TCFD disclosure categories.

**Businesses and governments to look for ways to work together to create more efficient and effective blended finance vehicles for long-term adaptation solutions**. The shift in private finance will not happen automatically. Because private capital responds to commercially attractive, risk-adjusted returns, rules and incentives must be in place to ensure the shift happens. The public sector will need to build the policy, regulatory and legal scaffolding for blended finance that is efficient, generates suitable revenue streams, and shares both costs and benefits.[236] Public funds that help catalyze investment play a critical role, such as the Special Climate Change Fund's new Challenge Program on Adaptation Innovation, managed by the GEF. The program supports continuous innovation and learning on private sector investment approaches, business models, partnerships, and technologies suitable for climate adaptation.[237] A second example is the Climate Resilience and Adaptation Finance and Technology-transfer facility (CRAFT) project, co-financed by the GEF and the Nordic Development Fund, which is an equity investment fund designed to expand the availability of private sector technologies used in climate adaptation solutions.[238]

Over time, as climate risks become better understood and the benefits more clear, private investment in adaptation will grow. Mechanisms such as land value capture—in which the property value gains and avoided losses that private owners experience by investing in resilient measures are used to shoulder some investment costs—are worth exploring further and expanding where appropriate.

**Greater incentives need to be created for the private sector to join with the public sector in investing more broadly in resilient infrastructure.**

PART III

# The Immediate Imperative: A Year of Action

**The previous sections lay out in detail a bold agenda to build a more resilient world. These actions are imperative if we want all people, especially people living on the frontlines of climate change, and youth who will inherit the impacts of climate change, to have the opportunity for a better future. If we act today, we can save lives, reduce risk, strengthen economies, and protect our environment.**

While these transitions will take time to fully implement, it is essential that they start with great energy. For this reason, the Commission*—through Commissioner commitments and partnership with others—will devote the coming 15 months to drive a set of Action Tracks that we believe are essential to jump-start the needed transitions. In some cases, these actions will involve mobilizing political, technical, and financial support to existing initiatives; in other cases, they will entail forging new coalitions for change.

The Commission will champion this package of initiatives at the September 2019 UN Climate Action Summit and throughout the coming Year of Action, including importantly at the Climate Adaptation Summit hosted by the Netherlands in October 2020. They will also aim to raise the level of ambition on adaptation among countries in the lead-up to the international climate summit (COP26) in December 2020. Through these Action Tracks, we will mobilize scaled-up action that will continue beyond the lifetime of the Commission and realize its goals over the next 5 to 10 years.

The following Action Tracks are currently under development. Each is at a different stage of development. More detailed descriptions are available. These tracks will continue to evolve over the coming months.

**We welcome all—governments at all levels, private sector entities, civil society, academia, grassroots groups, youth groups, and all others—to join as partners in this Year of Action.**

**ACTION TRACK**

## Finance and Investment

The starting point for effective adaptation—as noted in Chapter 1—is to make climate risks visible and actionable to public and private investors.

### INITIATIVES:

- **Expand climate-resilient fiscal and financial policy.** In partnership with the IMF, World Bank, and United Nations Development Programme (UNDP), we will support the work of the Coalition of Finance Ministers for Climate Action, the Vulnerable 20 Group of Ministers of Finance of the Climate Vulnerable Forum (V20), and others to create and apply new climate risk assessment and resource allocation methodologies, ranging from macroeconomic stress-testing to climate screening of all government expenditures. While some countries are already making good progress in this area, most are not—due to lack of capacity and the absence of data and user-friendly tools. Technical assistance will be provided to all countries requesting support, and a coalition of front-runner countries will be identified as living laboratories and mentors. The goal is to integrate climate risk into all aspects of national fiscal and financial planning and decision-making.
- **Make climate risks visible in private financial markets**. We will support the Coalition for Climate Resilient Investment (CCRI), a private sector and UK-led coalition with Willis Towers Watson, the World Economic Forum, and over a dozen other partners, as it develops and pilots to better price climate and systemic risks in large-scale infrastructure investments in several countries over

* In the following paragraphs we use the pronoun "we" to refer to individual or groups of Commissioners, ActionTtrack partners, and managing partners as the ones carrying forward commitments to action—not all members of the Commission or the Commission as whole.

the coming year. This will make climate risks explicit in financial decision-making and transform how infrastructure investment decisions are made. The initiative will facilitate a global effort to build consensus on metrics and standards for resilience, across sectors, regions, and investment types.

