
ADAPTATION TO CLIMATE CHANGE:

INTERNATIONAL POLICY OPTIONS

by

Ian Burton

UNIVERSITY OF TORONTO

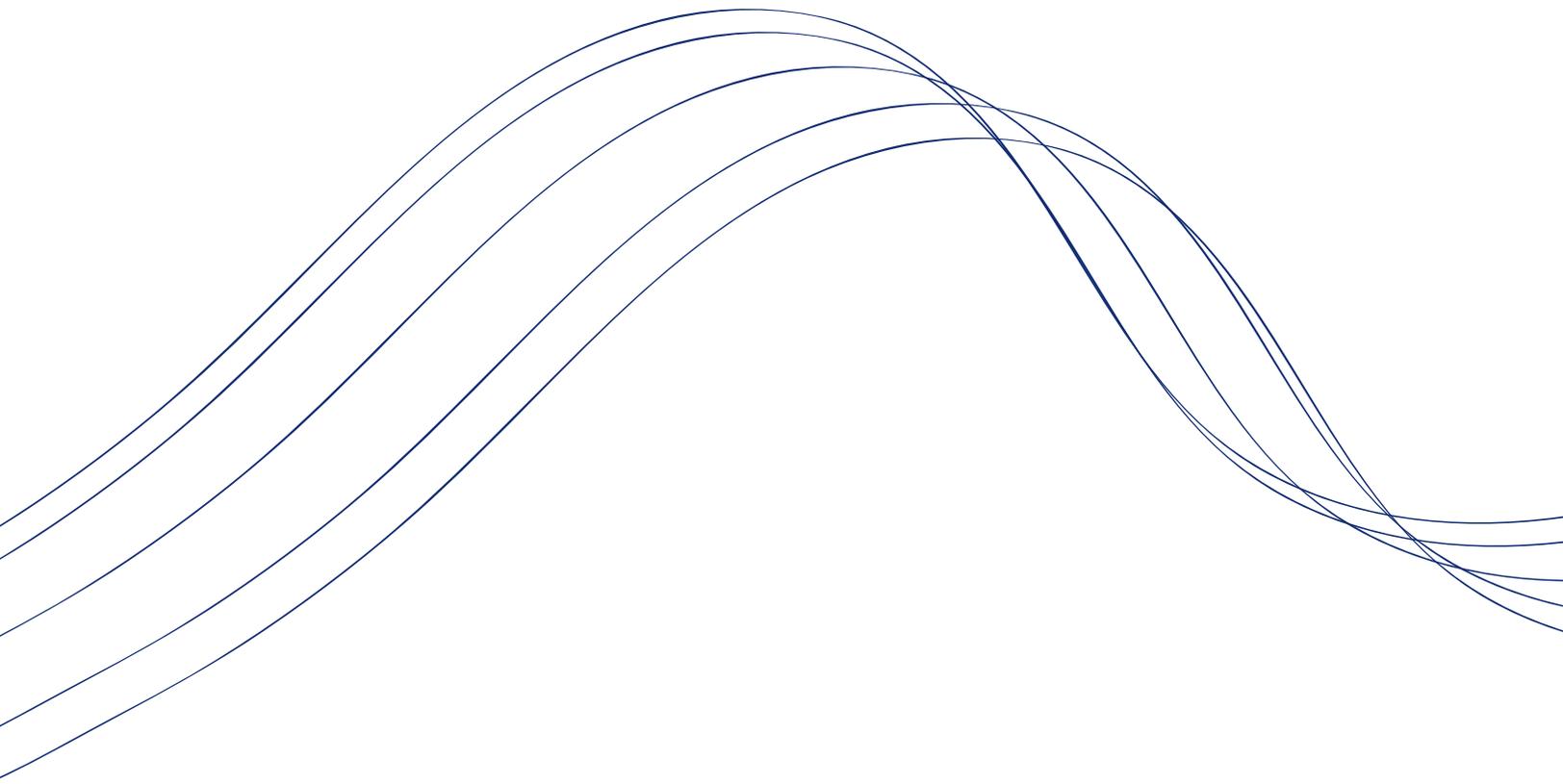
Elliot Diringer

PEW CENTER ON GLOBAL
CLIMATE CHANGE

Joel Smith

STRATUS CONSULTING INC.





ADAPTATION TO CLIMATE CHANGE: INTERNATIONAL POLICY OPTIONS

Prepared for the Pew Center on Global Climate Change

by

Ian Burton

UNIVERSITY OF TORONTO

Elliot Diringer

PEW CENTER ON GLOBAL
CLIMATE CHANGE

Joel Smith

STRATUS CONSULTING INC.

November 2006

The authors express their appreciation to Bonizella Biagini,
Ko Barrett, Paul V. Desanker, Saleemul Huq, Alan Miller,
Jo-Ellen Parry, Ulric Neville Trotz and others for their helpful
comments on earlier drafts of this paper.



Contents

Introduction	1
I. Adaptation: An Evolving Challenge	3
II. Adaptation Policy: Needs and Issues	9
Reactive and Proactive Adaptation	10
Specific Adaptations and Adaptive Capacity	10
Climate Change and Climate Variability	11
A Cross-Cutting Challenge	12
III. International Adaptation Efforts to Date	13
IV. Options Going Forward	15
Adaptation under the UNFCCC	15
Integration with Development	17
Climate “Insurance”	18
V. Conclusions	23
Endnotes	24
References	26



Introduction¹

From its inception, the international climate effort has focused predominantly on mitigation—reducing greenhouse gas (GHG) emissions to prevent dangerous climate change. The next stage of the international effort must deal squarely with adaptation—coping with those impacts that cannot be avoided. This is both a matter of need, as climate change is now underway, and a matter of equity, as its impacts fall disproportionately on those least able to bear them. It also may be a condition for further progress on mitigation. Indeed, substantial new mitigation commitments post-2012 may be politically feasible only if accompanied by stronger support for adaptation.

Ambitious mitigation efforts can lessen, but not prevent, future climate change. While steep reductions in emissions could stabilize atmospheric GHG concentrations at lower levels than under “business as usual,” they likely would be well above current, let alone pre-industrial, levels.² With higher concentrations will come further rises in temperatures and sea level, changes in precipitation, and more extreme weather. The early impacts of climate change already are being felt worldwide.³ Future impacts will affect a broad array of human and natural systems, with consequences for human health, food and fiber production, water supplies, and many other areas vital to economic and social well being. While certain impacts may in the nearer term prove beneficial to some, in the long term, the effects will be largely detrimental.⁴

Anticipating and adapting to these impacts in order to minimize their human and environmental toll is a significant challenge for all nations. Meeting it requires action at multiple levels, from the local to the international, within both public and private spheres. This paper explores one critical dimension of this multifaceted challenge—how adaptation can be best promoted and facilitated through future multilateral efforts.

Among the many issues confronting governments, two are especially daunting. The first is equity and its relation to cost. Difficult questions of fairness suffuse the climate debate but are particularly stark in the case of adaptation: those most vulnerable to climate change are the ones least responsible for it. Stronger international adaptation efforts—whatever form they might take, and whether understood as assistance or as compensation—will be possible, let alone effective, only insofar as affluent countries are prepared to commit resources. This is a question not of policy design but, rather, of negotiation and political will. Second, reliable information and relevant experience are in short supply. Relative to mitigation, the adaptation challenge is much less well understood—needs as well as solutions. A high priority in the near term is strengthening the knowledge base with better data and modeling to refine projections of future impacts, and with early insights from the field on the most effective responses.

It is at the same time essential to begin considering how future international efforts can best be structured. This paper examines underlying issues and lays out an array of possibilities. To set the issue in context, it looks first at the history and evolving nature of human adaptation to climate. It then highlights key issues in the design of adaptation policy, and summarizes and assesses international adaptation efforts to date. Finally, the paper outlines three broad and potentially complementary approaches to future international efforts:

- **Adaptation Under the UNFCCC**—Initiating new steps under the UN Framework Convention on Climate Change (UNFCCC) to facilitate comprehensive national adaptation strategies and to provide reliable assistance for high-priority implementation projects.
- **Integration with Development**—Integrating adaptation across the full range of development-related assistance through measures such as mandatory climate risk assessments for projects financed with bilateral or multilateral support.
- **Climate “Insurance”**—Committing stable funding for an international response fund or to support insurance-type approaches covering climate-related losses and promoting proactive adaptation in vulnerable countries.

