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STATE OF THE WORLD

Into a Warming World

THE WORLDWATCH INSTITUTE

Building Resilience

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Climate change is going to present society with a variety of new challenges. Individuals, households, and communities around the world—but particularly in low- and middle-income nations—will all be affected in the coming years and decades. Changes in mean temperature are going to affect food production and water availability, changes in mean sea level will increase coastal inundation, and more-frequent and more-intense extreme events will result in more damage and loss of life from floods and storms. On top of this, rising temperatures can increase the burden of malnutrition, diarrheal illnesses, cardiorespiratory diseases, and infections. These challenges are felt particularly strongly in some of the poorest regions of the world. As Mama Fatuma, a butcher and long-term resident of Njoro Division in Kenya, puts it: “These days we do not know what is happening. Either there is too much rain or none

at all. This is not useful to us. When there is too much rain, the floods that result cause us harm. When there is not enough rain, the dry conditions do us harm.”¹

What can be done to reduce the vulnerability of individuals, communities, and countries to the threats of climate change? Farmers in Njoro Division have come up with a wide array of adaptive strategies. They are switching from wheat and potatoes to quick-maturing crops such as beans and maize, and they are planting any time it rains because there is no longer a clear growing season. Their actions have been supported by community groups that have built rain-harvesting tanks and set up savings clubs, while local government agencies have bolstered local resilience by recommending new species and new cultivation techniques to cope with changes in the climate.

A large proportion of the world’s popula-

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tion is vulnerable to changes like those facing farmers in Kenya, but the risks are not distributed evenly. This reflects profound global inequalities: the countries that have profited from high levels of greenhouse gas (GHG) emissions are the ones that will be least affected by climate change, while countries that have made only minimal contributions to the problem will be among the most affected. The uneven distribution of climate change risk mirrors the existing uneven distribution of natural disaster risk—in 2007, Asia was the region hardest hit and most affected by natural disasters, accounting for 37 percent of reported disasters and 90 percent of all the reported victims. Human-induced climate change is likely to have the heaviest impact on small island developing states, the poorest countries in the world, and African nations. Taken together, these countries form a group of 100 nations, collectively housing more than a billion people but with carbon dioxide emissions (excluding South Africa's) accounting for only 3.2 percent of the global total.²

Adaptation and resilience not only can reduce the risks from climate change, they can also improve living conditions and meet broader development objectives around the world. This requires a recognition of the many ways in which experiences of vulnerability and resilience differ: between countries; between children, women, and men; and across class and caste within the same society. It requires accepting the importance of the interactions between human and natural systems and realizing that resilient social systems and resilient natural systems—although not the same thing—do exhibit a high degree of co-dependence. It also requires institutional transformations at a variety of scales: local organizations, local governments, national governments, and international organizations all need to become climate-resilient themselves and to work toward creating the

frameworks within which individuals, households, communities, and nations can deal with the challenges of climate change.

Vulnerability, Adaptation, and Resilience

Vulnerability, adaptation, and resilience are all deceptively simple concepts with widely varying meanings. Vulnerability is the basic condition that makes adaptation and resilience necessary. In reference to climate change, it is a measure of the degree to which a human or natural system is unable to cope with adverse effects, including changing variability and extremes. It can be seen as an outcome of the seriousness of the stress and the ability of a system to respond to it. Adaptation is a related concept that refers specifically to the adjustments made in natural or human systems in response to actual or expected threats.³

Both vulnerability and adaptation are unevenly distributed, and in many cases it is the most vulnerable individuals and communities who are least able to adapt. As the Intergovernmental Panel on Climate Change (IPCC) concludes, “the technical, financial and institutional capacity, and the actual planning and implementation of effective adaptation, is currently quite limited in many regions.” When properly implemented, however, adaptation strategies can help limit the loss of life and livelihoods from changes in mean temperatures and the more-frequent and intense extreme climatic events associated with climate change.⁴

The types and scales of adaptation activities are extremely varied (see Table 5–1), and particular strategies will depend on the nature and context of climatic vulnerability. For example, Cavite City in the Philippines is on a peninsula surrounded by three bodies of water, with about half its population on the

Table 5–1. Examples of Planned Adaptation for Different Sectors

Sector	Adaptation Strategies
Water	Expanded rainwater harvesting Water storage and conservation techniques Desalination Increased irrigation efficiency
Agriculture	Adjustment of planting dates and crop variety Crop relocation Improved land management (such as erosion control and soil protection through tree planting)
Infrastructure and settlement	Relocation Improved seawalls and storm surge barriers Creation of wetlands as buffer against sea level rise and flooding
Human health	Improved climate-sensitive disease surveillance and control Improved water supply and sanitation services
Tourism	Diversification of tourism attractions and revenues
Transport	Realignment and relocation of transportation routes Improved standards and planning for infrastructure to cope with warming and damage
Energy	Strengthening of infrastructure Improved energy efficiency Increased use of renewable resources

coast. Cavite experiences on average two tropical cyclones every year, and the city is also affected by drought and sea level rise, all of which are predicted to be greatly exacerbated by climate change. Currently 10 percent of the population is vulnerable to sea level rise, but a one-meter increase would put around two thirds of the population at risk. People have responded through various adaptation strategies, including building houses on stilts, strengthening or reinforcing the physical structure of houses, moving to safer places during extreme weather events, placing sandbags along the shorelines, and taking up alternative income-generating activities locally or in other areas.⁵

Whereas vulnerability is a particular state

and adaptation is a set of activities in response to it, resilience is a less distinct concept. In engineering it means the ability of a material to return to its original state after being subjected to a force; in ecology it often means the time taken for a system to return to a state of equilibrium. Both of these meanings have been applied to human systems, in an analysis that focuses on the ability of individuals, households, and nations to return to “normal” after disrupting events. The legacy of these definitions can be seen in the Fourth Assessment Report of the IPCC, which defines resilience as “the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.”⁶