- **Deepen economic understanding of adaptation.** While there is a growing body of economic research on adaptation, this area has not generally been translated into practical tools to inform decision-makers. Thus, in support of the above 2 initiatives, the Managing Partners of the Commission, World Bank, the Grantham Research Institute, and other organizations will convene a distinguished panel across academia, practitioners, and policymakers to identify and address the research gaps, issuing a synthetic report collating emerging findings, and promote the translation of these findings into decision-maker friendly tools and methods.

ACTION TRACK

## Food Security and Agriculture

As described in Chapter 2, food security is massively threatened by climate change, as are the livelihoods of hundreds of millions of farmers and their families. The Commission calls for a large-scale, international mobilization over the coming decade to deliver improved incomes, ecologically sustainable food systems, and resilience for 300 million small-scale food producers. This goal requires sharp increases in agricultural research and a step change in access to innovations, finance, and information for small-scale producers. The Commission will give immediate attention to the following:

### INITIATIVES:

- **Double the scale of agricultural research through the CGIAR System.** We will work with the CGIAR System to fully embed climate change in every aspect of its new 10-year strategy and support accelerated implementation of the CGIAR Two Degree Initiative, which aims to help small-scale food producers across the globe adapt their farming systems, livelihoods, and landscapes to weather extremes, as well as to put food systems on a low-emissions development pathway. The Commission will support CGIAR reforms under consideration to ensure research is firmly demand-led and reaches small-scale food producers as quickly as possible.
- **Expand access to climate-informed digital advisory services.** In partnership with the German Federal Ministry for Economic Cooperation and Development (BMZ), the World Food Programme, and several others, we will help expand access to information on weather and seasonal forecasts, pest and disease early warning, digital soil maps, and information on adaptive production practices. Through these efforts, we will support the spread of digital advisory services for small-scale food producers to help them make adaptation-related decisions in the face of a changing climate.
- **Expand small-scale food producers' access to insurance, finance, markets, adaptive technologies, and agroecological practices to build resilience.** In partnership with the BMZ, the UK Department for International Development, the GEF, UNDP, the Alliance for Green Revolution in Africa, Adaptation of African Agriculture Initiative, the InsuResilience Global Partnership, and other partners, we will scale access to insurance, finance, markets for climate-resilient crops, fish and livestock, and social protection for small-scale food producers and cooperatives to aid them in managing risks, while increasing incomes. We will support expanded access to and use of adaptive technologies and agroecological practices that build resilience of farms and ecosystems.

ACTION TRACK

## Nature-Based Solutions

Harnessing the power of nature to make people, places, and ecosystems more resilient to climate change, as highlighted in Chapter 3, is essential. The Commission calls for climate risks to be reduced for hundreds of millions of people through nature-based solutions and increased ecological resilience by 2030. This will require leadership from many stakeholders: national governments, local governments, nongovernmental organizations, civil society, companies, finance institutions, youth, and more.

### INITIATIVE:

- **Mobilizing national, local, and private sector leadership for nature-based solutions.** In partnership with Canada and others, we will mobilize political and private sector leadership to implement large-scale, coordinated approaches to nature-based solutions to minimize climate risks and maximize economic, social, and environmental

benefits, leveraging the differential capacities of national, local, and private sector actors. We will work with committed countries to strengthen policies, data and information, initiatives, and finance to protect the environment and reduce climate risk. In partnership with city networks and the Cities and Water Action Tracks, we will also mobilize cities to implement nature-based solutions that benefit a large proportion of the population, especially the most vulnerable, as part of citywide adaptation and resilience strategies to combat extreme heat, urban flooding, sea level rise, and water shortages. Finally, we will seek to mobilize commitments from industry leaders and work with them to accelerate the use of nature-based solutions in business operations.