I. Adaptation: An Evolving Challenge

Adaptation⁵ to climate is not a new phenomenon. Indeed, throughout human history, societies have adapted to natural climate variability by altering settlement and agricultural patterns and other facets of their economies and lifestyles. Human-induced climate change lends a complex new dimension to this age-old challenge.

Viewed over the long span of human history and pre-history, adaptation to climate has been remarkably successful. Biologists, anthropologists and archaeologists often characterize humans as the most adaptable of animal species. The record of collapsed societies shows that coping with climate has not always been easy or successful, and there are limits to adaptation.⁶ Yet societies have been able to thrive in all but the most extreme climate zones. Over time, often by trial and error, and by the adroit use of technology, human beings have adapted to cold sub-arctic, hot semi-desert, and tropical rainforest environments, as well as to temperate grasslands, mountains, coasts and small islands. Climate varies much more over space than over time, and the widespread distribution of human populations attests to a largely successful history of adaptation.

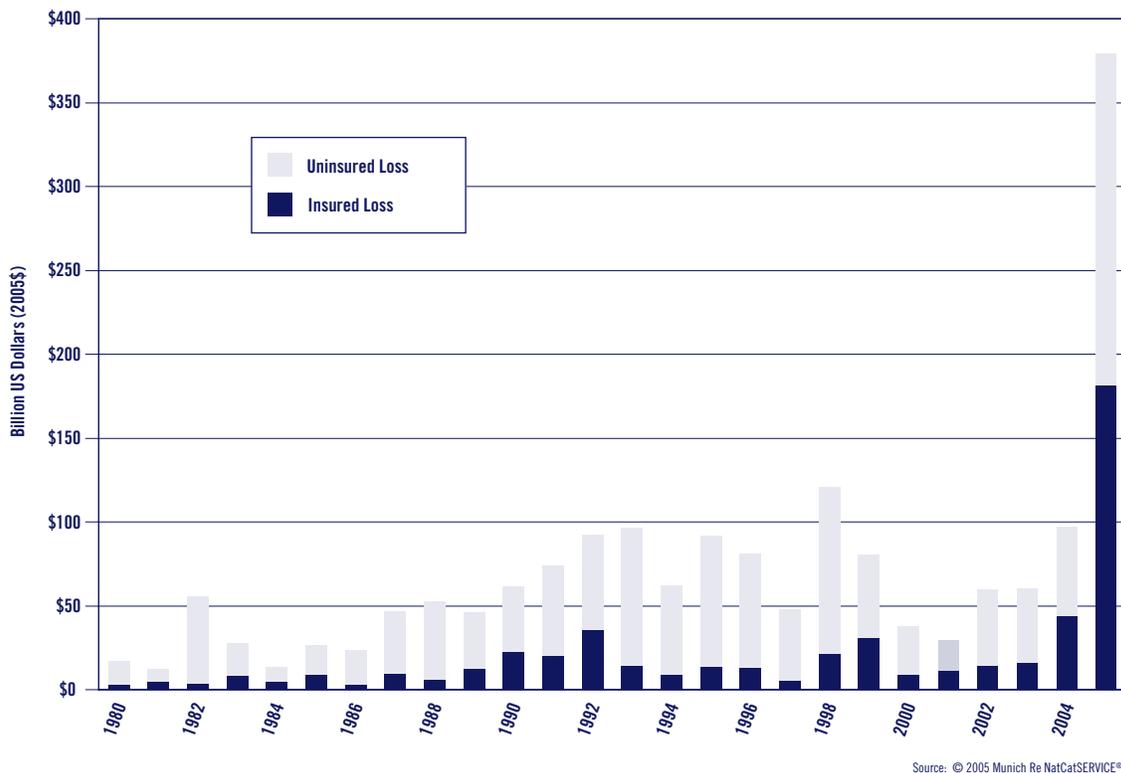
In broad terms, a society's *vulnerability* to natural climate variability or to human-induced climate change reflects its degree of exposure and its capacity to adapt. *Exposure* has two principal elements: the climatic conditions themselves, and the extent and character of the population, wealth, and development exposed to them. *Capacity* is a society's ability to adapt to changing climatic conditions, whether by reducing harm, exploiting beneficial new opportunities, or both. This ability to adapt, whether to changing climate or other new circumstances, is in part a function of a society's level of wealth, education, institutional strength, and access to technology.⁷ The nature and the extent of a society's development, therefore, heavily influence both its degree of exposure to climate risks and its capacity to adapt.

On the global scale, exposure to climate-related risks has risen dramatically in recent decades. With population and income growth, and with the expansion of human settlements into high-hazard zones, the number of people and the level of wealth exposed have steadily grown. Insurance industry figures show rising losses from extreme weather events over the past quarter-century even before the record losses in 2005 resulting from Hurricane Katrina (see Figure 1). While the greatest losses, in absolute terms, occur in industrialized countries, measured relative to wealth, losses from extreme weather are substantially higher in developing countries. From 1984 to 2003, losses as a percent of national income were three times higher in low- and lower-middle-income countries, with 80 percent of the world's population, than in

higher-income countries.⁸ Increasingly, these rising losses threaten the very process of development. High-risk countries frequently must borrow for disaster reconstruction, raising their indebtedness without necessarily contributing to economic growth or poverty reduction.⁹ In extreme cases, single events can cause significant economic setbacks. For example, in Honduras, where the economy had been growing at 4 to 5 percent a year, GDP fell the year following Hurricane Mitch.¹⁰

Figure 1

Losses from Global Weather Catastrophes 1980-2005



It is against this backdrop of increasing exposure and losses that climate change presents a significant new set of adaptation challenges. The impacts of climate change will be felt across sectors and across societies (see Box 1: Vulnerability of Key Sectors). While vulnerability to climate change varies from region to region and country to country, on the whole, it is highest in developing countries. First, they are more exposed by virtue of being at lower latitudes, where impacts such as increased disease and extreme heat and drought will be more pronounced, and because they derive a larger proportion of their economic output from climate-sensitive sectors such as agriculture, fishing, and tourism. In addition, developing countries generally have lower per capita incomes, weaker institutions, and less access to technology, credit and international markets—hence, lower adaptive capacity.

In assessing vulnerability in developing countries, the World Bank estimates that as much as 40 percent of the development financed by overseas assistance and concessional loans is “sensitive to climate risk.” Without adaptation, the Bank projects, the costs of climate change impacts in exposed developing countries could range from several percent to tens of percent of GDP, or up to \$100 billion, a year.¹¹ Absorbing these impacts, it warns, will hamper achievement of many United Nations Millennium Development Goals, including those on reducing poverty and child mortality and combating HIV/AIDS, malaria and other diseases.¹²

In some respects, the added challenge posed by climate change is one of degree. The same types of policies and practical strategies already employed to adapt to natural climate variability—dams to control flooding, coastal defenses against cyclones, and irrigation projects to endure drought—will continue to be employed, though on a larger scale, in different locations, and at greater cost. However, adaptation to climate change is different in two important respects. First, because climate change results from human activity, rather than pure forces of nature, the question of who pays for adaptation is more complicated and contentious. This question is especially relevant in considering future adaptation efforts at the international level. A second critical difference is that in a world subject to climate change, the historic climate records that have guided past adaptation are less reliable. Cropping patterns, engineering works, and other forms of adaptation have been designed with the expectation that general climatic conditions, as well as the frequency and magnitude of extreme events, will be largely consistent with those observed in the past. However, a “normal” or stable climate can no longer be assumed. The challenge is not successfully managing a transition from one equilibrium climate to another, but rather, adapting to a far more uncertain climatic future.

In the future as in the past, the success of human adaptation to climate will depend heavily on development options and choices: a higher level of development is likely to produce greater adaptive capacity, but certain patterns of development can undermine these advances by exposing populations to ever-higher levels of climate risk.

