



Climate Change Knowledge Network

Foundation Paper

Vulnerability and Adaptation to Climate Change: Concepts, Issues, Assessment Methods

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1. Introduction

It has become common knowledge that the poor are likely to be hit hardest by climate change, and that capacity to respond to climate change is lowest in developing countries and among the poorest people in those countries. It seems clear that vulnerability to climate change is closely related to poverty, as the poor are least able to respond to climatic stimuli. Furthermore, certain regions of the world are more severely affected by the effects of climate change than others. Generally speaking, vulnerability and adaptation to climate change are urgent issues among many developing countries. For this reason, there exist provisions in the United Nations Framework Convention on Climate Change (UNFCCC) to assist those countries that are thought to be most vulnerable and least able to adapt.

Within the context of the Climate Change Knowledge Network (CCKN), a project on the impacts of economic changes and climate change on India's agricultural sector is being pursued jointly by the International Institute for Sustainable Development (IISD), the Centre for International Climate and Environmental Research (CICERO) and the Tata Energy Research Institute (TERI). The project is innovative in that it uses the concept of "double exposure" (O'Brien and Leichenko 2000). This refers to the fact that climate change and globalization are occurring simultaneously, and that regions, sectors, ecosystems and social groups are often confronted by the impacts of both processes.

The development of a program on vulnerability and adaptation has been included among the long-term policy research and capacity-building activities in the network's work plan for the next three years. Such a program could take this foundation paper as its starting point and build on the experience of the partners in projects on vulnerability and adaptation.

This paper provides an overview of the state of adaptation issues in the context of climate vulnerability literature and climate negotiations. In preparing this paper, a review of the relevant literature was undertaken with the objective of identifying various adaptation issues. Assessments of vulnerability in various regions—developing countries, in particular—were covered. In addition, a review of related UNFCCC documents and analyses of the climate negotiations was conducted to understand priorities of UNFCCC Parties, and to assess possibilities for vulnerability and adaptation projects in developing countries. The final part of the paper briefly discusses some of the existing resources that can be used to "guide" vulnerability assessments and adaptation work.

2. The Concept of Vulnerability: Definitions and Issues

The Intergovernmental Panel on Climate Change (IPCC), in its Second Assessment Report, defines vulnerability as "the extent to which climate change may damage or harm a system." It adds that vulnerability "depends not only on a system's sensitivity, but also on its ability to adapt to new climatic conditions" (Watson et al. 1996: 23). In a

presentation made at the Sixth Conference of the Parties to the UNFCCC (COP-6), Robert T. Watson, Chair of the IPCC, defines vulnerability as

the extent to which a natural or social system is susceptible to sustaining damage from climate change, and is a function of the magnitude of climate change, the sensitivity of the system to changes in climate and the ability to adapt the system to changes in climate. Hence, a highly vulnerable system is one that is highly sensitive to modest changes in climate and one for which the ability to adapt is severely constrained. (IPCC 2000a)

The IPCC report, *The Regional Impacts of Climate Change: An Assessment of Vulnerability* (Watson et al. 1998), argues that the vulnerability of a region depends to a great extent on its wealth, and that poverty limits adaptive capabilities. According to the Second Assessment Report, vulnerability depends on the level of economic development and institutions. The report argues that socio-economic systems “typically are more vulnerable in developing countries where economic and institutional circumstances are less favourable” (Watson et al. 1996: 24). The report continues that vulnerability is highest where there is “the greatest sensitivity to climate change and the least adaptability.”

Looking at vulnerability from the food security point of view, the FAO publication *The State of Food Insecurity in the World* (1999), defines vulnerability as “the presence of factors that place people at risk of becoming food insecure or malnourished.” Clearly, this definition encompasses causes of food insecurity other than climate change (e.g., armed conflict, landlessness, etc.). Nevertheless, the concept of vulnerability includes hunger vulnerability—which refers to the vulnerability of individuals or households rather than that of regions or economic sectors.

The following observations highlight the seriousness of the potential impacts of climate change on food security:

[I]n the tropics and subtropics, where some crops are near their maximum temperature tolerance and where dryland, non-irrigated agriculture dominates, yields are likely to decrease for even small changes in climate, especially in Africa and Latin America, where decreases in overall agricultural productivity of up to thirty per cent are projected during the next century. Therefore, there may be increased risk of hunger in some locations in the tropics and subtropics where many of the world’s poorest live. (IPCC 2000a)

It is established... that climate change, mainly through increased extremes and temporal/spatial shifts, will worsen food security in Africa. (IPCC 2001: 11)

A common theme in the climate change impacts and vulnerability literature is the idea that countries, regions, economic sectors and social groups differ in their degree of vulnerability to climate change (see, for example, Bohle et al. 1994). This is due partly to the fact that changes in temperature and precipitation will occur unevenly and that

climate change impacts will be unevenly distributed around the globe. It is also due to the fact that resources and wealth are distributed unevenly. Though vulnerability differs substantially across regions, it is also recognized that “[e]ven within regions... impacts, adaptive capacity and vulnerability will vary” (IPCC 2001: 15).

