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Chapter III

The adaptation challenge

INTRODUCTION

The previous chapters have argued that living standards can be raised in developing countries without jeopardizing climate change mitigation efforts. It is clear, however, that the development path followed by today's rich industrialized countries can no longer serve as a model for catch-up growth. Rather, powering industrial expansion, rapid urbanization and population growth in the developing world will require a big push into cleaner and more efficient technologies, above all in the production and consumption of energy.

But even if the world shifts quickly onto a low-emissions path, the accumulation of greenhouse gases in the atmosphere from past emissions means that a noticeable increase in global temperatures is unavoidable and will bring serious environmental damage, including increased droughts, rising sea levels, ice-sheet and snow-cover melting, and extreme weather events. These phenomena will, in the coming decades, threaten and destroy livelihoods around the globe, especially for already vulnerable populations. As our knowledge of climate change deepens, scientists are becoming increasingly alarmed about the potential scale of environmental damage from what were previously considered manageable changes in global temperatures. The threats to livelihoods and security are also likely to be that much greater.

For many developing countries, environmental constraints and shocks are already part of a vicious development cycle that traps them in poverty, undermines their resource base and restricts their capacity to build resilience to future shocks. The problem is sure to become even more challenging with global warming. Poor health-care systems, lack of infrastructure, weakly diversified economies, missing institutions and soft governance structures expose poorer countries and communities not just to potentially catastrophic large-scale disasters but also to a more permanent state of economic stress from higher average temperatures, reduced water resources, more frequent flooding and intensified windstorms. These stresses will likely increase the risks of food and income insecurity and

further expose the inadequacy of health care, sanitation, shelter and social infrastructures.

Adapting to climate change must be a central component of any comprehensive and inclusive climate agenda. Several international funds have been set up to finance adaptation measures in developing countries, but they are woefully inadequate. Scaling up these funds is the first challenge in the adaptation agenda. A second challenge is that adaptation is still seen primarily as an environmental issue, and there is a tendency to compartmentalize climate change policies and isolate them in environmental ministries.

Even when adaptation measures have been linked to a development strategy, the focus has often been either on poverty alleviation (with the goal being to promote stronger safety nets and innovative insurance mechanisms for vulnerable groups and sectors) or on business opportunities (from strengthening climate-related markets). These actions have a role in a more integrated strategy, but they cannot frame it. Rather, this chapter argues that increased investment, improved access to finance, and strengthened regulations and institutional capacity are, as with climate mitigation, at the heart of confronting the adaptation challenge in most developing countries. Indeed, synergies between adaptation and mitigation strategies need to be explored much more fully, as an integral part of low-emissions, high-growth development pathways in countries vulnerable to climate change and shocks.

ADAPTATION AND VULNERABILITY

Mitigation is directed at slowing the growth of future emissions of greenhouse gases and eventually reducing their stock to a level consistent with manageable and stable temperatures. Adaptation is about mobilizing resources and devising policy strategies for coping with the unavoidable negative impacts of higher temperatures. This is not a challenge that is altogether new. Throughout history, human societies have shown an extraordinary capacity for adapting to climatic changes. However, the threats posed to security and livelihoods by anthropogenic global warming, like the appropriate responses, are likely to be unprecedented.

Climate change and vulnerability

Despite considerable variation in scientific estimates of the possible impacts of climate change, concern continues to grow over catastrophic risks to

the planet's ecology and to life in general. For example, James Hansen and others argue that the eventual temperature increase from a doubling of atmospheric carbon dioxide (CO₂) is more likely to be 6° C, rather than the 3° C assumed by both the Intergovernmental Panel on Climate Change (IPCC) and the *Stern Review*.¹ Many scientists estimate that global warming of 4° C or more is increasingly likely in this century; one recent analysis finds that under the IPCC's A1FI scenario (a high-emissions business-as-usual pathway), 4° C above pre-industrial temperatures would likely be reached by the 2070s or sooner; under the A2 scenario, that temperature threshold would likely be reached by the 2090s.²

The damage resulting from climate change will not be felt uniformly across countries and communities (see chap. I). The United Nations Development Programme notes that climate models show large losses in productivity for food staples in sub-Saharan Africa and South and East Asia, for example, and projects that 600 million people could face acute malnutrition by the 2080s due to climate change.³ By contrast, there will be some areas of the world that may experience small benefits, for instance, with regard to mortality rates and crop yields, provided that global temperature increases do not greatly exceed 2° C. (It should be noted, however, that the latest agricultural research suggests smaller gains and more widespread losses from even the earliest stages of warming.) Should temperatures rise more than about 2° C, the resulting proliferation of threats could rapidly heighten existing vulnerabilities.

New data on the melting of mountain glaciers and the ice sheets of the Arctic and Antarctic point to an increased likelihood of a significant rise in sea levels, which could lead to serious threats to several big cities such as New York, London, Tokyo, Dhaka, Shanghai, Mumbai and Rio de Janeiro. Similarly, in the Andean cordillera, melting of glaciers threatens the water supply and livelihoods of at least 30 million people (see box III.1). Worldwide, the livelihoods of about 500 million people depend on glacier-fed rivers. Sea-level rise and storm surges are also a direct threat to hundreds of millions of people in low-lying coastal zones.

Communities' adaptive capacity, of course, is also a major factor. Developed countries can draw on financial resources and institutional strengths to bounce back from environmental shocks and bolster their resilience to future impacts. This is not the case in most developing countries. In Africa, for example, where drought and famine are already serious problems, a UNFCCC report notes, communities' ability to respond to climate change will be hindered by poverty, illiteracy and lack

Box III.1: The multiple threats to livelihoods from climate change: the Andean case

The impacts of climate change are cumulative and are closely linked to other vulnerabilities, often in a dangerously reinforcing manner. This is clearly illustrated by the accelerated melting of mountain glaciers, which are a critical source of livelihoods for about 500 million people worldwide and essential contributors to regional and global biodiversity.