But is resilience of this type really desirable? Is it acceptable to return to the “same basic structure” in which some 1 billion people live on less than \$1 per day, in which there are 350–500 million cases of malaria each year, and in which around half of the people living in African and Asian cities lack adequate water and sanitation facilities? With this in mind, perhaps it is more appropriate to consider resilience as a process, a way of functioning, that enables not only coping with added shocks and stresses but also addressing the myriad challenges that constrain lives and livelihoods and facilitating more general improvements to the quality of human lives. Resilience as a process therefore needs to take into account the economic, social, psychological, physical, and environmental factors that are necessary for

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humans to survive and thrive.⁷

Many aspects of resilience are closely associated with a holistic approach to development. Individuals who have access to adequate food, clean water, health care, and education will inevitably be better prepared to deal with a variety of shocks and stresses—including those arising from climate change. Communities and cities that are served by appropriate infrastructure—particularly water, sanitation, and drainage—will also be more resilient to these shocks. Indeed, one of the most significant reasons poor people in developing countries are more at risk from climate change is because they are inadequately served by the day-to-day services that are taken for granted in more-affluent locations.

Resistance and resilience are shaped by a person's access to rights, resources, and assets.

Resilience of this kind requires a variety of components, all of which must be present to different extents, but some of which are more pertinent to human systems or to ecological systems. An overriding component is appropriate human-natural relations: human systems that do not exceed the capacities of the natural systems in which they are located, and natural systems that are not unduly threatened by human activities. Both human and natural systems require a capacity for self-organization in order to deal with threats, and diversity is a key element for both types of system too. As shocks and stresses create changes from the norm, a capacity for learning (to deal with novel threats) and innovation (coming up with new solutions) are also important.

At a practical level, people rely on a variety of assets and entitlements to support themselves in difficult times, including

human, natural, financial, social, and physical capital. Resistance and resilience are shaped by a person's access to rights, resources, and assets. Mobilizing these assets, however, requires local institutions and national and international systems of governance to provide the framework within which they can function. All these disparate elements—the ecological, the individual, and the institutional—need to come together in a mutually reinforcing manner to help individuals, households, and communities cope with change, including climate change.⁸

A recent adaptation program in five villages in Kabilas VDC in the Chitwan district of Nepal run by the nongovernmental organization (NGO) Practical Action demonstrates well the necessary links between assets, communities, and institutions in building resilience. The main activities focused on improving access to resources and assets, which involved small livestock distribution, vegetable farm demonstrations, kitchen gardening and organic farming, seed and fruit sapling distribution, and sloping agricultural land technologies. A subsequent evaluation suggests that the project had a positive influence on food production and income generation: vegetable production increased in the project area threefold, and farmers are able to sell surplus vegetables. Some 10 percent of farmers now grow vegetables on a small-scale commercial basis, compared with none prior to the project.⁹

The project was linked to local government structures through representatives of each project community being members of a broader Climate Change Impacts and Disaster Management group, which was registered with the District Administration Office. This group was responsible for coordination and implementation of the project in different villages, encouraging local institutional support for the scaling up of project benefits for

replication in other communities. The success of the project was ultimately limited, however, by a lack of access to national financial markets. And there was a lack of support for marketing the surplus agricultural products generated by the project. As a result, people have complained that they have been unable to receive reasonable enough prices for their produce to affect their incomes significantly.¹⁰

Linking Ecological and Social Resilience

There are many linkages between social and ecological resilience. Human livelihoods and settlements rely on the resources and services provided by natural systems, whether located nearby or far away—a concept often referred to as the “ecological footprint.” In the face of environmental changes, the resilience of communities that rely heavily on particular ecosystems will in part be determined by the capacity of those ecosystems to buffer against, recover from, and adapt to these changes and continue to provide the ecosystem services essential for human livelihoods and societal development. In turn, ecological resilience is influenced by the sustainability of the human behavior that has any impact on the environment: an ecosystem is more resilient when resources are used sustainably and its capacity is not exceeded.¹¹

Climate is one of the most important factors influencing habitats and ecosystems and the abundance, distribution, and behavior of species. Climate change therefore carries severe implications for the sustainability of the world’s ecosystems, and these impacts are already beginning to show. The ability of many ecosystems to adapt naturally is likely to be exceeded during this century by an unprecedented combination of change in climate and other global changes (including land use changes, pollution, and overex-

ploitation of resources). If global mean surface temperatures increase by more than 2–3 degrees Celsius, an estimated 20–30 percent of plant and animal species will be at increasingly high risks of extinction; substantial changes in the structure and function of terrestrial ecosystems are also expected.¹²

The resilience of ecosystems to climate change depends in large part on the stresses, human and otherwise, that are already being faced. Natural systems will be better able to adapt if other stresses are minimized. For example, chronic overfishing, blast fishing techniques, and the pollution of water around coral reefs in South Asia have made them more vulnerable to cyclones and warmer sea temperatures. In this sense, social resilience to climate change may sometimes be at odds with ecological resilience: human adaptive strategies for socioeconomic development may increase pressure on marine and terrestrial ecosystems through changes in land management practices, shifts in cultivation and livestock production, and changes in irrigation patterns. In addition, more resilient and developed communities may have a greater capacity to exploit natural resources to support their adaptive strategies.¹³

Attempting to address ecological resilience from this standpoint might encourage a return to protectionist approaches to conservation in an attempt to minimize the impacts of people on nature. But that could actually decrease social resilience where people are forced away from certain ecosystem services, which may in turn put greater pressure on alternative natural resources that had previously been managed sustainably. Further, such an approach to building ecological resilience overlooks the close relationship between environmental and social vulnerability to climate change and fails to acknowledge the notion of resilience as a process rather than a return to a “stable” state. First, climate change is bringing new

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pressures to ecosystems, so attempting to “restore” ecosystems in the context of a changing climate is inappropriate. For example, the notion of “invasive species” may become redundant as many species expand and retreat in reaction to changing climate patterns. Second, approaches to building ecological resilience must also focus on the socioeconomic development of the communities dependent on the ecosystem.