Box 1**Vulnerability of Key Sectors**

The impacts of global climate change will be felt across economies and societies. The present state of climate modeling does not allow precise forecasting of the full extent or distribution of impacts at any given level of climate change. This brief overview of projected impacts in key sectors gives a sense of the potential scope and range:

Human Health. The causes of adverse health effects are notoriously multi-factorial and there are so far few observed changes that can be confidently attributed to climate change.¹³ However, potentially hundreds of millions of people could be at risk from increased morbidity or mortality resulting from climate change.¹⁴ Infectious diseases may become more prevalent as their reach increases and seasonality expands; the frequency and intensity of heat waves and natural hazards such as droughts, floods, and cyclones may increase, causing adverse health effects; and levels of air pollution may increase. Small changes in climate can result in substantial changes in risk. The increased health risks are likely to be most acute in developing countries. This is because many climate-related infectious and vector-borne diseases are associated with warm or hot weather conditions and, most importantly, because public health systems, which can substantially reduce health risks, tend to be relatively weak in many developing countries. A key factor in reducing future risks in developing countries is the strengthening of public health systems, including monitoring and surveillance, public health infrastructure, and the development of effective adaptation measures.¹⁵

Agriculture. The production of food crops is the most climate-dependent economic activity. Changes in climate can be expected to have significant impacts upon crop yields through changes in both temperature and moisture. As climate patterns shift, changes in the distribution of plant diseases and pests may also have adverse effects on agriculture. At the same time, agriculture has proven to be one of the most adaptable human activities to varied climate conditions. Many investments are relatively short-term and crops and cultivars can be quickly changed to suit new conditions. There is flexibility also in farming practices, the application of irrigation water and other inputs. For these reasons, agriculture at the global level can probably adapt to a moderate amount of global warming (perhaps up to 2.5 degrees Celsius above current levels, assuming no dramatic change in climate variability). There are likely to be considerable regional variations, however. Crops in low latitudes are more often close to their limits of heat tolerance, while growing conditions are likely to improve in higher latitudes, where agriculture might gain in competitive advantage. As in other sectors, adaptive capacity is likely to be a major factor in determining the relative distribution of adverse impacts.¹⁶

Water Resources.¹⁷ Climate change is expected to have significant impacts on water supplies—creating or exacerbating chronic shortages—and on water quality. There is already widespread acceleration of glacial retreat and in many areas stream flow is shifting from spring to winter peaks. If continued, these shifts could affect the availability of water for agriculture and other uses. Sea-level rise will result in saltwater intrusion into coastal fresh water aquifers, potentially reducing water resource availability. Changes in quantity and intensity of precipitation are likely to result in more floods and droughts and increased demand for irrigation water.¹⁸ Water management often requires costly investment in infrastructure. Given the long economic and physical life of reservoirs, water withdrawal, treatment, delivery, and disposal systems, adaptive responses are generally slower in water management than in agriculture.¹⁹

Coastal Resources. One of the most certain effects of a warmer climate is sea-level rise. Although estimates of future sea-level rise vary, the scientific consensus is that it will be significant and will continue for centuries. Small island states and low-lying coastal areas will be subject to inundation, and risks of flooding and wind damage from coastal storms will increase. Many of the world's largest cities are at or close to sea level, and densely populated agricultural areas are situated on major river deltas. In high-income countries and communities, coastal engineering can provide protection against all but the most extreme events, but elsewhere evacuation and retreat may be the only option.²⁰

Ecosystems and Biodiversity.²¹ Changes in natural ecosystems are among the first observable impacts of climate change. Changes in plant flowering dates and bird migrations and distributions have already been widely recorded.²² Natural ecosystems are highly adapted to specific climatic conditions in specific localities. While some of the more mobile species (birds and larger animals) may be able to migrate rapidly enough in response to changing climate patterns, many ecosystem components, including many tree species, have much lower mobility. Even where migration is a theoretical possibility, human development has fragmented many ecosystems, weakened them through pollution and other forms of degradation, and in many places limited or cut off migration routes. The combined effects of human development and the slow rate of natural adaptation suggest that considerable ecosystem disruption will take place as the climate changes, and that substantial loss in the diversity of species is likely to occur.²³

II. Adaptation Policy: Needs and Issues

To be most effective, adaptation must proceed at several levels simultaneously. Adaptation is in fundamental ways inherently “local”—the direct impacts of climate change are felt locally, and response measures must be tailored to local circumstances. However, for these efforts to be robust—or, in many cases, even possible—they must be guided and supported by national policies and strategies. For some countries, these, in turn, need to be facilitated through international measures.

Collectively, these efforts must meet a wide range of interrelated needs. Briefly, these include:

Information—Effective strategies must rest on the best available data on the nature and severity of likely impacts over different timeframes in given locales, and on the cost and efficacy of possible response measures.

Capacity—An overriding priority is strengthening capacities in the technical and planning disciplines most relevant to understanding potential climate impacts and devising response strategies.

Financial Resources—Poorer countries will require resources to improve capacity, undertake specific adaptation measures, and cope with impacts as they occur.

Institutions—While adaptation must be integrated across existing institutions, focal points are needed at the national and international levels to garner expertise, develop and coordinate comprehensive strategies, and advocate for broad-based planning and action.

Technology—As in climate mitigation, adaptation success depends in part on access to—and, in some areas, development of—technologies suited to the specific needs and circumstances of different countries.

In considering how best to address these needs, the international community faces a host of difficult issues stemming from the underlying characteristics of climate risk, the institutional contexts for adaptation decision-making and action, and inherent limits on available resources—all compounded by politically sensitive questions of responsibility and equity. These issues include:

- the appropriate balance between “reactive” and “proactive” approaches;
- the proper coupling of specific adaptations and stronger adaptive capacity;
- the difficulty of distinguishing climate change impacts from those due to natural climate variability; and
- adaptation’s intersection with a broad range of other policy areas and priorities.

Reactive and Proactive Adaptation

Adaptation can be said to be “reactive” or “proactive” in two different senses. One distinction turns on the *stimulus* for adaptation—whether an action is in response to observed climate impacts, or in anticipation of future climate change. In this sense, adaptation historically has been largely if not entirely reactive. Human-induced climate change presents societies for the first time with the challenge of adapting to climatic changes forecast but not yet experienced. As reactive adaptation is informed by direct experience, resources can be targeted to known risks. In addressing future risks, however, uncertainties in the extent, timing, and distribution of impacts make it harder to determine the appropriate level of investment, exactly what measures are needed, and when.

Adaptation can also be said to be reactive or proactive in *form*. Here the distinction concerns not motivation—whether the climate impact is observed or anticipated—but rather the nature of society’s response. A proactive approach aims to reduce exposure to future risks, for instance by avoiding development on flood-prone lands; a purely reactive approach aims only to alleviate impacts once they have occurred, for instance by providing emergency assistance to flood victims. (When a reactive response perpetuates or exacerbates exposure to climate risks, for instance by assisting reconstruction in a flood-stricken area, it might be termed “maladaptation.”) Experience suggests that, typically, proactive adaptation requires a greater initial investment but is more effective at reducing future risk and cost.²⁴

As a general rule, adaptation strategies should give priority to proactive actions reducing future risk, but, insofar as significant risks will remain, should provide as well for reactive approaches to help vulnerable populations recover from unavoidable impacts.

Specific Adaptations and Adaptive Capacity

In concrete terms, adaptation to climate risks takes the form of specific actions or projects: construction of a sea-wall to protect low-lying coastal areas from rising sea levels, establishment of an early warning system for flooding or heat waves, or introduction of heat- or drought-resistant crop varieties. (Specific adaptations might also include correcting maladaptations—for instance, by no longer providing flood insurance in ways that encourage risky development in flood zones.)

A society’s ability to undertake such actions is largely a function of its adaptive capacity. Certain capacities may be especially critical in the climate context: the ability to project climate impacts, monitor and respond to disease trends, or develop new technologies, for instance. More broadly, though, adaptive capacity reflects fundamental conditions such as income and education levels, the strength of government institutions, and access to information and technology. Indeed, such factors heavily influence a society’s capacity to adapt to new or anticipated risks of any type. While it is unlikely that climate

concerns would on their own stimulate major improvements in basic adaptive capacity in countries where it is weakest, they can serve as an additional driver for such advances, yielding societal benefits well beyond the field of climate.