Most of the world's tropical glaciers are located in the Andean mountains of Peru, Bolivia and Ecuador, where melting threatens the water supply and livelihoods of at least 30 million people. Over one fifth of the surface of 18 mountain glaciers in Peru has already melted over the past 35 years, while most of the lower-altitude Andean glaciers are expected to diminish substantially during the next 10-20 years.

Direct impacts of this trend are being felt in large cities in the region, which depend on glacial run-offs for their water supply. Quito draws 50 per cent of its water supply from the glacial basin, and La Paz, 30 per cent. The loss in volume of the glacier surface of Peru, equivalent to 7,000 million cubic metres of water (about 10 years of water supply for Lima), has meant a reduction by 12 per cent of the water flow to the country's coastal region, which is home to 60 per cent of the population of Peru.

As glaciers retreat, the capacity to regulate water supply through run-off during dry and warmer periods and to store water in the form of ice during wet and colder periods is being lost, which in turn puts agriculture and power generation at risk. Without sufficient run-off, pasture land upon which to raise livestock and continue small farming will be insufficient. As the cultivation of local staples such as potatoes and quinoa is likely to dwindle, farmers may have to resort to planting costlier crops that need chemical fertilizers.

Moreover, most Andean countries are also dependent on the glaciers for hydroelectric power generation, which accounts for 50 per cent of the energy supply in Bolivia and 70 per cent or more in Colombia, Ecuador and Peru. With rising temperatures, energy generation will be diminished in areas where water basins depend on glaciers, increasing the need to invest in additional power capacity and, as in Peru, explore thermal-based power options.

Source: The World Bank, 2008.

of skills, weak institutions, limited infrastructure, lack of technology and information, poor access to resources, low management capabilities, armed conflicts, and other factors.⁴ The problems are even worse, meanwhile, for small, low-lying island nations such as the Maldives and Kiribati, where the climate threat is already so daunting that relocating their populations may be the only viable response.⁵

Climate change will also compound the interrelated threats faced by vulnerable communities. For instance, the number of outbreaks of tropical diseases is likely to be larger in areas with more frequent and severe heat waves, while the incidence of water-related diseases is likely to rise in areas

with more floods. Increased hurricane activity will also lead to an increase in respiratory diseases (for example, influenza), in particular when emergency shelter is inadequate and in areas with little or no medical assistance. As Harvard Medical School researcher Paul Epstein warns, climate change “could devastate public health by midcentury”.⁶ In addition, people will lose their livelihoods, lack adequate shelter and face food insecurity—with the worst impacts on vulnerable groups such as children, older persons and women.

The 2008–2009 winter drought in northern China, the worst in 30 years, provides an example of the compounding effects of multiple climatic shocks. Due to lack of rain and snow since November 2008, China’s Ministry of Water Resources reported in early February 2009, about 3.7 million people and 1.9 million large animals had limited access to drinking water in northern China. The drought damaged about 180,000 hectares of farmland, affecting about 40 per cent of China’s winter wheat crop and decreasing the total wheat harvest by about 5 per cent. Officials declared a state of emergency and allocated about 400 million yuan for drought relief.⁷

Adaptation and development

Reduced vulnerability to natural hazards is strongly correlated with income levels, and reflects changes in economic and social structures as countries diversify away from reliance on agricultural activities, establish stronger institutional networks, and begin to build more effective welfare states. Adaptation to actual or expected climate change will inevitably involve large investments to protect existing activities and livelihoods, facilitate needed adjustments, and exploit potential opportunities. Adaptation can emerge spontaneously as individuals and communities respond to repeated shocks or incremental changes in their surrounding environment. However—particularly when the changes are on a larger scale—lasting solutions will require deliberate policy decisions and public action, based on scientific research, assessment of previous crisis episodes, and consultations with local residents and grassroots groups.

Adaptation may be particularly hard for populations that are already vulnerable due to low levels of economic and human development. Experience with disasters shows how difficult it is to break out of poverty and insecurity that have been exacerbated by climate shocks, and how difficult it is to judge how much of the resulting impact can be attributed to “normal” economic versus “abnormal” climate factors. This also underscores

the interrelated nature of climatic and development-related pressures in adaptation. Not only can the damages be much larger than the resources available to provide protection, but poor countries may have difficulties mobilizing those resources and investing in effective adaptation measures.

Even in developing countries that have managed to foster sustained growth, vulnerability to shocks, both internal and external, remains a persistent concern for policymakers. Poor neighbourhoods, even in developed countries, are more at risk from shocks, including climatic shocks, because they have fewer coping resources and are inadequately served by basic services that are taken for granted in more affluent areas. Economic growth alone does not guarantee that needed adaptation measures will be taken; the United States had ample warning that New Orleans was at risk from a major hurricane, but did not construct adequate levees before Hurricane Katrina devastated the city in 2005.

In responding to the adaptation challenge, policymakers can usefully draw on the experiences of developing countries in adjusting to exogenous economic shocks. Perhaps the strongest conclusion that emerges from those experiences is that local circumstances and capacities have a profound influence on outcomes, and that policy responses should be tailored accordingly. However, some general lessons can also be drawn, such as:

- If countries are left to adapt on their own, they will likely be forced to squeeze down incomes, which would result in a prolonged and destabilizing adjustment process, increasing poverty levels, damaging long-term growth prospects and adding to further vulnerabilities.
- Economies that are more diversified (both structurally and spatially) tend to show greater resilience to external shocks and recover more quickly, as do economies that are strongly integrated both internally and externally.
- Societies with less inequality are better able to manage shocks by equitably distributing the burden of adjustment and avoiding the possibly dangerous conflicts that adjustment can trigger.