The close association between people and the environment is perhaps most apparent in poor rural societies in low-income countries that rely directly on ecological systems for environmental goods and services. Socio-economic development can reduce dependence on single ecosystems by paving the way for diversification of livelihood activities, while reliance on a narrow range of resources can lead to social and economic stresses on livelihood systems, thereby constraining development. This is not a fixed relationship, however. Many people living in rural areas use diverse approaches to meet their basic needs, although these often rely strongly on land-based resources. At the same time, mono-crop agriculture often allows large landowners to become wealthy on the basis of a reliance on a single activity. This highlights an important point: the strength of association between ecological and social resilience is closely tied to the development context and is mediated by a variety of other factors, including wealth, ownership of land and the means of production, and social networks. In situations where human activity has such direct implications for ecosystem resilience, and where the type and level of these human activities are determined by the resilience of the ecosystem and the wider institutional context, integrated approaches to building resilience are essential.

This social resilience-ecological resilience-development nexus is evident in the coastal

fishing communities in the Straits of Malacca in peninsular Malaysia. Following the Nagasaki Spirit oil spill in 1992, a study in Kuala Teriang, Malaysia, found that only 4 percent of individuals from non-fishing households reported any disruption in their activities or other impacts, including the ability to obtain fish for meals. In contrast, losses due to the oil spill were reported by 90 percent of fishers’ households. The concentration of impacts in these households demonstrates the fishers’ particularly high vulnerability, in part because their livelihood was tied to coastal resources. The resilience of the communities to the oil spill therefore depended both directly on ecosystem resilience (the ability of the coastal ecosystem to buffer against and recover from the impacts of the oil spill) and on the alternative livelihood options open to the fishers as the ecosystem regenerated. In turn, the resilience of the ecosystem was related to the extent to which social systems continued to exploit it in times of stress.¹⁴

So although building ecological resilience will certainly contribute to social resilience in resource-dependent communities, it is not enough. The institutional factors that tie a society to dependence on a narrow range of ecosystems must also be addressed. Adaptation strategies that focus on either social or ecosystem resilience must take into account the tight interactions between them—and then aim to address both. This requires a holistic approach that addresses the institutional barriers to sustainable development and livelihood diversification, as well as sound and participatory natural resource management strategies.

When considering how to build resilience in the face of climate change, therefore, it is necessary to consider not only the direct impacts of a changing climate on the environment but also the implications this has for

social resilience, the feedbacks on ecological vulnerability it may entail, and the wider institutional mechanisms that can enable this cycle to be broken. Building ecological resilience is essential, although not sufficient, for achieving social resilience. But achieving social resilience through sustainable development is essential for reducing pressures on ecosystems so they can adapt in the face of climate change.

Building Rural Livelihoods That Are More Resilient

As climate change has an impact on ecosystems, the livelihoods and well-being of those reliant on the functioning of those systems is clearly threatened. This vulnerability is particularly worrying because 75 percent of the 1.2 billion people who survive on less than \$1 per day live and work in rural areas of developing countries. They lack the institutional and financial capacity to cope with the impacts of climate change, and they already suffer problems associated with subsistence production, such as isolated location, small farm size, informal land tenure, low levels of technology, and narrow employment options, in addition to unpredictable and uneven exposure to world markets.¹⁵

Rural households engaged in subsistence and smallholder agriculture in developing countries have been identified as one of the groups most sensitive to the impacts of climate change because of their high dependence on a climate-sensitive sector within ecologically fragile zones. It is impossible to forecast the impacts on rural households accurately, as livelihood systems are small, complex, diverse, and context-specific and involve a variety of crop and livestock species. Nevertheless, the recent IPCC report on impacts, adaptation, and vulnerability identified several likely impacts of climate change on rural small-

holdings in developing countries:

- increased likelihood of crop failure;
- increased diseases and mortality of livestock and forced sales of livestock at disadvantageous prices;
- the sale of other assets, indebtedness, emigration, and dependence on food relief; and
- eventual worsening of human development indicators.¹⁶

In Bangladesh, for example, agriculture employs more than half of the labor force. Temperature and rainfall changes associated with climate change have already begun to affect crop production in many parts of the country, and the area of arable land is decreasing. On average during the period 1962–88 Bangladesh lost about half a million tons of rice annually as a result of floods, the equivalent of nearly 30 percent of the country's average annual food grain imports. Future climate change trends are set to worsen agricultural conditions; a study by the International Rice Research Institute showed that a 1 degree Celsius increase in night temperatures during the growing season would reduce global rice yields by 10 percent. Such temperature increases are well within the predicted ranges for global warming.¹⁷

Although local farmers in Bangladesh are generally unaware of the implications of climate change on their livelihoods, they are noticing changes in seasons and rainfall patterns. They have observed that planting seasons have shifted and are shorter and earlier than before; in addition, unusual extremes of temperature—including cold snaps and heat waves—are damaging crops. Temperatures in Bangladesh increased about 1 degree Celsius in May and half a degree in November between 1985 and 1998, and further temperature increases are expected. Extremes are also increasing, and winter temperatures as low as 5 degrees Celsius were recorded in January

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2007—reportedly the lowest in 38 years.¹⁸