The distinction between specific adaptations and enhanced adaptive capacity is not always clear-cut. Some activities may serve both purposes—for instance, resources and training to integrate adaptation considerations into development planning; expanded research into alternative crops or cropping patterns; or the strengthening of public health systems. Here, again, these are steps with multiple benefits beyond climate adaptation.

Many specific adaptations can be quite effective in reducing certain risks. For example, evacuation shelters in Bangladesh have proven very effective in reducing deaths during cyclones. However, specific adaptations deliver fewer ancillary benefits. In addition, where adaptive capacity is limited, the potential benefits of specific adaptations may be quite limited. For example, a weather warning system is of limited value if the people at risk have no televisions or radios, or no means of evacuation.

One objective of adaptation policy should be ensuring that specific adaptations are as successful and cost-effective as possible by coupling them with corresponding advances in adaptive capacity.

Climate Change and Climate Variability

One quandary, particularly in the international context, is the difficulty in most instances of distinguishing the specific impacts of climate change from those of natural climate variability. This lack of certainty especially complicates the political questions surrounding costs and burden-sharing, which invoke competing notions of equity and responsibility.

On the ground, however, the distinction between climate change and climate variability may be completely irrelevant. In a narrow range of cases, it may be possible to establish with reasonable confidence that a given impact results from climate change. One study, for instance, calculates with 90 percent confidence that risk of a heat wave like the one that killed 30,000 people in Europe in 2003 has more than doubled as a result of climate change.²⁵ In some cases, an adaptation response may be driven solely by—and protect solely against—a discrete human-induced impact such as sea-level rise. Far more often, however, the impact will not be entirely new and discrete, but rather the intensification of an underlying risk such as drought, flooding, or storm surges. In these cases, actions to adapt to climate change would almost invariably address risks arising from natural climate variability as well.

From a policy perspective, an overriding objective should be a comprehensive, integrated approach to managing climate risks of all types, regardless of their cause.

A Cross-Cutting Challenge

As noted earlier, both a society's exposure to climate risk and its capacity to adapt are closely related to the nature and level of its development. The adaptation challenge cuts across key economic sectors and, consequently, a wide range of policy areas. In the absence of explicit adaptation policy, a society's de facto response to climate risks is a reflection of other policies and priorities. A strategic response to the increased risk of climate change must reach into economic, trade, agricultural, and resource policy, among others. This includes integrating human-induced climate risk into disaster risk management as an essential dimension of preparedness and response planning.²⁶

Effective adaptation requires discrete institutions and policies to assess priorities, direct resources, and focus efforts. It also, however, must operate at the intersection of policy areas. To be addressed successfully, and as cost-effectively as possible, adaptation concerns and priorities must be integrated across the full breadth of economic and development decision-making.

III. International Adaptation Efforts to Date

In principle, adaptation was established as a priority at the very start of the international climate effort. In the UNFCCC, all parties committed generally to undertake national adaptation measures and to cooperate in preparing for the impacts of climate change.²⁷ The Convention also calls for full consideration of the specific needs and concerns of developing countries—especially the least developed—arising from the adverse effects of climate change.²⁸ More concretely, developed countries committed to help “particularly vulnerable” countries meet the costs of adaptation.²⁹ Nearly 15 years after the Convention’s negotiation, however, the international adaptation effort is more an irregularly funded patchwork of multilateral and bilateral initiatives than a fully conceived and functioning regime.

At the first Conference of the Parties (COP) to the Convention, in 1995, the parties established a three-stage framework for addressing adaptation. Stage I, to be carried out in the “short term,” was to focus on identifying the most vulnerable countries or regions and adaptation options. Stage II was to involve measures, including capacity building, to prepare for adaptation. Stage III was to entail implementing measures to facilitate adaptation. The latter two stages were to be implemented over the “medium and long term.”³⁰

Broadly speaking, the effort to date has centered primarily on Stage I- and Stage II-type activities, more often simultaneously than sequentially. Multilateral and bilateral support has focused on building the capacity of developing countries to assess their vulnerability to climate change and examine adaptation needs and options. For example, with assistance provided under the Convention, Bangladesh and small island states in the Caribbean and the Pacific have examined their vulnerabilities to climate change and are assessing options for adaptation. The U.N. Environment Programme has worked with about half a dozen countries on in-depth assessments of vulnerability, while the U.N. Development Programme is assisting scores of countries in assessing adaptation needs. In addition, several countries, including the United States, Britain, the Netherlands, Japan, Germany, and Canada, have provided bilateral assistance. By one recent accounting, bilateral programs have committed \$110 million to more than 50 adaptation projects in 29 countries.³¹

Recently, the emphasis has shifted to setting priorities among adaptation options. More than 40 least developed countries have received funding under the Convention to prepare National Adaptation Programmes of Action (NAPAs) addressing urgent needs.³² The NAPAs are meant to draw on existing information and community-level input to assess vulnerability to current climate variability and areas where risks will be heightened by climate change, and to identify priority actions. The Global Environment Facility (GEF),

which administers adaptation funding under the Convention, recently approved the first allocations for implementation projects through a \$50 million Strategic Priority on Adaptation (SPA) initiative.³³

Arguably, one significant constraint on adaptation efforts to date has been limited funding. At COP 7, in 2001, parties established three GEF-managed funds dedicated fully or in part to supporting adaptation.³⁴ However, not all funds pledged by developed countries have yet been made available, and some developing countries cite difficulties in accessing what funds are available. The World Bank reported in 2006 that its support for adaptation had been “on the order of approximately \$50 million over about five years,” mainly through the GEF.³⁵ Parties decided at COP 7 that, to supplement donor country contributions, one of the three new funds will be supported by a levy of two percent on proceeds from emission credits generated through the Kyoto Protocol’s Clean Development Mechanism (CDM). Future CDM flows, however, are highly uncertain; the Bank projects they could generate from “a few tens of millions” to \$1 billion for adaptation purposes by 2012. Within the negotiations, administration of the Adaptation Fund remains highly contentious, with many developing countries maintaining that as the funds are not from donor countries, they should be managed by an entity other than the GEF.

Funding levels aside, the adaptation effort has suffered from ambiguities in the regime. One concerns the very definition of adaptation, which is nowhere explicit in the Convention. In that adaptation is referenced only in the context of climate change, the implication is that support under the Convention must be directed to activities addressing primarily if not exclusively human-induced impacts. Yet, as noted earlier, and in expert meetings convened under the Convention, adaptation strategies often are most effective when addressing the full continuum of climate risk. In addition, there appears significant confusion over the terms for adaptation funding through the GEF. As the GEF was established to address global environmental issues, projects supported through its principal trust fund must deliver a “global environmental benefit.” In the area of adaptation, most funding flows through the separate dedicated funds established under the Convention and the Kyoto Protocol. Although guidance from the parties is not explicit on the point, the GEF’s position is that the “global environmental benefits” test does not apply to these funds.³⁶ Yet there remains a widespread perception among potential recipients that it does.³⁷

Referring back to the policy needs identified in Section II, the international effort to date has delivered some information, resources, and capacity building, but has 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. Even if significant new resources were forthcoming, it appears improbable that existing arrangements under the Convention could alone serve as an adequate basis for a strengthened adaptation effort. The next section explores options within and outside the climate regime for more comprehensive and effective future efforts.

IV. Options Going Forward

As is true on the mitigation side of the climate equation, an effective adaptation response requires a wide array of measures and strategies. Three broad approaches are described here:

- **Adaptation under the UNFCCC**—Strengthening mechanisms and support for proactive adaptation under the Convention by facilitating comprehensive national strategies and committing reliable funding for high-priority implementation projects.
- **Integration with development**—Factoring adaptation into development assistance through measures such as mandatory climate risk assessments for projects financed by multilateral and bilateral lenders.
- **Climate “insurance”**—Committing funds to support climate relief or insurance-type approaches in vulnerable countries for losses resulting from both climate change and climate variability.

Each of these approaches, pursued independently, could contribute to national-level efforts to reduce or cope with climate risks. Together, these three strategies also could be seen as complementary elements of a comprehensive international effort—the first, supporting proactive planning and high-priority implementation; the second, promoting integration with the broader development agenda; and the third, providing a safety net to ameliorate unavoidable impacts.