Handmer et al. (1999) posit that many regions and countries will be capable of adapting to climate change, but that poorer countries and regions will have difficulty responding to climate change. These authors argue that the study of adaptation to climate change should begin with the study of social and economic vulnerability.

As noted by Smit et al. (2000), some authors distinguish “pre-adaptation vulnerability” from “post-adaptation vulnerability.” Kelly and Adger (2000) argue that according to the IPCC approach, vulnerability is contingent on estimates of the potential climate change and adaptive responses. In other words, “the level of vulnerability is determined by the adverse consequences that remain *after* the process of adaptation has taken place” (Kelly and Adger 2000: 327).

From a natural hazards perspective, Blaikie et al. (1994) define vulnerability as “the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard” (9). The same authors argue that vulnerability “is a measure of a person or group’s exposure to the effects of a natural hazard, including the degree to which they can recover from the impact of that event” (57).

These definitions of vulnerability and adaptation have implications for assessments of vulnerability. In one case, vulnerability depends on the adaptation that has taken place; in the other, vulnerability is defined in terms of capacity to adapt, and capacity to respond to stress is a starting point for impact analysis.

Blaikie et al. argue that households that have access to resources and social networks are less vulnerable. Although they may experience greater losses (in absolute terms) than the poor, it can be argued that resource-rich households are more resilient in that they recover more quickly from a stress/stimulus.

Following Blaikie et al., Kelly and Adger (2000: 328) define vulnerability as “the ability or inability of individuals or social groupings to respond to, in the sense of cope with, recover from or adapt to, any external stress placed on their livelihoods and well-being.” Their approach focuses on existing “wounds” (or prior damage), which might limit capacity to respond to stresses and are independent of future threats.

Various authors (e.g., Liverman 1994; Adger and Kelly 1999) have argued for the use of a political economy framework, often using the “entitlements approach” developed by Sen (1981), in analyses of vulnerability. As Ribot (1996) argues, this approach introduces a household perspective on vulnerability, one that replaces “ecocentric” approaches to environmental change. The main contribution of this approach lies, perhaps, in its focus on the vulnerability of individuals and social groups. Within this framework,

vulnerability is understood as being determined by access to resources—specifically, by individuals’ “entitlement” to call on these resources (Adger and Kelly 1999).

3. Adaptation: Definitions and Issues

Smit et al. (2000) point out that several definitions of adaptation are found in the climate change literature. The following are some of the examples found:

Adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides (Burton 1992, quoted in Smit et al. 2000);

Adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer-term climate change (Smit 1993, quoted in Smit et al. 2000);

The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Stakhiv 1993, quoted in Smit et al. 2000);

Adaptation to climate change includes all adjustments in behaviour or economic structure that reduce the vulnerability of society to changes in the climate system (Smith et al. 1996, quoted in Smit et al. 2000); and

Adaptability refers to the degree to which adjustments are possible in practices, processes or structures of systems to projected or actual changes of climate.

Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions (Watson et al. 1996, quoted in Smit et al. 2000).

Smit et al. (2000) also discuss various typologies and distinctions related to the process of adaptation which appear in the literature. For example, according to some of the typologies considered, adaptation can be planned or spontaneous; passive, reactive or anticipatory, etc.

From our point of view, it may be that planned, anticipatory adaptations that are undertaken by governments or NGOs as a policy initiative (as opposed to those that are autonomous and/or mainly reactive) are those that require the most attention. Though, as argued by Fankhauser et al. (1999), the distinction between autonomous and planned adaptation may be blurred in practice. The evaluation of adaptations must address the following question: “how good is the adaptation?” (Smit et al. 2000). Furthermore, it is

important to assess not only the “best” adaptation options, but also what adaptations are *likely* in various settings.

According to the IPCC Third Assessment Report, adaptation “has the potential to reduce adverse impacts of climate change and to enhance beneficial impacts, but will incur costs and will not prevent all damages.” Furthermore, it is argued that human and natural systems will, to some extent, adapt autonomously and that planned adaptation can supplement autonomous adaptation. However, “options and incentives are greater for adaptation of human systems than for adaptation to protect natural systems” (IPCC 2001: 6-8).