The effort to build resilience to climate change in rural livelihoods is one of the best illustrations of the close relationship between ecological resilience, social resilience, and the development and institutional context. There are a range of adaptation options, many of which are already under way in developing and industrial countries, with their effectiveness varying from only marginally reducing negative impacts to bringing about positive benefits for the communities involved. Clearly, the latter is desirable in terms of being resilient.¹⁹

Many autonomous adaptations to climate change are already occurring in rural areas, where livelihood systems experience a number of interlocking stressors other than climate change and where the most appropriate strategies will incorporate local knowledge and take a livelihoods-first approach. These include altering the timing or location of cropping activities and adopting water storage and conservation strategies in times of water stress. Poor smallholders in areas of ecological fragility tend to have extensive knowledge of options for coping with adverse environmental conditions and shocks. Further, local farmers often have intricate systems of gathering and interpreting weather patterns and adapting their seasonal farming practices accordingly.²⁰

In northeast Tanzania, for example, local farmers use very specific indicators to predict the beginning of the rains: increases in temperature; lightning; changing behavioral patterns of birds, insects, and mammals; and three different types of plant changes (flowering, new leaves, and grass wilting). Indicators for the end of rains rely on meteorological factors such as steady rainfall and wind strength, but also fauna and flora signals such as bee swarms and the ripening of seeds. In the same region, the intensity and quantity of

rainfall are predicted through local assessments of the distribution of rains, fogs, and sunshine periods.²¹

Strengthening and adapting existing local and indigenous coping strategies is key to enabling and empowering communities to enhance their own resilience. Community-based adaptation strategies use participatory tools to identify, assist, and implement community-based development activities that contribute to resilience building in rural areas in regions where adaptive capacity depends as much on livelihoods indicators as it does on climatic changes.

In Humbane village in Gwanda, Zimbabwe, for instance, traditional methods of rainwater harvesting are being communicated and aided by the NGO Practical Action in order to help rural communities adapt to increasing drought conditions. Rainwater is being captured as it falls and retained in the soil or in tanks below ground so that it can be used later as a source of clean water. By constructing ridges of soil along the contours of fields, rainfall is held back from running off the hard-baked soils too quickly, so that even when rain levels are low, families can harvest enough food.²²

Tias Sibanda, one of the first farmers on his ward to build contours to conserve rainwater, has experienced significant improvements in the harvest on his farm. Before the program, he used to plant maize on 4.5 hectares but often had nothing to harvest because of droughts. Following the project, he had two crops of maize, yielding 1.5 tons and then 0.75 tons. This meant that Sibanda did not have to buy food that year and even had enough left over to last until the next season, saving about \$400—or the equivalent of about 12 goats—on food.²³

However, resilience building is only effective insofar as it is supported by wider institutional and fiscal support mechanisms.

Efforts to build rural resilience need to address the social processes that have caused particularly vulnerable groups to be vulnerable in the first place and then consider how climate-related stresses can exacerbate risks to rural livelihoods. Higher-level structures are needed to mediate increasing competition for resources, protect poor households against marginalization by powerful actors, and coordinate responses to increasing climate variability. This would reduce the risk that household decisionmaking, which is typically focused on economic opportunities rather than climate-related risk, results in “mal-adaptive” practices.²⁴

All of this requires adaptive institutions—rural institutions that encourage and facilitate resilience and that are themselves resilient in the face of climate change. Institutions and their organizational forms shape the adaptation practices of the rural poor. In order to craft external interventions that can build rural resilience, it is important to understand how local institutions can respond.²⁵

The activities of the Direction Nationale de la Météorologie (DNM) in Mali show how government institutions can help rural communities manage climate risks. For the past 25 years, the DNM has been providing climate-related information directly to farmers, helping them to measure climate variables themselves so they can incorporate this information into their decisionmaking. The project has evolved into an extensive collaboration between government agencies and research institutions, media, extension services, and farmers, forming a strong institutional base on which the challenges of climate change can be faced by helping smallholders make the most efficient decisions.²⁶

Testimonies from farmers indicate that following the DNM initiative they felt less exposed to the uncertainties of a changing climate and more confident about investing in

improved seeds, fertilizers, and pesticides, all of which boost production. Results from the cropping season also show that crop yields and farmers’ incomes were higher in DNM program fields than in those where it was not used. However, it is difficult to prove that agrometeorological information is the main reason for the increased yields. Further, measuring the success of any adaptation program is inherently problematic. The impacts are mainly in the form of negative outcomes that have not happened: the houses that have not been destroyed, the people who have not suffered from diseases, and the children who are not malnourished.²⁷

Building Urban Areas That Are More Resilient

While cities are often blamed inaccurately for producing the bulk of climate-changing activities, there is little doubt that they are centers of climate vulnerability. Hundreds of millions of urban dwellers in low- and middle-income nations are at risk from the direct and indirect impacts of climate change. As the number of people living in cities and towns has grown—more than half of the world’s population now lives in urban areas—so too has the concentration of residents in vulnerable settings. U.N. estimates suggest that at least 900 million urban dwellers in low- and middle-income nations “live in poverty,” a situation exacerbated by the greater need in urban areas to pay for housing, water, access to toilets, health care, education for children, and traveling to and from work. Yet this concentration of people and economic activities also provides the potential for effective adaptation, improved resilience, and the chance to meet broader development needs.²⁸

Building urban resilience is important, first, because of the scale of the population at risk: a large and growing proportion of

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those most at risk from climate change live in urban areas. Second, it is important because of the potential economic costs of not having effective adaptation strategies: successful national economies depend on well-functioning and resilient urban centers. Third, it is important because of the vulnerability of these large urban populations to a variety of hazards that will result from climate change, including extreme weather events, floods, and water shortages.