Adaptation Under the UNFCCC

From a political standpoint, it may be most plausible to pursue future adaptation efforts within the Framework Convention. To the degree that additional adaptation support is bound with the question of future commitments on climate mitigation, the UNFCCC negotiating process is the most obvious venue for structuring agreements that speak to both. Further, it makes sense to build on, or where appropriate redirect, the adaptation apparatus already established under the Convention. There may be constraints, however, on what can be achieved within a regime created specifically to address climate change. First, the climate regime has not traditionally engaged many of the agencies and actors whose participation in adaptation is essential. Even if the regime assigned a higher priority to adaptation, it still might not be the best channel for engaging relevant policymakers and stakeholders. Second, the regime’s inherent focus on climate change may not easily lend itself to a comprehensive effort addressing both climate change and natural climate variability.

Still, a proactive approach under the regime could help to address urgent climate change-specific impacts while also facilitating comprehensive long-term climate risk management at the national level.³⁸ Specific elements of a Convention-based approach could include:

- Support to vulnerable countries for the development of comprehensive national adaptation strategies;
- Reliable funding to assist countries with approved national strategies to implement high-priority measures, with priority given to those addressing impacts reasonably attributable to climate change; and
- Establishment or designation of an international body to provide technical support, judge the adequacy of national strategies, and select high-priority projects for funding.

Convention support for developing national adaptation strategies would help establish frameworks for action and strengthen capacity in vulnerable countries. The strategies could build on the NAPAs, which target urgent priorities, to map out comprehensive long-term plans identifying: climate risks (from both climate change and climate variability); existing and needed adaptation capacities; risk reduction objectives; high-priority adaptation measures; and national policies and measures to fully integrate climate risk management into development decision-making. In addition to organizing national-level adaptation efforts, the strategies could serve as a basis for targeting implementation assistance through the regime or other channels. Such assistance could be made conditional on a country's completion of an adequate national strategy.

If assistance is provided for specific adaptation measures, parties would need to establish parameters for qualifying projects. Given that assistance through the Convention would likely be limited, and that the Convention concerns itself specifically with climate change, such funds presumably would be targeted to urgent needs arising directly from climate change impacts. This determination may be possible only in a narrow range of circumstances—such as sea-level rise or glacial melting—which could be agreed as classes of impact eligible for funding. Beyond such readily identifiable priorities, Convention funds could be packaged with other assistance through development channels to support broader climate risk management efforts in vulnerable countries.

Institutionally, such an approach would require means to support development of national plans and capacity, assess the adequacy of national plans, and allocate any implementation assistance made available under the Convention. These functions could be performed by a new or existing body, which, in coordination with other expert and implementing agencies, could serve as a clearinghouse for information, expertise, and funding. This institution would need political legitimacy with both donor and recipient countries, and sufficient independence to credibly pass judgment on national plans and to choose among competing projects. Some form of political oversight, perhaps by the Conference of the Parties, also would be needed.

A Convention-based approach, whether initiated through an “adaptation protocol” or another instrument, would most likely be agreed as part of a broader package that also addresses mitigation. In the long term, a Convention-based strategy would be effective only insofar as it succeeded in institutionalizing adaptation in vulnerable countries. To the degree possible, assistance provided for planning or implementation should serve simultaneously to build or strengthen national capacities so that, over time, countries are better able to adapt on their own. Also critical to long-term success would be adequate, predictable, and sustained funding. This would require supplementing or replacing the present system of pledging-plus-CDM levy with a stronger, dedicated source such as a wider levy on the emissions market or funding commitments under an agreed formula.

Integration with Development

Another approach at the international level is to work through existing channels of multilateral and bilateral assistance to integrate adaptation considerations across the full range of development support. Working through the development process may be the most direct and effective means of discouraging investments that heighten climate vulnerability and promoting those that strengthen climate resilience. A development-centered strategy could closely complement the Convention-based approach described above, helping to ensure that national adaptation strategies prepared with Convention support are implemented, and could over time leverage far more resources than likely would be forthcoming under the climate regime.

One means of more closely integrating adaptation into development decision-making would be the systematic application of climate risk assessment to projects considered for development assistance. Proposed investments could be assessed for their own vulnerability to climate variability and climate change and for any broader effect on climate vulnerability within the host country. As with the environmental impact assessments now performed routinely by multilateral lenders, this would in the first instance provide critical information to decision-makers. The World Bank has begun to develop a “screening tool” to help project developers assess whether proposed investments face significant climate risk.³⁹ The computer-based package would also provide sources of information and expertise on ways to reduce a project’s vulnerability. The Bank says that “in the longer term, it could become a standard tool for screening new...projects for climate risk early in the project cycle.”⁴⁰

For assessments to contribute effectively to risk reduction, it may be necessary to require that the information generated be formally taken into account in project design, review, and approval. One option would be to condition project approval on satisfactory performance against a set of vulnerability criteria. A project that would itself be highly vulnerable to climate risk, or would otherwise contribute to heightened societal vulnerability, would be financed only if modified to reduce projected risks to acceptable levels. For instance, a proposed highway might be rerouted to steer development away from flood-prone areas.

Conversely, projects that substantially reduce climate vulnerability, or are identified as priorities in national adaptation strategies, might be given preferential treatment. Such criteria might be established first at the multilateral development banks, and then applied at their discretion by donor countries providing bilateral assistance, and by private lenders.

Efforts to fully integrate adaptation into development assistance may encounter institutional and political resistance, particularly if they entail new conditionalities. Institutions and constituencies whose overriding objective is economic and social development may view the introduction of climate concerns as a distraction from their core missions. Objections by recipient countries could be especially strong if new measures are not accompanied by increased assistance so that it appears existing flows are being diverted to needs other than development. However, with or without additional assistance, routine climate risk assessment could well contribute to development objectives, rather than compete with them, by helping to ensure that whatever aid is available is wisely invested.

While a development-centered approach would operate largely outside the climate regime, it may be through the regime that the necessary political momentum is most readily achieved. Conceivably, donor countries could commit in the climate regime to take the necessary decisions within the international finance institutions to establish climate risk lending criteria and to provide additional adaptation assistance. It also could be agreed that the provision of such assistance would be closely guided by national adaptation strategies prepared under the Convention.

Climate “Insurance”

The two previous approaches are largely proactive; they aim to reduce climate risk. As such measures, even if robust, are unlikely to be fully effective, reactive approaches are also needed to help vulnerable countries cope with the risks that remain. Climate “insurance”—identified in both the Framework Convention and the Kyoto Protocol as one means of adaptation—could take many forms (some only loosely related to insurance in the traditional sense). While intended primarily to provide relief after losses occur, insurance-type approaches could in some cases be designed to encourage proactive efforts as well.

Two possibilities are described here:

- **International response fund**—Donor countries would commit to regular contributions to a multilateral fund to assist countries suffering extreme and/or long-term climate impacts.
- **Insurance “backstop”**—Donor countries support the introduction or expansion of insurance-type instruments in vulnerable countries by committing funds to subsidize premiums or to reinsure governments or primary insurers.

Events such as the 2004 Asian tsunami have in recent years drawn record levels of post-disaster assistance from donor countries. However, these humanitarian flows remain largely ad hoc, dependent on a new round of pledging following each new event. To provide a more predictable and timely response to natural disasters and other humanitarian crises, the United Nations recently established a \$500 million Central Emergency Response Fund supported by voluntary contributions and replenished at regular intervals.⁴¹ This approach could be taken further within the climate arena through a new instrument—supported by long-term funding commitments—to provide relief from climate impacts.

Such a fund could narrowly target impacts directly attributable to climate change. As early as 1991, Vanuatu, on behalf of the Alliance of Small Island States, proposed an International Insurance Pool to compensate low-lying countries for damages resulting from sea-level rise.⁴² Conceptually, providing assistance for a broader range of climate change impacts would be challenging because many are, as a practical matter, indistinguishable from the impacts of climate variability. One option would be a response fund for major climate-related impacts—both extreme events and long-term losses—whatever their cause. A relief fund of this sort could be administered by U.N. agencies in collaboration with organizations such as the International Federation of the Red Cross, under the guidance of Framework Convention parties and the U.N.⁴³ In addition to addressing losses directly attributable to climate change, such a fund would help rationalize climate disaster assistance generally by substituting regularized funding for reactive and unpredictable post-disaster aid.