ACTION TRACK

## Water

The effects of climate change will most immediately and acutely be expressed through water, as shown in Chapter 4. We must urgently invest in strengthening the resilience of natural freshwater and critical human water systems to reduce risks for billions of people facing high water stress and for those whose lives are impacted by floods and droughts.

### INITIATIVES:

- **Expand support for planning and financing of climate adaptation in river and groundwater basins.** With the World Bank, the Government of the Netherlands and others, we will launch the global Resilient Basins Initiative to support planning and financing of climate adaptation and resilience measures in river and groundwater basins. The initiative will operate at basin scale in order to ensure the ecological integrity of natural freshwater systems and to address the water security and resilience needs for all water-dependent sectors—agriculture, energy, industry, cities, and nature. Priority will be given to strengthening natural defenses and ecological resilience, investing in green and gray infrastructure to mitigate floods, regulate water flows and increase storage capacity, resolve trade-offs among sectors, and improve water use efficiency, particularly in agriculture.

- **Support a network of cities to develop and implement more resilient urban water systems.** We will work with the World Bank, the Government of the Netherlands, the Resilient Shift, the Cities for Forests Network, and leading cities to advance integrated urban water resilience planning and investment to address critical vulnerabilities in infrastructure and management, building water security for growing urban populations and increasingly water-stressed cities. Cities will be supported to diagnose water risks and to design and upgrade their water systems for resilience through investments in managing water use, diversified supply, reuse and recycling, and mitigating extreme water events.

ACTION TRACK

## Resilient Cities

Chapter 5 calls for redoubled efforts to build more resilient and equitable cities. Toward that end, the Commission calls for all cities to put in place inclusive polices, projects, and structures that will deliver climate-resilient cities by 2030, building on the initiatives below as well as those in other Action Tracks.

### INITIATIVES:

- **Expand national and international investment in climate-resilient cities.** In collaboration with city networks, the Financing Sustainable Cities Initiative, the GEF, and other efforts, we will mobilize increased financial flows for urban resilience in developing countries by supporting cities in developing appropriate financial models for adaptation and supporting cities in preparing bankable adaptation projects. We will help develop a strong business case to national governments for the importance of investing in resilience at the city level, working in close partnership with the Coalition on Urban Transitions.

- **Building the climate resilience of the urban poor.** In partnership with local communities and civil society actors, UN Habitat, Shack/Slum Dwellers International, and others, we will work to put people living in poverty at the center of urban adaptation by contributing to a global analysis that identifies communities at risk (including informal settlements) to climate impacts. We will use this hotspot mapping and associated tools to engage urban networks and city and national governments to identify and strengthen resilience. We will do so by identifying and preparing priority projects and establishing funding streams and work plans to support climate adaptation in an equitable and inclusive manner, driven by the priorities of urban people living in poverty.

ACTION TRACK

## Locally Led Action

People and communities on the frontlines of climate change are often the most active and innovative in developing adaptation solutions. Yet, too often, they lack access to the resources and power needed to implement solutions. To address this imbalance, the Commission calls for significant increases in the volume of devolved and decentralized funding available to local governments, community-based organizations, and others working at the local level to identify, prioritize, implement, and monitor climate adaptation solutions.

### INITIATIVE:

- **Mobilize funder and government commitments to expand resources and support for locally led action and in-country action.** We will collaborate with Asian Development Bank, UNDP, the Adaptation Fund, and other international climate funders and multi-lateral organizations, as well as with governments, such as the Least Developed Countries (LDC) Group and civil society such as Shack/Slum Dwellers International, BRAC, and others to expand the amount of funding available for devolved and decentralized adaptation action. We will also seek to improve the quality of the funding available so that it is more coordinated, flexible, empowering, long-term, risk-tolerant, inclusive, transparent, and accountable both to communities and investors. Further, we will work with national governments, civil society, and other partners committed to scaling up locally led adaptation in 50 countries to put in place or strengthen inclusive policies and structures, including those related to procurement, and capabilities to enable devolved decision-making on adaptation investment and action among local governments, community-based organizations, civil society organizations, and federations. A framework for implementing and monitoring locally led action will be developed in collaboration with partners to track progress in devolving finance and its impact.