The city of Manizales in Colombia has taken steps to build resilience, particularly by not letting rapidly growing low-income populations settle on dangerous sites.

Urban residents are vulnerable to a wide range of climate change impacts. Changes in temperature may worsen air quality and increase energy demands for heating or cooling, changes in precipitation will increase the risk of flooding and landslides, and sea level rise will lead to coastal flooding and the salinization of water sources. More-frequent and more-intense extreme events—such as tropical cyclones, drought, and heat waves—will also affect human health and well-being. In addition, there will be changes in the types of threats cities are exposed to as people move away from stressed rural habitats and as biological changes mean disease carriers can survive in a wider area.

All these threats come together in cities like Dhaka, the capital of Bangladesh. Its population has grown more than twentyfold in the last 50 years, and it now has more than 10 million inhabitants. Severe floods, most recently in 2007, have had major economic impacts: damaging houses and infrastructure and reducing manufacturing productivity through power outages, increased conges-

tion, and poor health among the work force. Large sections of the city are only a few meters above sea level, and the combination of sea level rise and increasingly frequent and intense storms is likely to greatly increase these risks.²⁹

The challenges are often even more acute in smaller urban centers. Elsewhere in Bangladesh, Khulna is a coastal city with a population of 1.2 million. Large parts of the city are frequently waterlogged after heavy rainfall, and there are problems with the salinization of surface water. Despite being neglected by policymakers and researchers, small- and intermediate-sized cities house an increasing proportion of the world's urban population, and the changes that are made—or not made—in these places will have substantial implications for resilience to climate change in future years.³⁰

What can be done to build resilience in these settings? Resilience will require improving urban infrastructure, creating more effective and pro-poor structures of governance, and building the capacity of individuals and communities to address these new challenges and move beyond them. In some ways, building infrastructural resilience is the most straightforward aspect of this. After all, cities around the world exist in hostile natural surroundings: much of lower Manhattan is land that has been reclaimed from the sea, and London is protected from major flood events by the Thames Barrier. Even in wealthy countries, however, these measures may not be sufficient to deal with the most extreme events, as was horribly evident in the aftermath of Hurricane Katrina in New Orleans.

In many of the most vulnerable cities, the financial resources to provide this sort of protection are not available. Thus it is necessary to place a high priority on ensuring that the systems that facilitate resilience—at the urban, community, and household scale—are

adapted to take into account the threats of climate change. Indeed, effective adaptation is all about the quality of local knowledge and about local capacity and the willingness to act, although this has to take place in the context of transparent and effective systems of local and national governance.

City and municipal governments have a key role to play in facilitating urban resilience. (See Box 5–1.) They participate directly, through the provision and maintenance of infrastructure, but even more important they participate indirectly through encouraging and supporting particular activities by individuals and private enterprises. Municipal authorities often have responsibility for land use planning, which needs to ensure that low-income groups can find affordable land for housing that is not on a site vulnerable to climate change. They also often have responsibility for enforcing building codes, and they can ensure that buildings and infrastructure take account of climate change risks without imposing unaffordable costs on low-income urban residents. Urban resilience can also be facilitated through the adoption of pro-poor strategies that enable individuals to develop sustainable and resilient livelihoods. Indeed, having a solid economic base is one of the main ways to help households cope with the shocks and stresses that will become more frequent as a result of climate change.³¹

All these urban actions to build resilience rely on the active engagement of other local stakeholders and a supportive national government. Higher levels of government have key roles in building urban resilience as they provide the legislative, financial, and institutional basis within which urban authorities, the private sector, civil society, and other stakeholders act to adapt to climate change. A supportive legal system can bolster locally developed responses and provide appropriate guidelines for stakeholders to build

resilience at the most appropriate scale. Unfortunately, many bilateral aid agencies and multilateral development banks do not recognize the importance of local authorities in this process and fail to provide adequate support to increase local competence and willingness to act. Redressing this situation would provide a substantial boost to building urban resilience.³²

Recent activities in Durban, one of South Africa's largest cities, illustrate the practical ways that forward-thinking urban institutions can help cities become more resilient to climate change. The Environmental Management Department in eThekweni Municipality (an expansion of what was Durban Municipality) initiated a Climate Protection Programme in 2004. This has included building an understanding of global and regional climate change science and then translating that into the implications of climate change for Durban. The city developed a Headline Climate Change Adaptation Strategy to highlight how key sectors should begin responding to unavoidable climate change. Most important, the municipality has incorporated climate change into long-term city planning to address the vulnerability of key sectors such as health, water and sanitation, coastal infrastructure, disaster management, and biodiversity. Adaptation strategies of this type yield few obvious short-term benefits but will generate greater rewards as the effects of climate change are increasingly felt.³³

The city of Manizales in Colombia has also taken steps to build resilience, particularly by not letting rapidly growing low-income populations settle on dangerous sites. Its population was growing rapidly, with high levels of spontaneous settlement in areas at risk from floods and landslides. Local authorities, universities, NGOs, and communities worked together to develop programs aimed not only at reducing risk but also at improv-

Box 5–1. Protecting Watersheds to Build Urban Resilience

In a warmer world, water supply challenges will require new ways of thinking about resilience that go beyond the engineering of pipes and ditches to new nonstructural land management approaches that work with nature to protect the quality and quantity of the resource. Among the pioneers of such new thinking was New York City, which in the early 1990s rejected a proposal to build more water filtration plants in favor of buying and protecting forested land well beyond city lines in the upstream watershed of the Hudson River.