Adaptation is very much a *local* challenge which will require locally appropriate strategies and mechanisms. However, in general, economic development is the most reliable insurance against climate impacts. On the whole, populations that have access to adequate food, clean water, health care and education are better prepared to deal with a variety of shocks, including those from climate change. Access to adequate resources to invest in adaptive capacity, including human and social capital, determines how resilient countries and communities are likely to be. In addition, access to

technologies and know-how will play an important role in strengthening adaptive capacity. Thus the ability of decision makers to mobilize and manage resources and to engage in difficult trade-offs involving their use will be an essential component of the response to the adaptation challenge.

Many developing countries remain heavily dependent on natural resource-based activities and are likely to be seriously threatened by projected climate changes. Communities and countries that primarily produce and export low value-added agricultural goods and primary commodities are typically found at the lower end of the development ladder and are vulnerable due to small market size, heavy import dependence, low technological capacity and other factors. Food security remains a basic challenge, particularly where agriculture is dominated by smallholder production, productivity is low, and support services are poorly developed. Climate change is certain to exacerbate these problems.

Other developing countries are transitioning to more urban and economically diversified economies and must cope with new risks and interrelated shocks. By 2030, it is estimated that 60 per cent of the world's population will reside in urban areas, compared with 47 per cent in 2000, according to the United Nations Human Settlements Programme (UN-Habitat).⁸ Cities are also national and regional economic hubs and play crucial roles in the globalization process. The policy challenges accompanying this transition can be compounded by increasing insecurity and inequality, as new urban residents may find themselves forgoing the minimal levels of protection offered in rural communities, while receiving little or no government support.

Overall, in the absence of more effective adaptation strategies, rising global temperatures are likely to exacerbate the differences in vulnerability between rich and poor—both internationally, and within countries. This is a concern for the international community both in its own right and because in an increasingly divided and unequal world agreement on an international framework for tackling climate change will be even more difficult to achieve.

The limits of existing policy frameworks

The economic stabilization and structural adjustment programmes implemented in many developing countries over the past three decades have done little to reduce vulnerability. Adopted in response to a series of large shocks in the late 1970s and early 1980s and to the ensuing debt crisis, those

programmes aimed to remove structural and institutional impediments to growth and create more stable and resilient economies. They typically gave a much greater role to market forces and reduced that of the state, including capacities for providing public services. One prominent aspect of this shifting emphasis was fiscal retrenchment and the accompanying decline in public investment across much of the developing world. As a consequence, even with greater macroeconomic stability, private investment was insufficiently supported through infrastructure and basic services, thereby limiting productivity growth and economic diversification. In many instances, income-earning capacities were not improved and sometimes even fell, through premature de-industrialization, wage compression and the informalization of economic activity.⁹

Towards the end of the 1990s, a second generation of adjustment programmes added good governance and poverty reduction to the reform agenda, in part to deal with perceived policy slippages but also in response to the adverse impact of the earlier measures. These efforts have placed a greater emphasis on participation and ownership in the design of programmes, culminating in the preparation of Poverty Reduction Strategy Papers (PRSPs) which have become the main policy vehicle for allocating bilateral grants and concessionary loans and for advancing debt relief. However, the PRSPs have mostly left intact the economic reforms of the first-generation programmes, have done little to seriously assess the impact of major macroeconomic and structural measures on the poor, and have failed to establish a more integrated approach to economic and social challenges. In particular, as a 2002 United Nations Conference on Trade and Development analysis found, they have continued to promote unduly restrictive macroeconomic policies to the detriment of investment-led growth and diversification strategies, denied the contribution of industrial and technology policies towards supporting such strategies, and adopted a one-size-fits-all approach to integration into the international economy.¹⁰

In order to adapt to a warming world, developing countries will need new policies that build robust links among investments, growth and diversification, allowing them to make progressive adjustments to climatic changes and to strengthen national resilience to climatic shocks.

THE IMPACTS OF CLIMATE CHANGE

As noted, the damage from climate change will not be felt uniformly. Some damages will be gradual, such as those caused by sea-level rise or the

spread of drought. Others will be inflicted suddenly, in the form of more frequent and intense natural disasters. Some threats will be confined to specific sectors, while others will have a systemic impact. Moreover, while the impacts will have ramifications across all countries and regions, their intensity will often be quite localized, with some communities and countries much more exposed than others.¹¹ In general, most of the imminent adverse impacts on livelihoods are expected to be felt in developing regions, where drought (Africa) and flooding (parts of Asia) are already serious threats. On the other hand, heat spells might challenge water security in some developed regions, for instance, in Australia and New Zealand, particularly if temperatures rise by more than 2° C.

Agriculture and forestry

Globally, more than one third of households rely on agriculture for their livelihoods; in sub-Saharan Africa, the proportion is over 60 per cent. Moreover, in many poorer countries, primary products are a major source of foreign-exchange earnings and provide important inputs into fledgling manufacturing activities. While the economic weight of this sector is expected to decline further over the coming decades, improving agricultural performance is essential for food security and for sustained economic growth, particularly at lower levels of development.

The net impact of climate change on global agricultural production remains uncertain. There are regional variations in the expected pace of warming, but the agriculture and forestry sectors in developing countries of all regions are particularly vulnerable to climatic shifts, as even small changes in temperatures and precipitation levels can disrupt growth cycles and yields.