ACTION TRACK

## Infrastructure

As explained in Chapter 6, climate resilience needs to be integrated into all infrastructure assets and systems throughout their lifecycles. The Commission seeks to ensure that, by 2025, all significant new and retrofit infrastructure is climate-resilient, by systematically mainstreaming climate resilience into infrastructure planning, design, operation, and maintenance.

### INITIATIVES:

- **Build and strengthen partnerships for climate-resilient infrastructure by leveraging international best practices and tailoring them to local conditions.** We will work with national governments, public institutions, and the private sector to support mainstreaming climate resilience into infrastructure policy through peer-learning and targeted technical assistance. This will be based on strong understanding of countries' infrastructure priorities, context, and credible data on climate risks. Focal areas include screening projects for exposure to climate risks, integrating adaptation into the planning and delivery of infrastructure networks, improving design standards, updating procurement policies, and developing financing strategies to mobilize additional private and public investment. These efforts will be undertaken collaboratively with other relevant initiatives such as the Coalition for Disaster Resilient Infrastructure (convened by India) and the Coalition for Climate Resilient Investment (convened by the United Kingdom).

- **Expand uptake of risk finance and insurance mechanisms for resilient infrastructure.** Through this initiative, we will ensure rapid recovery after extreme weather events and facilitate private investment in resilient infrastructure, as part of financial protection strategies. Financial protection strategies—combining financial reserves, prearranged credit, and insurance—can support resilience of critical infrastructure by improving risk assessment, encouraging proactive risk reduction, and enabling more rapid recovery after a disaster. In collaboration with the InsuResillience Global Partnership and Global Risk Financing Facility, we will expand existing disaster risk finance and insurance programs to strengthen resilience of critical infrastructure.

ACTION TRACK

## Preventing Disasters

A rapid scale-up in investment will be needed across the risk chain to improve people's ability to act ahead of extreme weather events, reduce deaths and human suffering, and lessen economic impacts, as outlined in Chapter 7. We aim to support this vision in a way that ensures vulnerable and marginalized communities are not left behind and by leveraging the existing global architecture for disaster risk management, based on the Sendai Framework for Disaster Risk Reduction. The Action Track will be a key delivery mechanism for the Risk-Informed Early Action Partnership (REAP).

### INITIATIVES:

- **Scale-up investment in people-centered early warning systems.** This initiative focuses on early warning, including heat early warning systems, that prioritizes vulnerable members of society. We will work with the World Meteorological Organization, International Federation of Red Cross and Red Crescent Societies, Global Facility for Disaster Reduction and Recovery, the United Nations Development Programme, and others to systematically link investments in national hydrological and meteorological services with investments in effective people-centered early action, with a focus on increasing the number of early warning systems in least developed countries and small island developing states. We will support action to put in place heat early warning systems in the most vulnerable regions to help ensure that millions more people can protect themselves from heat waves in collaboration with national meteorological services, ministries of health, community health workers, volunteers, urban planners, and city governments.

- **Expand forecast-based financing and action in the humanitarian sector.** Forecast-based financing is an innovation that predeploys resources in advance of an extreme event based on agreed early action plans, thereby saving lives, reducing damage, and speeding up recovery. We will work with the International Federation of Red Cross and Red Crescent Societies, World Food Programme, and others to expand this practice to at least 20 vulnerable countries.

- **Strengthen national social protection systems and the coherence of disaster management and adaptation policies.** In partnership with the World Food Programme, Global Facility for Disaster Reduction and Recovery, and others, we will support governments that integrate climate risks and extreme events into social protection policies to help low-income communities bounce back more quickly following disasters and strengthen social protection programs to ensure that the people most vulnerable to climate change are prioritized. Together with UNDRR and International Federation of Red Cross and Red Crescent Societies, Global Facility for Disaster Reduction and Recovery, and others, we will also support 50 countries to put in place coherent climate change and disaster regulatory frameworks and a common implementation agenda for their disaster risk management and climate change adaptation policies, which are often developed by different ministries, so that these are working in concert to help people adapt to new climate extremes.