Having a forested watershed may not guarantee more water flow; trees, after all, transpire vast amounts of water into the atmosphere. But the soils that healthy forests develop tend to ensure water filtration, as well as to filter out sediment and impurities from water that flows into rivers. The spongelike forest soil, the product of high carbon content in combination with healthy microbial communities as leaves and other tree litter decay, also holds water and thus moderates the extremes of stream flow—which could temper the water-flow extremes that follow the melting of mountain glaciers.

Some communities are building new institutions rather than water infrastructure in hopes of reducing their vulnerability to hydrological extremes. One such community is Quito, the capital of Ecuador. Set in a bowl-shaped basin in the northern Andes, Quito receives most of its water from mountain grasslands that have long been considered virtual water factories because of their capacity to turn the melting snow and the cold, humid air above glaciers into stream flows that make their way into the metropolis.

As human activities strained the water supply from these grasslands at the end of the last century, however, Quito began investing in an innovative public-private partnership to protect and manage the grassland-covered watersheds above the city. The Quito Watershed Protection Fund (known as FONAG, from its name in Spanish) is funded through a 1.25-per-

cent tax on municipal water in the metropolitan area, supplemented by payments by electrical utilities and donations from private water users. A diversity of outside donors, both domestic and international, have contributed as well. The money raised finances the conservation and protection of the grasslands, wetlands, and upstream forests and natural areas.

FONAG finances predominantly long-term activities—community park rangers for protected areas, reforestation, environmental education, outreach and training, and hydrology. Some short-term interventions or projects, such as sustainable production activities and handicrafts, are also supported in order to ensure innovative approaches and promote continuous learning and improvement. With assets of \$5.5 million, FONAG had a budget in 2008 of \$2.9 million.

One of the Fund's challenges is that hydrological science and information have yet to catch up to the need to work with nature in supplying metropolitan water. River systems are a complex product of physiology, hydrology, biology, and human demands. Data are only beginning to come in that can demonstrate the cost-effectiveness of FONAG's efforts. Trained human resources in the new field are scarce, and institutional capacity is in its infancy. There is no certainty that taking preventive measures today will ameliorate the impacts of future climate change.

Despite these challenges, other cities in Ecuador and in neighboring Colombia and Peru are beginning to replicate the FONAG model of public-private partnerships that aim to conserve clean and abundant water supplies. The days when water resources were assumed to be both renewable and “always there” are fading, especially as dwindling glaciers remind those who depend on high-mountain water that yesterday's climate is no guarantee of tomorrow's.

—Marta Echavarría, *Ecodecisión*

Source: See endnote 31.

ing the living standards of the poor. Between 1990 and 1992, some 2,320 dwelling units were built for people in the lowest-income groups, reducing the number of households in high-risk zones by 63 percent and allowing 360 hectares of land to be reforested as eco-parks with strong environmental education components.³⁴

Unfortunately, actions of this type are not widespread and are particularly rare in small- and medium-sized cities. Where cities and urban institutions have addressed climate change issues, this has usually been from the perspective of mitigation, which involves limiting GHG emissions, particularly carbon dioxide and methane, to reduce further climate change. Adaptation is far more complicated to measure, resolve, and bring about. On a more positive note, however, many of the strategies to build urban resilience to climate change also represent good practice for urban development more generally. More-responsive local governments, improved infrastructure, and better systems for disaster preparedness are all key for improving the quality of life for urban residents more generally, as well as for building resilience.³⁵

Financing Resilience

One major constraint on building more-resilient local and national institutions has been the limited funds available. The costs of adapting to climate change are huge: while accurate calculations are difficult, the World Bank estimates the amount at between \$10 billion and \$40 billion annually for “climate-proofing” investments in developing countries. This estimate has been criticized, however, for failing to take into account several additional factors, such as climate-proofing existing supplies of natural and physical capital where no new investment was planned, financing new investments specifically to deal

with climate change, and the adaptation costs faced by households and communities. Taking these into account, Oxfam recently put the figure at over \$50 billion annually.³⁶

Currently, funding for adaptation falls woefully short of these figures. There are two main avenues for financing resilience in developing countries: formal climate change financing mechanisms under the United Nations Framework Convention on Climate Change (UNFCCC) and various national mechanisms for official development assistance (ODA).

Funding for adaptation under the UNFCCC is currently disseminated through four funding streams: the Least Developed Countries Fund (LDCF), established to help developing countries prepare and implement National Adaptation Programmes of Action; the Special Climate Change Fund (SCCF), intended to support a number of climate change activities such as mitigation and technology transfer, but with adaptation as a top priority; the Global Environment Facility (GEF) Trust Fund’s Strategic Priority for Adaptation (SPA), which pilots operational approaches to adaptation; and the Adaptation Fund (AF), which under the Kyoto Protocol is intended to help developing countries carry out “concrete” adaptation activities.³⁷

The LDCF, SCCF, and Trust Fund are relatively small funds based on voluntary pledges and contributions from donors. All three are managed by the GEF, the primary financial mechanism used by the UNFCCC. The LDCF and SCCF only amount to around \$114 million in received allocations. The GEF Trust Fund SPA contains \$50 million to support adaptation pilot projects. The Adaptation Fund of the Kyoto Protocol is financed by a 2-percent levy on transactions in the Clean Development Mechanism (CDM), the market-based initiative under the protocol that allows countries with greenhouse gas

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reduction targets to generate emission “credits” from projects that offset emissions in developing countries and produce sustainable development benefits. The Adaptation Fund has the potential to generate by far the largest amount of funds for adaptation; the revenue generated from the CDM levy alone is projected to be between \$160 million and \$950 million. There is also talk of applying the levy to international air travel, which could generate \$4–10 billion annually.³⁸