Significant reductions in the average yield of key staples and protein sources, and increased flood risks and consequent damage to assets are a few of the most adverse effects of climate change on developing regions. In contrast, warming and a general increase in rainfall are likely to lead to increases in crop productivity in northern and central Europe, particularly as some crops that are traditionally grown in southern Europe will become viable farther north. However, newer research suggests that the benefits in temperate and cooler regions may not be as great as initially estimated, if there are benefits at all. The economist William Cline, for example, has projected that by the 2080s, a business-as-usual climate scenario would reduce world agricultural output by 16 per cent without any estimate

for carbon fertilization, or by 3 per cent with carbon fertilization effects included. For the United States, Cline projects an agricultural output loss of 6 per cent without carbon fertilization, or a gain of 8 per cent with it.¹² Other recent research implies even greater yield losses for the United States, driven by the rapid increase in the number of extremely hot days during the growing season.¹³

For developing countries, not only will the impacts be more uniformly negative, but their greater reliance on agriculture and the vulnerabilities of small-scale producers will make it even harder to cope. In many developing regions, growing seasons will shorten, areas suitable for agriculture will decline, and land degradation will intensify—especially along the margins of semi-arid and arid areas. Moreover, heat-related plant stresses will contribute to reduced yields in staple crops. In sub-Saharan Africa, one recent study projected, yields will drop by 22 per cent for maize, 17 per cent each for sorghum and millet, 18 per cent for groundnut, and 8 per cent for cassava by mid-century.¹⁴ Likewise, extreme wind, storms, and turbulence are expected to decrease fish catches in several countries; the effects of ocean warming and acidification will only make this problem worse, reducing the productivity of fisheries almost everywhere.

Food security and rural livelihoods are closely linked to water availability and use. Scarcity of freshwater already threatens livelihoods linked to agriculture and forestry in an estimated 40 per cent of rural areas worldwide, and the heightened threat from climate change introduces the risk of far greater damage, increasing the likelihood of social conflict and triggering large-scale migration. Rising sea levels may also lead to salinisation of rivers, which further increases freshwater stress.

Moreover, many developing countries are lacking irrigation and modern agricultural inputs such as fertilizers, herbicides and insecticides. Under these conditions, yields are low, and climate change could have disastrous consequences for food security. In Mali, for instance, the proportion of the population at risk for hunger could increase from 34 to over 70 per cent by the 2050s, one study estimated.¹⁵

Forests cover about 30 per cent of the global land surface and contribute to the livelihoods of more than 1.6 billion people, providing food, fuel for cooking and heating, medicine, shelter and clothing, according to the Food and Agriculture Organization of the United Nations (FAO). An estimated 60 million highly forest-dependent people live in the rainforests of Latin America, South-East Asia and West Africa; another 350 million people directly depend on forest resources for subsistence or income, and 1.2 billion people in developing countries rely on trees on farms. In much of

rural sub-Saharan Africa, forest foods are a regular part of the diet, and some farmers earn more than half their cash incomes from selling forest products such as wild honey, charcoal, fuelwood and wild fruits.¹⁶

Rising temperatures, shifting precipitation patterns and increasing emissions are likely to have significant impacts on forest growth, though the extent to which they will be positive or negative is not yet entirely clear. Indirect impacts such as the intensity of forest wildfires, invasions of insects and pathogens, and extreme weather events will definitely do harm. Overall, climate change is expected to both increase global timber production and shift supply locations from temperate to tropical zones and from the northern to the southern hemisphere. While this will lead to an increase in the trade in forest products, the benefits are likely to be unevenly distributed and are expected to adversely affect people in extreme poverty who depend on forests for their livelihoods.

Urban environments

Cities, meanwhile, are already home to more than half the world's people, and as noted earlier, the urban share of the population is growing rapidly, especially in developing countries. Urbanization is a major driver of climate change, and climate change will also have a significant impact on urban environments, adding a dangerous feedback loop to growing urban stresses.

Much of the urbanization in developing countries is unplanned and poses massive challenges, even without taking heightened climatic threats into account. These include health problems linked to air pollution and high population density, problems associated with transportation and inadequate infrastructure, personal safety problems linked to high levels of criminal activity, and deficient access to and provision of social services. Climate change is likely to exacerbate all these problems. Increased migration from rural areas affected by climate change will also put pressure on cities, overloading their already strained infrastructure and services.

While there are many climate-related hazards facing urban areas, coping with an increased incidence of natural hazards may pose the most immediate challenge. For instance, unplanned urban settlements, especially slums, often materialize in high-risk areas, such as river banks and unstable hill slopes. While slum dwellers may be able to cope with occasional shocks, more frequent flooding of greater magnitude would likely force them to resettle, possibly pushing them into greater poverty and increased climate exposure.

In the absence of any forward-looking strategy, an estimated 1 billion people are already at risk from hydro-meteorological hazards, and that figure is predicted to increase to 1.4 billion people by 2020, according to UN-Habitat.¹⁷ More frequent and more intense rainfall will, for instance, increase the risk from landslides and the threat from water inundation. In fact, poor drainage is already a serious issue in many cities, particularly in developing countries, and climate change increases the risk of both flooding and disease.

Health and water security

The need to adapt to difficult environmental conditions has been a perennial challenge for human societies. Now, with warming on an accelerating trend, the impacts of climate change on health and water security merit particular attention.