A different strategy would be to commit funding to help facilitate insurance and other risk-transfer mechanisms within vulnerable countries. This, too, would be most practical if directed at risks arising from both climate change and climate variability. Commercial insurance is presently available, to those who can afford it, for a wide variety of weather-related risks. Insurance covered 40 percent of weather-related disaster losses in high-income countries from 1980 to 2003, but only 4 percent in low-income countries.⁴⁴ The insurance sector is growing rapidly in emerging economies, which, at current growth rates, will represent half the world market by 2050.⁴⁵ But this growth is unlikely to reach many among the populations most vulnerable to climate change.

Donor governments, possibly in partnership with the private sector, could support insurance-type approaches in vulnerable countries by subsidizing premiums or by pledging backup capital to reduce risks to public or private providers.⁴⁶ A variety of risk-transfer instruments could be supported for different sectors and types of risk (see Box 2: Insurance-Type Instruments). One promising approach is index-based mechanisms such as weather derivatives, which assure payoffs to farmers experiencing prolonged heat or drought without requiring that losses be demonstrated, avoiding the costly and time-consuming process of

Box 2**Insurance-Type Instruments**

The insurance industry and developing country governments are exploring or testing a number of insurance-type approaches to cover climate-related risks. Examples include:

Pooling Cash Reserves. As a form of collective self-insurance, the Eastern Caribbean Central Bank is accumulating cash reserves through mandatory contributions by member governments, which can then draw loans if struck by natural disasters.

Indemnifying Debts. The Commonwealth and Smaller States Disaster Management Scheme provides insurance to risk-prone governments so they can continue to service outstanding debt following natural disasters. Countries pay a flat-rate premium of 1 percent of the sum insured.

Catastrophe Bonds. The World Bank is exploring whether catastrophe bonds, now in use in developed countries, might be extended to developing country markets. “Cat” bonds insure against a predefined event. Investors who purchase them realize a return if the event does not occur but may lose their entire investment if it does.

Indexed Insurance for Agriculture. These contracts, also known as weather derivatives, provide payments to farmers under predetermined conditions (such as number of days with temperatures above a set threshold) without requiring proof of loss. The World Bank is studying their feasibility in Ethiopia, Morocco, Nicaragua, and Tunisia.

Source: DFID Fact Sheet 8 “Adaptation to Climate Change: Can insurance reduce the vulnerability of the poor?” Global and Local Environment Team, Policy Division, Department for International Development, United Kingdom, 2004 at <http://www.dfid.gov.uk/pubs/files/climatechange/8insurance.pdf>.

verifying claims. The World Bank is developing a proposal for a Global Index Insurance Facility, with \$100 million in public and private capital, to reinsure governments and primary insurers providing index-based coverage against weather and other risks.⁴⁷

Reinsurance—or “backstopping”—also could be provided for acute losses from extreme events such as hurricanes or typhoons. One potential model is the Turkish Catastrophe Insurance Pool, a national earthquake insurance program backed by a standby line of credit from the World Bank, the first instance of an international financial institution absorbing developing country risk. Backstopping also could take the form of catastrophe bonds, in which investors funding a reinsurance pool receive above-market returns if no losses occur but risk their full investment should there be a major disaster. Mexico plans to issue catastrophe bonds on the private market to reinsure its national catastrophe relief fund. Donor governments, alone or with private investors, could use the same mechanism to back climate relief in vulnerable countries.

Insurance-type approaches can serve also to promote proactive climate risk management. In traditional property insurance, risky behavior is discouraged by requiring the insured to retain some risk in the form of a deductible. A similar incentive could be provided by having governments in recipient countries share in the cost of coverage, with discounted “premiums” for countries with effective risk reduction programs. Or assistance could be explicitly conditioned on a country’s progress in meeting risk management goals. The World Bank’s support for Turkey’s earthquake insurance, for instance, is contingent on progress in regulatory reform and prevention measures.⁴⁸

As with a development-centered approach, climate “insurance” would extend well beyond the traditional purview of the climate change regime, particularly if designed to address the impacts of climate variability as well. Here, too, however, it may be possible to launch a concerted effort only through a political bargain struck within the climate regime. Technical issues aside, the fundamental challenge may be one of political acceptability. Wealthy countries will not easily commit to substantial long-term funding, without which a meaningful program would not be viable. Developing countries, on the other hand, may resist sharing in the costs of a program that, in their view, should hold them harmless for risks created by others. Deftly designed insurance-type approaches may nonetheless be an equitable means of delivering material support while circumventing legalistic, and politically acrimonious, questions of liability for climate change.

V. Conclusions

The preceding section outlines three approaches and suggests ways they can serve as complementary elements of a comprehensive international adaptation effort. One fundamental challenge in mobilizing such an effort is bridging the seeming gap between political and policy contexts.

Adaptation has become an issue for the international community by virtue of climate change: the onset of human-induced climate impacts presents not only significant new risks and needs, but also difficult issues of global equity. However, the new adaptation challenges presented by climate change must be understood within the broader context of climate risk generally, and against a backdrop of rising vulnerability driven by other forces. Such a perspective likewise suggests that the most effective adaptation strategies will in many cases be those addressing climate risk generally. From a policy perspective, then, much of the action necessary is in processes and venues traditionally far removed from the issue of climate change. Yet from a political perspective, the strongest drivers—and, hence, the greatest prospect for achieving the necessary political momentum—are in the climate change arena.

Bridging this gap will require unusual facility by governments in looking—and acting—across policy areas. It could, for instance, entail decisions or commitments in the climate framework requiring corresponding decisions and implementation within institutions focused primarily on development or disaster preparedness. Such coordinated action assumes, of course, that the necessary political will does in fact emerge. However great the need for stronger adaptation efforts, this is hardly a foregone conclusion. Ultimately, the marshalling of a truly effective adaptation response at the international level may be possible only as part of a broader package of commitments also addressing the root causes of climate change—in other words, as part of a political bargain encompassing both adaptation and mitigation.

Endnotes

1. This report was prepared initially as input to the Climate Dialogue at Pocantico convened by the Pew Center in 2004-5, and in its final form reflects contributions from the dialogue. The Pocantico dialogue brought together 25 senior policymakers and stakeholders from 15 countries to recommend options for advancing the international climate change effort beyond 2012. The group's report is available at: http://www.pewclimate.org/global-warming-in-depth/all_reports/climate_dialogue_at_pocantico/index.cfm.

2. Metz et al. (2001).

3. Parmesan, C. and G. Yohe (2003); Root, T. L. et al. (2003); Stott et al. (2004).

4. McCarthy et al. (2001).

5. Adaptation is defined by the Intergovernmental Panel on Climate Change as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (Third Assessment Report, Working Group II).

6. Lamb (1995); Wright (2004).

7. Smit et al. (2001).

8. Authors' calculations based on Munich Re loss data and World Bank income data.

9. Dilley et al. (2005). This figure includes all natural disasters, not just weather-related.

10. ECLAC (2002); UNEP (2002).

11. The World Bank (2006).

12. Van Aalst (2006).

13. McMichael and Githeko (2001).

14. Campbell-Lindrum et. al. (2003).

15. Tol and Dowlatabadi (2002); Ebi et. al. (2005).

16. Gitay et. al. (2001).

17. Patz et al. (2005); Arnell (2004).

18. Arnell and Liu (2001).

19. Burton and May (2004).

20. Nicholls (2004); Nicholls and Lowe (2004).

21. Malcolm et al. (2006).

22. Root et al. (2003); Parmesan and Yohe (2003); Parmesan and Galbraith (2004).

23. Gitay et. al. (2001); Thomas et. al. (2004).

24. National Academy of Sciences (1992).

25. Stott et al. (2004).

26. Sperling and Szekely (2005).

27. UNFCCC, Article 4.1.

28. UNFCCC, Article 3.

29. UNFCCC, Article 4.4.

30. UNFCCC, Decision 11/CP.1.

31. Frankel-Reed (2006).

32. GEF (2006).

33. GEF was established in 1992 to channel financing to developing countries to address environmental problems of global concern. It operates through three implementing agencies—the World Bank, the U.N. Environment Programme, and the U.N. Development Programme.