The propensity of systems (e.g., socio-economic systems) to adapt is influenced by certain system characteristics that have been called “determinants of adaptation” in the literature. These include terms such as “sensitivity,” “vulnerability,” “resilience,” “susceptibility” and “adaptive capacity,” among others. The occurrence as well as the nature of adaptations are influenced by these. As Smit et al. (2000) point out, there is some overlap in the concepts captured in these terms. The same authors argue that sensitivity, vulnerability and adaptability capture the broad concepts. Definitions of terms that describe system characteristics that are relevant for adaptation include the following:

Sensitivity: degree to which a system is affected by, or responsive to, climate stimuli

Vulnerability: degree to which a system is susceptible to injury, damage or harm

Impact potential: degree to which a system is susceptible to climate stimuli

Resilience: degree to which a system rebounds, recoups or recovers from a stimulus

Responsiveness: degree to which a system reacts to stimulus

Adaptive capacity: the potential or capability of a system to adapt to (to alter to better suit) climatic stimuli

Adaptability: the ability, competency or capacity of a system to adapt to (to alter to better suit) climatic stimuli

Building on some of this literature, and on its previous work, the most recent definitions adopted by the IPCC (2001) are the following:

Sensitivity: the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli.

Adaptive capacity: the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Vulnerability: the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. [It] is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Adaptation is often the result of interactions between climatic and other factors:

Adaptations vary not only with respect to their climatic stimuli but also with respect to other, non-climate conditions, sometimes called intervening conditions, which serve to influence the sensitivity of systems and the nature of their adjustments. For example, a series of droughts may have similar impacts on crop yields in two regions, but differing economic and institutional arrangements in the two regions may well result in quite different impacts on farmers and hence in quite different adaptive responses, both in the short and long terms. (Smit et al. 2000: 235)

It is important to highlight that the relationship between a changed climate system (e.g., higher temperatures, altered precipitation regime, etc.) and impacts on human systems is not necessarily linear—as early approaches used in climate impact studies (e.g., crop yields research and various analyses of land and regional production potentials—as applied in studies of agricultural impacts of climate change) seemed to imply. Human agencies and institutions can play a crucial role in minimizing the adverse impacts of—and in seizing opportunities resulting from—climate change. In particular, the role of adaptation (whether reactive or anticipatory, spontaneous or planned, etc.) is crucial for assessments of potential impacts of climate change (Smit et al. 2000).

4. Current Variability and Future Changes in Climate

Decreasing the vulnerability of socio-economic sectors and ecological systems to natural climate variability through a more informed choice of policies, practices and technologies will, in many cases, reduce the long-term vulnerability of these systems to climate change. (IPCC 2000a)

While members of the scientific community and policy-makers are particularly concerned about adaptation to climate change, some authors (e.g., Burton 1997) have argued that attention should be given to adaptation to current climate. Bohle et al. (1994), for example, argued that a full understanding of current vulnerability is necessary for developing strategies to coping with future climate change. This school of thought stresses the potential benefits and enhanced resilience that can result from practices and infrastructure that are well suited to the current climate. Given the uncertainties about future climate under various scenarios, efforts to assess adaptation to current climate can be useful as improved adaptation to current climate may be a crucial step in reducing vulnerability.

Burton (1997) argued that for developing countries it makes sense to focus on current problems that affect the economy rather than on uncertain changes that will only be manifested at some point in the “distant” future. It is in this context that current vulnerability is likely to be most relevant. The same author pointed to the need for more convergence between the scientific communities studying adaptation to current climate and extreme weather and those studying longer-term changes (e.g., ISDR)—advice which seems to have been taken by the IPCC. From the point of view of “the person on the ground” (i.e., those adversely affected by climate change), distinctions between “normal” climate and climate change might be irrelevant.

There may be some merit in following Burton’s (1997) suggestion about “integrating” the study of adaptation to current variability (i.e., extreme events) and that of long-term changes in climate. The projected increased frequency of extreme events, and the related reduction in recovery time, “would greatly affect the effectiveness of adaptation options” (Smit et al. 1999: 206).

As argued in the Third Assessment Report of the IPCC:

Experience with adaptation to climate variability and extremes can be drawn upon to develop appropriate strategies for adapting to anticipated climate change.
Adaptation to current climate variability and extremes often produces benefits as well as forming a basis for coping with future climate change (IPCC 2001: 8).

5. Vulnerable People and Places

People who live on arid or semi-arid lands, in low-lying coastal areas, in water-limited or flood-prone areas, or on small islands are particularly vulnerable to climate change (Watson et al. 1996: 24).