The range of health risks from climate change is likely to be considerable, with all parts of the globe affected, as the unprecedented number of deaths in Europe from recent heat waves has demonstrated. However, health vulnerability is closely linked to other vulnerabilities. The people most vulnerable to climate change are those who already lack access to adequate health services, and the greatest factor determining the intensity of impacts across regions is not the severity of climate change, but variation in the magnitude of pre-existing health problems.

Many of the most important infectious diseases are highly sensitive to both temperature and precipitation conditions, so global warming will increase the prevalence of vector-borne diseases, particularly in poor countries. The World Health Organization notes that many major killers, such as diarrhoea, malnutrition, malaria and dengue are “highly climate-sensitive” and expected to worsen over time; already, it estimates, the effects of climate change since the 1970s are causing about 140,000 additional deaths each year.¹⁸ Extensive research also indicates that over the long term, higher temperatures will increase the levels of ozone and other air pollutants that provoke cardiovascular and respiratory diseases, as well as pollen and other aeroallergens that trigger asthma, affecting the poor and elderly most severely.

Climate change is likely to have the most immediate effect on health and well-being via the declining availability of water. It is estimated that one quarter of the population in Africa (about 200 million people) experience water stress. Increasing temperatures and more variable precipitation are expected to reduce the availability of fresh water, making it more difficult

to fulfil basic needs for drinking, cooking and washing. Meanwhile, a greater incidence of floods due to more intense precipitation, sea-level rise and other factors will further contaminate freshwater supplies and increase water scarcity. It will also create opportunities for the breeding of mosquitoes and other disease vectors as people are forced to store water for longer periods.

Higher temperatures and more extreme heat waves are also expected to increase mortality rates, both from the heat itself, and from increased air pollution. Urban areas will be particularly hard-hit due to the “heat island effect”, which can make urban areas warmer than surrounding areas, especially at night, by 5° C or more.¹⁹ The summer of 2003 provided a stark reminder of the potentially devastating impacts of heat waves: temperatures that soared above the range of historical experience over large parts of the European continent are estimated to have caused as many as 70,000 deaths, the majority of which occurred in urban areas.

MEETING THE CHALLENGE OF ADAPTATION

Despite the imminent threat, adaptation to climate change has not been mainstreamed into decision-making processes in developing or developed countries. Instead, it tends to be addressed by adding an “extra” layer to existing policy designs and implementation mechanisms. The frequent approach of equating adaptation measures with emergency relief, and framing the challenge in terms of requests for donor support, has not helped. Instead, it has often given rise to a bifurcated approach to adaptation, where efforts either focus on responses to the impacts of climate change (coping measures) or on reducing exposure by climate-proofing existing projects and activities, particularly in the context of disaster risk management. The underlying philosophies can pull in different policy directions. There is a real danger, already apparent in the response to natural disasters, that underlying structural causes of vulnerability and maladaptation will be missed, including a number of closely interlinked and compounding threats to social and economic security.²⁰

Recent efforts to forge a more consistent approach to adaptation stress the central role of market incentives. However, this approach also tends to treat the challenge as a series of discrete and unconnected threats which can be addressed through incremental improvements made to existing arrangements, thereby missing the large-scale investments and integrated policy efforts that are likely to be needed.

An alternative is to focus on building resilience to climatic shocks by realizing higher levels of socio-economic development that can provide a buffer for threatened communities. This helps address the interrelated socio-economic vulnerabilities, such as a narrow economic base, limited access to financing, and food insecurity, that can hold back growth prospects and expose communities to unmanageable shocks.

From this perspective, well-designed adaptation measures for addressing climate threats should simultaneously meet other needs, avoid conflict with development objectives, and avoid measures that increase vulnerability to other environmental risks. For example, adaptation to climate change in agriculture should be part of broader agricultural policy efforts to raise productivity and reduce the vulnerability of the sector to outside shocks. Similarly, forest conservation and reforestation policies should be an integral part of broad development and poverty reduction strategies, encompassing investment in economic diversification, human capital and employment creation as well as improvement of land, soil and water management. However, the room for “win-win” (or “no-regrets”) solutions should not be exaggerated. The cost of adaptation is likely to be high, and a majority of solutions will involve difficult choices and trade-offs. Making such choices will require enhanced national regulatory authority and strategic planning processes encompassing open discussion within the entire community.

More effective and inclusive institutional responses to the adaptation challenge are also needed. The scale of resources required will, in most cases, call for national resource mobilization and an integrated and strategic approach. Integration of adaptation measures into overall planning and budgeting should start with the assessment of local vulnerabilities to existing climate threats, including their variability and extremes, and the extent to which existing policy and development practice has served to reduce or increase those vulnerabilities. In doing this, policymakers must engage more closely with the affected local communities. They should also draw lessons from past government failures due to insufficient dialogue and cooperation among different ministries, and invest in new capacities to deal with the specifics of the adaptation challenge. For example, meteorological services in many developing countries will need to be improved so they can provide agriculture with more reliable forecasts.