Collectively, these Action Tracks build on this report's recommendations, as well as extensive input from our partners, creating a comprehensive platform for urgent, bold, and inclusive adaptation. The Action Tracks will continue to evolve and expand as we build further momentum during the Year of Action. Each Action Track will develop a monitoring and accountability framework to track progress toward the overarching goal. We aim to catalyze greater adaptation action beyond the lifetime of the Commission, which will be tracked by the Commission's Managing Partners.

We invite collaboration from all segments of society to join us in urgently taking this agenda forward to achieve a vision for a stronger, safer, and thriving world.

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*Achieving Adaptation through Climate Smart Landscapes: Integrating Food Security, Water, Energy and Biodiversity:* Seth Shames (Ecoagriculture Partners); Sara J. Scherr (Ecoagriculture Partners)

*Global Food Security under Climate Change: Outlook and Adaptative Responses:* Alessandro de Pinto (International Food Policy Research Institute, IFPRI); Elizabeth Bryan (IFPRI); Claudia Ringler (IFPRI); Nicola Cenacchi (IFPRI)

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### CITIES & URBAN AREAS

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# ACTION TRACK PARTNERS

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## ACTION TRACK: Finance and Investment

- Africa Adaptation Initiative
- African Development Bank
- Coalition for Climate Resilient Investment
- Coalition of Finance Ministers for Climate Action
- Grantham Research Institute for Climate Change and the Environment
- UK Department for Business, Energy and Industrial Strategy
- United Nations Development Programme
- Vulnerable 20 (V20) Group of Ministers of Finance of the Climate Vulnerable Forum
- World Bank

## ACTION TRACK: Food and Agriculture

- Adaptation of African Agriculture Initiative
- African Development Bank
- The Alliance for Green Revolution in Africa
- Australian Centre for International Agricultural Research
- Bill and Melinda Gates Foundation
- BRAC
- CAB International (CABI)
- CGIAR
- DSM
- Esoko
- German Federal Ministry for Economic Cooperation and Development (BMZ)
- Global Environment Facility
- InsuResilience Global Partnership
- International Fund for Agricultural Development
- International Research Institute for Climate and Society, Columbia University
- Southern African Confederation of Agricultural Unions
- UK Department for International Development
- United Nations Development Programme
- World Bank
- World Food Programme
- World Meteorological Organization

## ACTION TRACK: Water

- Cities for Forests Network
- Government of Bangladesh
- Government of Netherlands
- Resilience Shift
- World Bank

## ACTION TRACK: Nature-Based Solutions

- Government of Canada
- Global Environment Facility
- United Nations Environment Programme

## ACTION TRACK: Resilient Cities

- C40
- The Global Covenant of Mayors for Climate and Energy
- Global Environment Facility
- Shack/Slum Dwellers International
- UN-Habitat
- United Nations Development Programme

## ACTION TRACK: Locally Led Action

- Adaptation Fund
- Asian Development Bank
- BRAC
- Huairou Commission
- International Centre for Climate and Development
- International Institute for Environment and Development
- Shack/Slum Dwellers International
- United Nations Development Programme

## ACTION TRACK: Infrastructure

- African Development Bank
- Coalition for Climate Resilient Investment
- Coalition for Disaster Resilient Infrastructure
- Global Risk Financing Facility
- Government of the Netherlands
- InsuResilience Global Partnership
- Macquarie Group Ltd.
- Oxford University Environmental Change Institute
- United Nations Environment Programme
- United Nations Office for Project Services

## ACTION TRACK: Preventing Disasters

- African Development Bank
- International Federation of Red Cross and Red Crescent Societies
- United Nations Development Programme
- United Nations Office for Disaster Risk Reduction
- World Bank
- World Food Programme
- World Meteorological Organization

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## THE GLOBAL CENTER ON ADAPTATION