34. The three funds are the Least Developed Countries Fund, the Special Climate Change Fund, and the Adaptation Fund. The first two are supported by voluntary contributions from donor countries; the third by a share of the proceeds from credits generated through the Kyoto Protocol's Clean Development Mechanism.

35. The World Bank GEF (2006). In addition, the GEF has provided approximately \$170 million for the preparation of national communications, which address both mitigation and adaptation. See Assistance to Address Adaptation, GEF/C.23/Inf.8/Rev.1 of May 11, 2004; and Status Report on the Least Developed Countries Fund For Climate Change and The Special Climate Change Fund, GEF/C.25/4/Rev.1 of May 2, 2005.

36. See Working Draft GEF Climate Change Strategy, Meeting on the Fourth Replenishment of the GEF Trust Fund, GEF/R.4/Inf.7. Also see Decision 7/CP.7 on funding under the Convention and Decision 10/CP.7 on funding under the Kyoto Protocol in FCCC/CP/2001/13/Add.1. Also see Decision 5/CP.9 on further guidance for the financing mechanism to operate the SCCF and Decision 6/CP.9 on further guidance for the operation of the LDCF in FCCC/CP/2003/6/Add.1.

37. Personal communications with developing country officials engaged in adaptation efforts.

38. "Reactive" approaches under the Convention are considered in the section on Climate "Insurance."

39. Burton and van Aalst (2004).

40. The World Bank GEF (2006).

41. To learn more about the Central Emergency Response Fund see the UN Office for the Coordination of Humanitarian Affairs website at <http://ochaonline.un.org/webpage.asp?Page=2101>

42. INCFCC (1991).

43. Müller (2002).

44. Mills (2004).

45. Mills (2004).

46. Linnerooth-Bayer (2005).

47. CRMG and World Bank (2006).

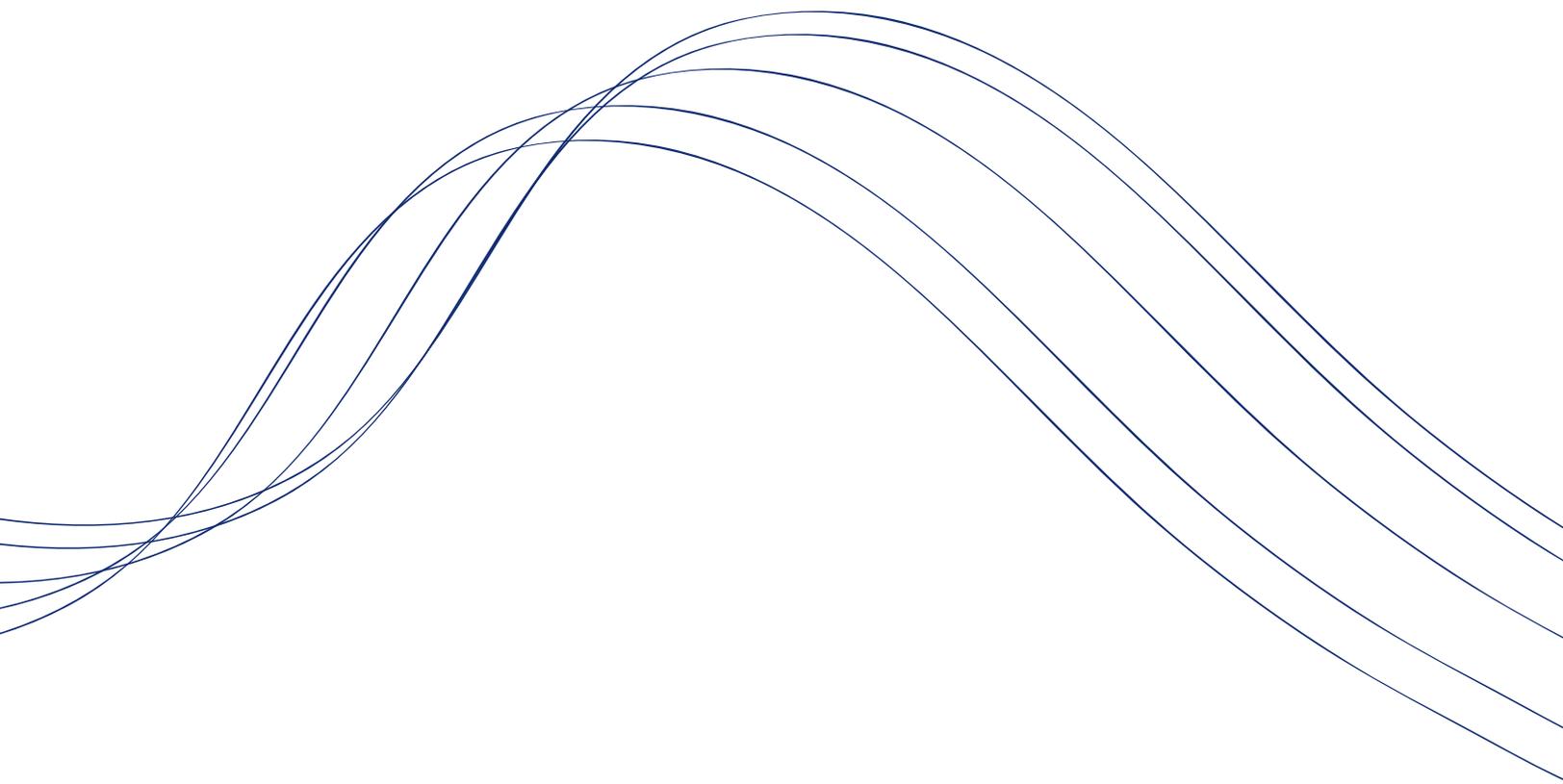
48. Linnerooth-Bayer and Verheyen (2003).

References

- Arnell, N. W. 2004. "Climate change and global water resources: SRES emissions and socio-economic scenarios." *Global Environmental Change*, 14, pp. 31-52.
- Arnell, N., C. Liu, R. Compagnucci, L. Da Cunha, K. Hanaki, C. Howe, G. Mailu, I. Shiklomanov, and E. Stakhiv. 2001. "Hydrology and Water Resources," in J. McCarthy, O. Canziani, N. Leary, D. Dokken, and K. White, eds. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. New York: Cambridge University Press, pp. 191-233.
- Barnett, T. P., J. C. Adam and D.P. Lettenmaier. 2005. "Potential impacts of a warming climate on water availability in snow-dominated regions." *Nature*, 438, pp. 303-308.
- Burton, I. 2004. "Climate Change and the Adaptation Deficit," in A. Fenech, D. MacIver, H. Auld, R., Bing Rong, and Yongyuan Yin, eds. *Building the Adaptive Capacity*. Toronto: Meteorological Service of Canada, pp. 25-33.
- Burton, I. and E. May. July 2004. "The Adaptation Deficit in Water Resources Management." *IDS Bulletin*, vol 35, no. 3, pp. 31-37.
- Burton, I. and M. Van Aalst. 1999. *Come Hell or High Water: Integrating Climate Change Vulnerability and Adaptation into Bank Work*. The World Bank Environment Department Paper No. 72. <http://www.worldbank.org/climatechange>.
- Burton, I. and M. Van Aalst, 2004. *Look Before You Leap: A Risk Management Approach for Incorporating Climate Change Adaptation into World Bank Operations*. World Bank Environment Department Paper No. 100.
- Campbell-Lendrum, D. H., C. F. Corvalan, and A. Prüss-Ustün. 2003. "How Much Disease Could Climate Change Cause," in A. J. McMichael, D. H. Campbell-Lendrum, C. F. Corvalan, K. L. Ebi, A. K. Githeko, J. D. Scheraga, and A. Woodward, eds. *Climate Change and Human Health: Risks and Responses*. Geneva: World Health Organization, pp. 133-158.
- Commodity Risk Management Group (CRMG), ARD and the World Bank. 2006. "Global Index Insurance Facility (GIIF) Concept Note Synopsis." Draft.
- Diamond, J. 2005. *Collapse: How Societies Choose to Fail or Succeed*. New York: Viking Penguin Group.
- Global and Local Environment Team, Policy Division, Department for International Development. 2004. "DFID Fact Sheet 8; Adaptation to Climate Change: Can insurance reduce the vulnerability of the poor?" UK. <http://www.dfid.gov.uk/pubs/files/climatechange/8insurance.pdf>.
- Dilley, M., R. S. Chen, U. Deichmann, A. L. Lerner-Lam, and M. Arnold. 2005. *Natural Disaster Hotspots: A Global Risk Analysis*. Disaster Risk Management Series, No 5. The World Bank.
- Ebi, K. L., J. B. Smith, and I. Burton, eds. 2005. *Integration of Public Health with Adaptation to Climate Change*. New York: Taylor & Francis.
- Economic Commission for Latin America and the Caribbean (ECLAC). 2002. "El impacto socioeconómico y ambiental de la sequía de 2001 en Centroamérica", (LC/MEX/L.510/Rev.1/E). Santiago, Chile: United Nations publication.