An initial step towards a more integrated approach has been taken by some countries through National Adaptation Programmes of Action, conceived as a means through which least developed countries could secure financial support for climate adaptation. The concept was negotiated during the seventh session of the Conference of the Parties to the United

Nations Framework Convention on Climate Change in Marrakech, Morocco, in 2001. These programmes, which are structured through a bottom-up approach, are action-oriented and tailored to specific national circumstances; they identify “urgent and immediate” investment projects that could significantly contribute to adaptation and poverty alleviation. Some of their greatest strengths are the participation of government agencies and civil society, the consistency with national development plans, and the focus on vulnerability assessment. Still, they are hindered by difficulties in scaling up projects, funding and institutional shortcomings, and a failure to adopt a more broadly developmental approach.²¹

Climate-smart development

In managing climate change, its impacts should be considered in concert with other processes of change, such as urbanization, economic development, and shifts in land use and resource demands. Development policy must become “climate-smart” through its awareness of the range of risks that will emerge over the coming decades. The commitment of resources to meet these risks will be beneficial if it protects the growth path from unforeseen and large-scale shocks, but it does carry a cost, diverting resources from other productive investments. Policymakers must plan adaptation efforts accordingly, with an eye to boosting broader development efforts and special attention to:

- ***Vulnerable populations***, whose “coping range” with respect to climate shocks is limited. For example, some 28 per cent of people in the Mekong and Red River Deltas (some 8.7 million) are small-scale farmers who are estimated to be actually or potentially food-insecure. A changing climate may further stress their livelihoods, with salinity intrusions in the summer and risks of higher-than-historic flooding in the monsoon season. Thus the local impacts of a changing climate would be devastating and would require priority considerations in adaptation plans. This does not mean there should be an exclusive focus on the “poorest of the poor”, however; often, for relief purposes, it is better to scale up programmes to include wider rural groups who are at risk for spells of economic insecurity and poverty.
- ***Synergies*** in responding to multiple development challenges. The failure of key infrastructure systems typically results not from a single factor, but from a combination of risks. For example, irrigation could become more difficult due to climate change, exacerbating the impact of

unemployment and food scarcity. The interrelation between adaptation and mitigation also provides opportunities for synergies, for example, where irrigation systems expanded to meet adaptation challenges can be used to open up new markets for low-emissions technologies such as those developed to provide renewable energy.

- ***Scale economies***, resulting from opportunities such as the development of an entire river basin or coastal zone, encompassing major, long-term infrastructure investments in coastal roads, hydropower and irrigation systems. For example, the maritime coast of Mozambique, one of the longest in Africa, extends over a distance of 2,400 kilometres, and is home to about 60 per cent of the population. The area's leading economic activities, including fisheries, tourism and ports, as well as mining, oil and gas, are of immense economic value today, and will continue to be in the future. Ecological and economic stresses already threaten the region, however, and climate change is expected to increase the incidence of destructive cyclones. The Government of Mozambique has drawn up ambitious plans for the sustainable development of the coastal region, including infrastructure (transportation, drainage and water supply), land-use changes, and soft options to manage beach erosion. Such plans, which present unique opportunities for a massive stimulus to development, need to deal with climate risks in an integrated manner, across seasonal, inter-annual and multi-decadal time scales.
- ***Complementarities***, achieved by piggybacking on efforts already under way, such as the expansion of a metropolitan water supply and sewerage system. For example, concerns about maintaining a steady water supply for a hydropower plant on the Rio Amoya in Colombia have led to efforts to preserve the *páramo* ecosystem upstream, in the Las Hermosas massif in the central range of the Andes.²²

How to apply the integrated approach

To tackle the underlying vulnerabilities that put communities at risk in the face of climate-related threats due to global warming, states must ensure that climate risks are integrated into national and local disaster risk-reduction plans. To be effective, adaptation strategies will have to differentiate among the various dimensions of adaptation at the local, regional, national and international levels as well as within different economic sectors. Table III.1 provides examples of potential adaptation measures for different sectors following the integrated developmental approach suggested above.

Table III.1

Potential measures of adaptation to climate change for different sectors

<i>Sector</i>	<i>Adaptation measures</i>
Urban planning	Building residences closer to workplaces in order to reduce transportation time and costs, thereby boosting productivity in a service economy
Water	<ul style="list-style-type: none"> • Expanded rainwater harvesting • Water storage and conservation techniques • Desalinization • Increased irrigation efficiency
Agriculture	<ul style="list-style-type: none"> • Adjustment of planting dates and crop diversification • Crop relocation • Improved land management, for example, erosion control and soil protection through tree planting
Infrastructure	<ul style="list-style-type: none"> • Improved seawalls and storm surge barriers • Creation of wetlands as a buffer against sea-level rise and flooding
Settlement	Relocation
Human health	<ul style="list-style-type: none"> • Improved climate-sensitive disease surveillance and control • Improved water supply and sanitation services
Tourism	Diversification of tourism attractions and revenues
Transport	<ul style="list-style-type: none"> • Realignment and relocation of transportation routes • Improved standards and planning for infrastructure in order to cope with warming and damage
Energy	Strengthening of generating facilities and grids against floods, windstorms and heavy precipitation
Source: Adapted from table 5-1 in Dodman, Ayers and Huq, 2009.	

Forestry and agriculture

Adaptation practices for the forestry sector today are generally based on lessons learned from past adaptations to climate variability. Important elements of forest protection include improved climate forecasting and disease surveillance systems, and strategies for preventing and combating forest fires, including the construction of fire lines, controlled burning and the utilization of drought- and fire-resistant tree species, such as teak, in tropical forest plantations. Some additional measures aimed at assisting forests in adapting to climate change are also needed to enable sustainable forest management. These include facilitating the adaptive capacity of tree species by maximising silvicultural genetic variation, and management approaches such as minimising slash, reduced-impact logging and widening buffer strips and firebreaks.