The funds managed by the GEF have been heavily criticized for failing to meet the needs of vulnerable developing countries. These nations have expressed concern over difficulties in getting funds for adaptation through the GEF due to burdensome criteria for reporting, additionality, and co-financing, which most vulnerable developing countries simply do not have the capacity to meet. In addition, while international adaptation efforts have delivered some information, resources, and capacity building support, they have yet to facilitate significant on-the-ground implementation, technology development or access, or the establishment of robust national institutions to carry the adaptation agenda forward.³⁹

The Adaptation Fund is the most promising financing vehicle, not only because it has the potential to generate the greatest amount of money but also because of its unique governance structure, decided upon at the Conference of the Parties to the UNFCCC in Bali in 2007. The fund is not managed by the GEF. It has its own independent board with representation from the five U.N. regions as well as special seats for least developed countries and small island developing states. The GEF provides secretariat services on an interim basis. Further, countries can make submissions for funding directly to the Adaptation Fund as opposed to going through designated implementing agencies (as is the case

with the GEF funds), and governments can also designate their own implementing agencies (such as NGOs) to make funding submissions. It is hoped that this governance structure will minimize problems of accessibility and increase the effectiveness of climate change financing for adaptation. In addition, the fund is designed to fund concrete adaptation action on the ground, which has the potential to contribute significantly to building resilience. However, funding through the Adaptation Fund is not yet operational, and even when it is it will still fall short of meeting the full finance costs of adaptation.

A second option for funding resilience building is through existing ODA financing. Given the close relationship between development objectives and building climate change resilience, funding adaptation this way might appear to make sense: sustainable development reduces vulnerability to climate change, while resilience-building activities often contribute to the broader goals of sustainable development. Reaching the Millennium Development Goals, for example—reducing poverty, improving living conditions in urban and rural settlements, providing general education and health services, and providing access to financing, markets, and technologies—will improve the livelihoods of the most vulnerable and in turn improve their resilience regarding climate change. A recent analysis of ODA activities reported by members of the Organisation for Economic Co-operation and Development found that more than 60 percent of development assistance could be relevant to building adaptive capacity and facilitating adaptation. To date, bilateral programs have committed more than \$110 million to more than 50 adaptation projects in 29 countries.⁴⁰

Although ODA contributions can complement UNFCCC actions on adaptation, they cannot be seen as a means of “plugging

the gap” in adaptation financing. Fundamentally, the responsibility for helping the most vulnerable countries cope with the impacts of climate change ought to be in addition to existing aid commitments. Industrial-country financing for adaptation should be based on the “polluter pays principle,” which attributes the costs of pollution abatement to polluters without subsidy, pointing toward responsibility-based rather than burden-based criteria. As highlighted by Oxfam, ActionAid, and many other NGOs advocating for greater UNFCCC funding for adaptation, these monies should not be donated to poor countries as “aid” but are owed as compensation from high-emissions countries to those that are most vulnerable to the impacts of climate change. So although there is clearly a role for development institutions in enhancing adaptive capacity, responsibility for adaptation does not lie with these institutions, particularly when it may compete with other development objectives in partner countries.⁴¹

At the same time, however, there is certainly room for complementarities. The UNFCCC explicitly provides support for adaptation to climate change rather than climatic variability. In climate negotiations, the distinction is important, informing political questions regarding costs and burden sharing. Yet building resilience through development can address a much broader range of factors contributing to vulnerability on the ground than targeted climate change interventions alone. Further, development assistance can invest in capacity building in partner countries in order to facilitate UNFCCC-financed activities. For example, donors are well positioned to strengthen national capacity, while development practitioners and disaster risk reduction practitioners have a wealth of experience in dealing with reducing vulnerability to climate hazards and extremes at local, subna-

tional, and national scales.⁴²

ODA can therefore be used to add value to the formal UNFCCC mechanisms through development that contributes to resilience. But regardless of development investments in resilience building, funding through the UNFCCC must be scaled up significantly, and existing funding needs to be more accessible, in order to come close to meeting the huge challenge of building climate change resilience in vulnerable developing countries.

The responsibility for helping the most vulnerable countries cope with the impacts of climate change ought to be in addition to existing aid commitments.

At the country level, there is a need to think carefully about the delivery mechanisms for this funding. Experience with adaptation funding under the UNFCCC has shown that national institutional responsibilities for adaptation are unclear and sometimes competing. With the proliferation of bilateral, multidonor, and convention funds, it is vital to avoid duplication of efforts and to ensure consistency in approach.⁴³

One solution that is currently being piloted in Bangladesh is the development of a country-owned multidonor trust fund to receive all funding for adaptation from different national and multilateral climate change funds. This fund was launched in London in September 2008 and will consist of contributions from the Bangladeshi, British, Danish, and Dutch governments as well as from the World Bank. It is hoped that this framework will significantly reduce transaction costs for global and bilateral funds and could pave the way for large flows of money in the future, while ensuring proper institutional structures, governance, management, and targeting of

funds at the national level. The scale and scope of the fund are currently under discussion, but it is hoped that the fund would be accessible to government agencies, NGOs, and the private companies that design and implement climate change mitigation and adaptation projects.⁴⁴

It is also important that the institutions and agencies that channel funds to vulnerable people on the ground are given careful consideration. The role of government institutions is clearly vital, and mainstreaming adaptation through existing national, sectoral, and local development plans is one way to build the resilience of government institutions and services, and, by extension, of the people who use them. However, this is not always appropriate—for example, under weak governments or in situations where local government capacity and accountability are flawed. In such circumstances, building resilience through NGOs and private institutions may be more appropriate.

Early NGO efforts to enhance resilience of vulnerable communities have proved promising, but they have also been limited in scale and scope where they have not been closely linked to and supported by governmental plans and institutions. Another avenue that is receiving increasing attention is the private sector, particularly in relation to technology transfer and insurance schemes. One example is index-based insurance, still in the formative stages, which is intended to facilitate adaptation by farmers by discouraging risk-averse behavior. Crops are insured against weather patterns rather than crop losses, which also reduces perverse incentives to underproduce.