- Frankel-Reed, Jennifer. 2006. "Emerging Approaches in Climate Change Adaptation from Theory and Practice." Unpublished Master's thesis.
- Gitay, H., S. Brown, W. Easterling, and B. Jallow. 2001. "Ecosystems and their Goods and Services," in McCarthy et al., pp. 235-342.
- Global Environment Facility (GEF). May 12, 2006. *Programming Paper for Funding the Implementation of NAPAs under the LDC Trust Fund*. (GEF/C.28/18.)
- Intergovernmental Negotiating Committee for a Framework on Climate Change (INCFCC) Working Group II, Fourth Session. 17 December 1991. "Vanuatu: draft annex relating to Article 23 (Insurance) for inclusion in the revised single text on elements relating to mechanisms." Geneva, Agenda Item 2(b), A/AC.237/WG.II/CRP.8.
- Lamb, H.H. 1995. *Climate History and the Modern World*. New York: Routledge. Second Edition.
- Linnerooth-Bayer, J., R. Mechler, and G. Pflug. August, 2005. "Refocusing Disaster Aid." *Science*, Vol. 309. no. 5737, pp. 1044 – 1046.
- Linnerooth-Bayer, J. and R. Verheyen. 2003. "Insurance-Related Actions and Risk Assessment in the Context of the UNFCCC." Background paper for UNFCCC workshops, commissioned by the UNFCCC Secretariat.
- Malcolm, J. R., C. Liu, R. P. Neilson, L. Hansen, and L. Hannah. 2006. "Global Warming and Extinctions of Endemic Species from Biodiversity Hotspots." *Conservation Biology*, 20(2), pp. 538-548.
- McCarthy J. J., O. F. Canziani, N. A. Leary, D. J. Dokken and K. S. White, eds. 2001. *Climate Change 2001: Impacts, Adaptation & Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). New York: Cambridge University Press. [Available from http://www.grida.no/climate/ipcc_tar/wg2/359.htm]
- McMichael, A, and Githeko, A. 2001. "Human health. Climate change 2001: impacts, adaptation and vulnerability," in McCarthy et al., pp 451-485.
- Metz, B., O. Davidson, R. Swart, and J. Pan. 2001. *Climate Change 2001: Mitigation*. New York: Cambridge University Press.
- Mills, E. 2004. "Insurance as an Adaptation Strategy for Extreme Weather Events in Developing Countries and Economies in Transition: New Opportunities for Public-Private Partnerships," Lawrence Berkeley National Laboratory Report No. LBNL-52220. http://eetd.lbl.gov/emills/PUBS/Insurance_Emerging_Markets.html
- Milly, P. C. D., K. D. Dunne and V. Vecchia. 2005. "Global pattern of trends in streamflow and water availability in a changing climate." *Nature*, 438, pp. 347-350.
- Müller, B. 2002. "An FCCC Impact Response Instrument as part of a Balance Global Climate Change Regime," presented at the Tata Energy Research Institute, New Delhi.
- National Academy of Sciences. 1992. *Policy Implications of Greenhouse Warming*. Washington, D.C.: National Academy Press.
- Nicholls, R. J. 2004. "Coastal Flooding and Wetland Loss in the 21st Century: Changes Under the SRES Climate and Socioeconomic Scenarios." *Global Environmental Change*, 14(1), pp. 69-86.
- Nicholls, R. J. and J. A. Lowe. 2004. "Benefits of Mitigation of Climate Change for Coastal Areas." *Global Environmental Change*, 14(3), pp. 229-244.

- Parmesan, C. and G. Yohe. 2003. "A globally coherent fingerprint of climate change impacts across natural systems." *Nature*, 421, pp. 37-42.
- Parry, J., A. Hammill and J. Drexhage. 2005. "Climate Change and Adaptation." Winnipeg: International Institute for Sustainable Development.
- Patz, J. A., D. Campbell-Lendrum, T. Holloway, and J. Foley. 2005. "Impact of Regional Climate Change on Human Health." *Nature*, 438, pp. 310-317.
- Root, T. L., J. T. Price, K. R. Hall, S. H. Schneider, C. Rosenzweig, and J. A. Pounds. 2003. "Fingerprints of global warming on wild animals and plants." *Nature*, 421, pp. 57-60.
- Sperling, F. and F. Szekely. 2005. "Disaster Risk Management in a Changing Climate." Discussion Paper prepared for the World Conference on Disaster Reduction on behalf of the Vulnerability and Adaptation Resource Group (VARG). Reprint with Addendum on Conference outcomes. Washington, D.C.
- Stott, P. A., D. A. Stone, and M. R. Allen. 2004. "Human contribution to the European heatwave of 2003." *Nature*, 432, pp. 610-614.
- Smit, B., O. Pilifosova, I. Burton, B. Challenger, S. Huq, R. Klein, and G. Yohe. 2001. "Adaptation to Climate Change in the Context of Sustainable Development and Equity," in J. McCarthy et al., pp. 877-912.
- Thomas, C. and 18 co-authors. 2004. "Extinction Risk from Climate Change." *Nature*, 427, pp. 145-148.
- Tol, R.S.J. and H. Dowlatabadi. 2002. "Vector-Borne Diseases, Development, and Climate Change." *Integrated Environmental Assessment*, 2, pp. 173-181.
- United Nations Environment Programme (UNEP). 2002. *The Sustainability Of Development In Latin America And The Caribbean: Challenges And Opportunities*. Libros de la CEPAL series, No. 68 (LC/G.2145/Rev.1-P). Santiago, Chile: United Nations publication.
- UNDP. 2004. *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies, and Measures*. New York: Cambridge University Press.
- Feenstra, J. F., I. Burton, J. B. Smith, and R.S.J. Tol, eds. 1998. *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*. Version 2.0. UNEP.
- UNFCCC. Decision 7/CP.7 and 10/CP.7 in FCCC/CP/2001/13/Add.1.
- UNFCCC. Decision 5/CP.9 and 6/CP.9 in FCCC/CP/2003/6/Add.1.
- The World Bank, Global Environmental Facility. 2006. *Managing Climate Risk: Integrating Adaptation into World Bank Group Operations*.
- The World Bank. April 5, 2006. *Clean Energy and Development: Towards an Investment Framework*. (DC2006-0002.) Available at: [http://siteresources.worldbank.org/DEVCOMMINT/Documentation/20890696/DC2006-0002\(E\)-CleanEnergy.pdf](http://siteresources.worldbank.org/DEVCOMMINT/Documentation/20890696/DC2006-0002(E)-CleanEnergy.pdf)
- Yohe, G. and R.S.J. Tol. 2002. "Indicators for Social and Economic Coping Capacity – Moving toward a working definition of adaptive capacity." *Global Environmental Change*, 12, pp. 25–40.



This paper examines options for strengthening international support for adaptation to climate change. It is part of a Pew Center series on *Advancing the International Effort Against Climate Change*. The Pew Center was established by The Pew Charitable Trusts to bring a new cooperative approach and critical scientific, economic, and technological expertise to the global climate change debate. We inform this debate through wide-ranging analyses in four areas: policy (domestic and international), economics, environment, and solutions.