In order to succeed in the long run, forest adaptation measures need to include development of alternative, sustainable economic activities for the affected communities. For instance, the Brazilian Amazon is home to 20 million people, many of them poor, and many of them dependent on activities linked to deforestation, such as logging and use of cleared land. This ongoing deforestation releases 200 million tons of carbon into the atmosphere each year, the Brazilian Government reports—about 3 per cent of total global greenhouse gas emissions from all sectors.²³

In many poorer countries, increasing agricultural productivity and reducing vulnerability to climatic shocks are crucial to long-term sustainability. Decreasing crop failure and maximizing yields over good and bad years alike will be important, particularly where subsistence farming is involved. Strategies to decrease crop failures will include crop diversification, which is potentially one of the most important strategies for achieving food security in a changing climate, and the use of new crop strains that are more weather-resistant and have higher yields. For example, at the Njoro division in Kenya, farmers have been trying to switch from wheat and potatoes to quick-maturing crops such as beans and maize, while planting every time it rains since there is no longer a clear-cut growing season. Still, it is not clear how sustainable this strategy will be, in particular given the multiple vulnerabilities that such communities often face.²⁴

In Bangladesh, whereas people traditionally grew low-yield deep-water rice during the monsoon season, they now grow, in areas covered by flood management projects, one high-yield rice crop (*aman*) that is planted during the monsoon, another (*boro*) that is planted in the dry season, with irrigation, and a third (*aus*) that is planted in the pre-monsoon season. Innovative approaches to protecting agriculture in Bangladesh, which is particularly prone to natural hazards and frequent flooding, also include *dap chas* (floating gardens), where crops are grown on floating rafts to protect them from floods.²⁵

The interconnections of the risks arising from development and climate are particularly apparent when considering food security. In the Sudan, persistent and widespread drought is likely to worsen with climate change. On the other hand, a more integrated approach to climate risk and livelihoods has increased resilience in some communities. Water harvesting, new crops and types of livestock, and rehabilitation of rangelands, along with access to finance and improving farm skills, have enhanced capacity for adaptation and improved food security.²⁶

More generally, economic policies to promote agricultural development should focus on extending support services, particularly for smallholders, and improving infrastructure (such as roads, storage facilities and irrigation networks). Those policies should address land reform and build research and technical capabilities. The establishment of strategic food reserves, including at the international level, would allow governments to reduce price volatility by releasing food in times of emergency and crisis. These reserves could help poor countries which may not have the capacity to respond quickly to sudden scarcity, while proving more effective than other approaches in controlling international price volatility. The need to adapt to climate change could reinforce strategies to promote adaptive agricultural research and development, particularly in Africa, where there is a large gap between current yields and agricultural potential. For example, a new rice variety was successfully developed by the government rice research station in Sierra Leone that has a higher yield and is better suited to drier climate conditions. The new variety is already in use among farmers.

Urban environments

Urban adaptation requires a long-term perspective, recognizing that climate change may amplify the underlying vulnerabilities associated with rapid urbanization. The strain on cities in developing countries is already enormous; adding climate change to the picture may require a paradigm shift in urban planning. National policies to identify and influence formal and informal urban developments are essential, as is the allocation of areas for housing development in order to anticipate and shape the vision for cities. Preventing informal settlements in areas that should not be developed requires governance structures and a solid institutional basis, with city visions and master plans supported by an institutional fabric. Such a fabric is often weak or non-existent in many developing countries.

Disaster risk reduction is an important part of adaptation in urban areas. Institutions established to address disasters are typically weak, and the traditional focus is on disaster relief, consisting largely of searching for missing persons and providing short-term shelter and food. Anticipatory adaptation, in contrast, would encompass preparedness, including relief plans and awareness-raising activities. Thus, looking beyond the emergency dimension of post-disaster response, anticipatory adaptation will need to focus on infrastructure, land-use planning and regulatory measures. Particular attention will need to be paid to temporary dwellings, such as

shanty towns and slums, as well as areas built in vulnerable locations and in high-risk areas, such as river banks or unstable hill slopes; in many developing countries sewage and drainage systems need to be built to reduce the risk resulting from more intense precipitation. Some current approaches, such as the elevated walkways set up in Bangkok to cope with flooding, are mere stopgap measures designed to increase pedestrian mobility in high-traffic areas, rather than to shield people from exposure to stagnant surface water.

Long-term measures should address climate vulnerability in the context of rapid urbanization. This would include, for instance, changing legislation that withholds tenure and thus obstructs the consolidation of buildings, contributing to the perpetuation and expansion of shanty towns. Adaptation in urban areas requires strong governance that is focused on sustainable development and supported by appropriate institutional arrangements. As things currently stand, most of the risk to urban areas is in fact associated with the incapacity of local governments to provide for infrastructure, disaster risk reduction and disaster preparedness.

Health and water security

Protection from and adaptation to climate change risks are part of a basic preventive approach to public health, not a separate or competing demand. However, while the global health community has a wealth of relevant experience, shortfalls in provision of basic public health services leave much of the global population exposed to climate-related health risks, making it difficult for health services to look beyond the horizon of urgent short-run health gaps. Thus, there is a need for both additional investment to strengthen key functions, and forward-looking planning for systems that will be able to address new challenges posed by climate change.

Adaptation in the public health realm also requires a broader cross-sectoral approach, as the risks that climate change poses to health are embedded within the wider challenge of achieving genuinely sustainable development. The links between poverty and vulnerability to climate change are clearly in evidence in the health sector, highlighting the importance of further development. Indeed, poverty is one of the leading determinants of vulnerability to climate-related health risks.

Improved water management can have a direct impact on development opportunities, because it is primarily poor water management and lack of water entitlements, rather than physical scarcity of water, that generate

water-related tensions and poverty. Along these lines, Bangladesh has begun a pilot project to remove the mountains of silt that build up in its rivers in order to fill in shallow lowlands prone to flooding, or to create new land in order to protect its long, exposed coast against sea-level rise. The silt-trapping experiment has yielded visible gains in small areas such as Beel Bhaina, a low-lying 243-hectare (600-acre) soup bowl of land on the banks of the Hari River, about 55 miles upstream from the Bay of Bengal. United States scientists have recommended a similar silt diversion programme: opening Mississippi River levees south of New Orleans to allow sediment-rich water to flow over the region's marshes, which have been starved of silt since levee-building began in the region hundreds of years ago.