The social enterprise BASIX has been piloting an index-based insurance program in India, which initially has grown from 230 customers to around 12,000 in 2006–07. However, an early review of this program shows that it has not fulfilled expectations for

encouraging adaptive strategies of poor and vulnerable farmers. One reason is the high cost of the product (5–12 percent of the value insured), which reduces the coverage that clients can afford. The vast majority of clients insure only their inputs, not the projected value of their crops. Coverage is therefore not sufficient to encourage risk-taking. Further, reinsurers are increasing prices on these policies because of growing climate change concerns, putting the product even further out of the reach of many potential customers.⁴⁵

The private sector may produce some options for financing resilience building, but these have so far been shown to be limited, particularly for enabling adaptation by the most vulnerable. Therefore attention is currently best focused on improving the capacity of existing local institutions that have knowledge and a history of working with the most vulnerable, in order to lessen gaps between local and national processes and to ensure that financial resources reach those who can use them best. This requires the involvement of local groups and civil society organizations with the knowledge and capacity to act, as well as a willingness among governments to work with lower-income groups.⁴⁶

Linking Mitigation and Adaptation

Although this chapter has focused on responding to the impacts of climate change, mitigation is another response strategy that is both necessary and urgent to ensure long-term resilience. As Tom Wilbanks and colleagues note, “if mitigation can be successful in keeping impacts at a lower level, adaptation can be successful in coping with more of the resulting impacts”. Until recently, mitigation and adaptation have been considered separately in climate change science and policy. Mitigation has been treated as an issue for

industrial countries, which carry the greatest responsibility for climate change, while adaptation is seen as a priority for developing countries, where the capacity to mitigate is low and vulnerability is high.⁴⁷

But in order to maximize global resilience against climate change, any post-Kyoto arrangements will have to engage developing countries in the mitigation agenda. And mitigation strategies that offset carbon in developing countries through carbon trading mechanisms such as the CDM and the voluntary carbon market have the potential to bring sustainable development benefits, which can contribute to climate change adaptation and resilience. Taking this further, attention has recently started to focus on exploring synergies between mitigation and adaptation, to see if they can be achieved together, contributing to both short-term local and long-term global resilience.⁴⁸

Linking mitigation and adaptation at the national and sectoral level is problematic, because the needed actions and policies involve different sectors. Mitigation actions tend to focus on transport, industry, and energy, while adaptation decisionmakers usually focus on the most immediately vulnerable sectors such as agriculture, land use, forestry, and coastal zone management. There is some potential for overlap at the sectoral level, however: for example, adaptation policies on agriculture, land use, and forestry have implications for carbon dioxide sequestration and avoided methane emissions.⁴⁹

Achieving synergies between mitigation and adaptation strategies is most fruitful at the project level, where the activities are linked in very specific ways. In Dhaka, for instance, a CDM mitigation project uses organic waste to produce compost. This reduces methane emissions by diverting organic waste from landfills (where anaerobic processes occur that generate higher lev-

els of methane) to a composting plant (where aerobic processes occur).⁵⁰

This mitigation project has clear potential for contributing to climate change resilience in rural areas. The impacts of climate change will include agroecosystem stresses in drought-prone areas in Bangladesh. Thus, enhancing soil organic matter content through organic manure to increase the moisture retention and fertility of soil both reduces the vulnerability to drought and increases the carbon sequestration rates of crops. Linking mitigation and adaptation in this way contributes to both long-term and short-term ecological and social resilience. The composting projects contribute to global resilience by reducing GHG emissions directly through preventing the generation of methane and indirectly through contributing to the carbon sequestration capabilities of crops. They also build local resilience through soil improvement in drought-prone areas, as poverty is exacerbated when climate change reduces the flows of ecosystem services.⁵¹

An integrated approach could therefore go some way toward bridging the gap between the development and adaptation priorities of developing countries and the need for mitigation at the global level. In addition, this will increase the relevance of mitigation for the most vulnerable developing countries, moving beyond the perception of mitigation as only an issue for industrial nations and helping to engage even the poorest developing countries in global mitigation efforts. Building resilience requires climate change response measures that bring together integrated climate change, development, and resource management concepts to build adaptive capacity. Linking mitigation at the project level is one way of achieving such an integrated approach, to build local and global resilience now and for the future.⁵²

Bouncing Forward to Greater Resilience

Low- and middle-income countries—and particularly their poorest inhabitants—are at the frontline of climate change. The political difficulties in drawing attention to their plight and the practical difficulties of measuring increases in resilience present serious challenges.

As discussed at the beginning of this chapter, building resilience to climate change is not only about ensuring that individuals, communities, and nations can maintain their current situation. It is also about improving living standards in a way that does not worsen the problems of climate change. When billions of people around the world lack adequate water supplies, building resilience involves extending the provision of water and sanitation. When millions of children die of preventable diseases each year, building resilience means improving child mortality figures rather

than merely preventing them from increasing. Rather than thinking about resilience as “bouncing back” from shocks and stresses, it is perhaps more useful to think of it as “bouncing forward” to a state where shocks and stresses can be dealt with more efficiently and successfully and with less damage to individual lives and livelihoods.

Bouncing forward will require new commitments from influential actors at a variety of scales, including NGOs, local and national governments, and international bodies. The good news is that building resilience to climate change will also help address many of the environmental, health, and developmental challenges facing the world today. And as the farmers in Njoro Division in Kenya, the climate scientists in Mali’s Direction Nationale de La Météorologie, and the planners in Durban have all shown, practical actions to support human ingenuity can yield impressive results.

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