The Global Center on Adaptation is an international organization, hosted by the Netherlands government, strategically focusing on bridging gaps in knowledge, serving as a resource for technical expertise, and helping to guide investments in adaptation solutions. Broadly, its mission is to accelerate knowledge-sharing, investments in people, and financing of solutions to ensure that building resilience becomes a higher priority at all levels of decision-making. The Global Commission is indebted to current and former staff for their support to the Global Commission: Patrick Verkooijen, Barney Dickson, Al Anstey, Fred Boltz, Bruce Campbell, Alex Gee, Mike Girling, Julie Greenwalt, Britta Horstmann, Imogen Jacques, Richard Klein, Paul Langeveld, David Mfitumukiza, Dominic Molloy, Michael Mullan, Laura Scheske, Seth Schultz, Herman Sips, Thijs Stoffelen, Elina Väänänen, Michel van Winden, and William Walter.

# ACRONYMS

- African Development Bank Group (AfDB)
- Africa Disaster Risks Financing (ADRiFi)
- Africa Risk Capacity (ARC)
- Asian Coalition for Community Action (ACCA)
- Asian Disaster Reduction Center (ADRC)
- Benefit-Cost Ratio (BCR)
- Climate Resilience and Adaptation Finance and Technology-transfer facility (CRAFT)
- Climate Risk and Early Warning Systems (CREWS)
- Coalition for Climate Resilient Investment (CCRI)
- Contingent emergency response component (CERC)
- Community-driven development (CDD)
- Disaster Mitigation and Adaptation Fund (DMAF)
- Environment and Climate Adaptation Levy (ECAL)
- Financial Stability Assessment Programs (FSAPs)
- Food and Agriculture Organization of the United Nations (FAO)
- Forecast-based financing (FbF)
- Geographic information system (GIS)
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- Global Framework for Climate Services (GFCS)
- Global Risk Financing Facility (GRiF)
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- International Development Association (IDA)
- International Food Policy Research Institute (IFPRI)
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- Kenya Livestock Insurance Programme (KLIP)
- Least developed countries (LDCs)
- Multilateral development banks (MDBs)
- National Adaptation Fund on Climate Change (NAFCC)
- National adaptation plans (NAPs)
- Nationally determined contributions (NDCs)
- North-East Asia Clean Air Partnership (NEACAP)
- Organisation for Economic Co-operation and Development (OECD)
- Payments for ecosystem services (PES)
- Risk-Informed Early Action Partnership (REAP)
- Science Information Network (CIESIN)
- Shared Socioeconomic Pathways (SSPs)
- Small island developing states (SIDS)
- Sustainability Accounting Standards Board (SASB)
- Sustainable Development Goals (SDGs)
- Task Force on Climate-Related Financial Disclosures (TCFD)
- Uganda Red Cross Society (URC)
- United Nations Convention to Combat Desertification (UNCCD)
- United Nations Convention on Biological Diversity (CBD)
- United Nations Development Programme (UNDP)
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- United Nations Framework Convention on Climate Change (UNFCCC)
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- World Meteorological Organization (WMO)

# ENDNOTES


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## PHOTO CREDITS

Cover: A woman harvesting rice in Nepal. Credit: Neil Palmer/CIAT; Foreword: Urban gardens in Milan, Italy. Credit: Shutterstock; Executive Summary: Eastern Scheldt storm surge barrier designed to protect the Netherlands from flooding from the North Sea. Credit: Shutterstock; Part I: Preperations underway in Mozambique in advance of Cyclone Idai. Credit: Denis Onyodi/IFRC-DRK-Climate Centre; Part II: Clare Mukankusi, plant breeder at The International Center for Tropical Agriculture (CIAT), in Kawanda, Uganda. She leads breeding efforts for CIAT's bean genebank, working with farmers to preserve beans and maintain genetic diversity in the genebank. Credit: Georgina Smith/CIAT; Part III: Christel Jacques leads her Wildlife Club on an outing to learn about mangroves. The Wildlife Clubs of Seychelles are school-based clubs that teach children how to be environmentally friendly citizens. Credit: Ryan Brown/UN Women.

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