An even greater threat is the increased variability of water supplies in a changing climate. As demand rises due to population growth, increased resilience is required in water management systems. Although efforts are already under way to strengthen these systems in a number of developing countries, significant public investment will be needed to achieve sustainable results.

INTERNATIONAL COOPERATION ON ADAPTATION

International cooperation on adaptation is essential for a number of reasons. First, the heaviest impact of human-induced climate change will be on small island developing States and the poorest countries in the world, including many African nations. These are the countries that have contributed least to the problem of global warming. Second, these and other developing countries often have difficulties mobilizing the resources needed to reduce their climate exposure, build up resilience and make a rapid recovery after disasters strike. This is a development challenge that can be properly met only through large-scale investments and strategic policies that can draw on the assistance of the international community to help strengthen economic and social capacities at the local and national levels. Third, finding the right response to adaptation can point the way to developing more integrated responses to other shocks that threaten peace, security and well-being.

Setting aside their responsibility for the heightened threats from climate change, the fact remains that developed countries themselves stand to benefit from helping developing countries adapt. The wider consequences of climate impacts, such as increased destabilization and violence resulting from climate-induced conflict, have the potential to jeopardize national and international security. Moreover, the rising level of global inequality

that could result from climatic shocks is in neither the economic interest (given the lost export and investment opportunities involved) nor the political interest (given the threat to global cooperation) of rich countries seeking to forge a global framework for better managing climate change. Developing countries, in turn, should give priority to formulating plans for adaptation and take advantage of expertise made available by adaptation funds to establish more integrated and transparent strategies, which would include close consultation with and the participation of their citizens most immediately affected by rising temperatures and climatic shocks.

Scientists confirm that the time frame for acting to curb global greenhouse gas emissions and reduce the probability of catastrophic events is no more than decades—perhaps only the next few decades. Estimates of the cost of adaptation are still tentative and incomplete. The risk, however, lies in underestimating the scale of the challenge, which is made even greater by the slow pace to date of climate change mitigation efforts.

Funding for adaptation has grown substantially in recent years, with almost \$4 billion provided in 2009 by the top four bilateral finance institutions alone, according to the United Nations Environment Programme.²⁷ In addition, there are several specialized funds, including three under the Global Environment Facility and the Adaptation Fund under the Kyoto Protocol. One recent analysis found that six major specialized funds were providing \$100 million to \$200 million per year for adaptation. It also noted that adaptation funding could increase substantially as a result of commitments made in the Copenhagen Accord and the Cancún Agreements—which include up to \$30 billion per year in “Fast-Start” funds for 2010–2012, with “balanced allocation between adaptation and mitigation”—and in the long term, with the new Green Climate Fund.²⁸ Even so, there is an enormous gap between the resources considered to be necessary for adaptation, in the range of \$50 billion–\$100 billion per year, and the amount actually mobilized and available.

A key issue with adaptation funding is its relation to development aid. The difficulty in scaling up aid is a real cause for concern, given the urgency of the adaptation challenge in many countries. The current bilateral instruments are unlikely to suffice: more innovative (and predictable) sources of funding will be needed. The principles set out in the UNFCCC, which distinguish between development and adaptation financing, insist on the need for additional funds above existing development aid. This rightly highlights the responsibility of rich countries for funding adaptation, but it runs the risk of ignoring the interconnected nature of these two sets of

challenges, of sidestepping the long-standing debate on the adverse impact of excessive policy conditionality attached to aid and other development financing, and of leading to a proliferation of funding mechanisms and facilities that would likely reduce the effectiveness of international support (see chap. VI for further discussion).

CONCLUSION

All countries will face the challenge of adapting to warmer temperatures and related climatic changes in the coming decades, even if rapid progress is made towards a lower-emissions global economy. However, for some, the threat to livelihoods is already very real and, in some extreme cases, approaches catastrophic levels.

The adjustments required to adapt to climate change cannot be assessed in isolation or undertaken incrementally. Rather, they are closely interconnected with other risks and vulnerabilities that accompany development and will be heavily constrained by local institutional and technological conditions. Successful adaptation hinges on faster and more equitable growth, even as failure to adapt threatens those goals.

This chapter has argued that, in many cases, the response will involve a sizeable investment of resources to make countries and communities more resilient and to address vulnerabilities that can turn even small climatic shocks into long-term development disasters. This excludes a one-size-fits-all policy response. The right approach is an integrated national strategy, which will require mobilization of domestic resources and the guidance of an effective developmental state.

Meeting such challenges will require a break with recent policy approaches which have given undue attention to market forces and competition. Adaptation, like mitigation, is a public policy challenge, the complexity of which will require using a broad array of strategies to build resilience.

A smarter approach will build adaptation responses into ongoing development strategies by paying particular attention to vulnerable populations, by making use of large public works and taking advantage of scale economies, by addressing the thresholds below which current systems consistently fail, and by exploiting investment complementarities.

Even so, many countries for whom the challenge is simply too big cannot be expected to meet it by themselves. Hence, it was agreed at the UN Climate Change Conference in Bali in 2007 that finance and

technical assistance would be available to help developing countries meet the adaptation challenge. Years later, that assistance remains woefully inadequate and poorly organized. Improvements in this regard are likely to be a prerequisite for making real headway towards putting those countries on more sustainable development paths.

NOTES

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