It is... clear that climate change will, in many parts of the world, adversely affect socio-economic sectors, including water resources, agriculture, forestry, fisheries and human settlements, ecological systems ..., and human health ..., with developing countries being the most vulnerable. (IPCC 2000a)

[D]eveloping countries... have lesser capacity to adapt and are more vulnerable to climate change damages, just as they are to other stresses. This condition is most extreme among the poorest people. (IPCC 2001: 8)

While there are vulnerable regions and populations throughout the globe, the two examples below illustrate well the fact that some regions are particularly vulnerable to climate change and warrant the attention of policy-makers.

Small-island developing states are thought to be very vulnerable to climate change in general and sea-level rise in particular (Watson et al. 1998). The economic vulnerability of many South Pacific small-island developing states is, according to Cocklin (1999),

related to the increasing reliance on imported food products and a result of relatively narrow resource bases. Resource degradation appears to be contributing to increasing vulnerability among these countries. Sea-level rise represents the most significant implication of climate change for small-island developing states, as many important economic activities tend to be concentrated in their coastal areas. Sea-level rise may result in accelerated coastal erosion, salt-water intrusion of fresh water reservoirs and increasing reach of storm waves, in addition to the possibility of actual drowning of some low-lying islands and atolls.

Not only small-island developing countries, but also countries that have considerable low-lying coastal areas are particularly threatened by sea-level rise:

A number of studies have shown that small islands and deltaic areas are particularly vulnerable to a one-metre sea-level rise. In the absence of mitigation actions... land losses are projected to range from 1.0 per cent for Egypt..., 17.5 per cent for Bangladesh, to about 80 per cent for the Marshall Islands, displacing tens of millions of people, and in the case of low-lying Small-Island States, [resulting in] the possible loss of whole cultures. (IPCC 2000a)

According to the IPCC report on the regional impacts of climate change, “Africa is the continent most vulnerable to the impacts of projected changes because widespread poverty limits adaptation capabilities” (Watson et al. 1998: 8). The importance of agricultural activities for the economies of most African countries, combined with the farming sector’s reliance on the quality of rains during the rainy season, make countries in the region particularly vulnerable to climate change. Thus, from the point of view of food security, the increasing incidence of drought represents a very serious threat. It has been argued that, in Africa, drought hazard and vulnerability “are... likely to be the most damaging locus of impacts of climate change” (Downing et al. 1997: 37)

6. Other Issues

According to Kates (2000), most efforts to address climate change to date have focused on mitigation, or preventive action to limit greenhouse gases, rather than adaptation. A recent review of the current state of climate change research and analysis in India by Kandlikar and Sagar (1999) provides a concrete example. These authors found that while India is advanced in terms of climate change research and analysis with respect to other developing countries, adaptation issues have yet to come to the forefront. Authors such as Lorenzoni et al. (2000) and Sharma and Kumar (1998), among others, argue that disproportionately greater attention has been paid to climate change mitigation than to adaptation measures.

Discussions of vulnerability and adaptation in developing country contexts often highlight the importance of poverty and inequality—or differential resource access (Adger and Kelly 1999). According to Ribot (1996), inequality and marginalization are among the most important determinants of vulnerability. Kates (2000) argues that

different groups and places within countries differ in their ability to adapt and that divisions between rich and poor translate into differentials in people's ability to adjust and in access to adjustments. This author argues for a focus on poor people, rather than a focus on poor countries, in efforts to facilitate adaptation among the global poor. O'Brien and Leichenko (2000: 225), on the other hand, point out that vulnerability "is not exclusively related to poverty" and that both the wealthy and the poor can be adversely affected by the impact of extreme weather events.

Prominent in the climate change impacts literature is the idea of "winners and losers" emerging from the process of climate change. O'Brien and Leichenko argue that the interaction of climate change and the process of economic globalization is likely to result in more complex sets of "winners and losers"—including "double winners" and "double losers." The concept of "double exposure," which these authors advance, is innovative in that it attempts to consider two global processes (i.e., climate change and globalization) simultaneously. The concept has as a point of departure the "widely recognized perception that there are 'winners' and 'losers' associated with both of these global processes" (O'Brien and Leichenko 2000: 222).

The concept of "double exposure" may be particularly important in contexts where the negative consequences of the two processes are likely to be experienced. Thus, regions that are characterized by economic marginalization and high-risk environments may be potential "double losers" in a context of globalization accompanied by climate change. In other contexts, economic gains experienced as a result of globalization can be offset by damages resulting from climate change. The important point is that the "winners" and "losers" resulting from the interaction of the two processes may be different from the set of "winners" and "losers" which are identified when each of the two processes is examined independently.

Globalization, not unlike climate change, has been characterized by uneven impacts on different regions, countries, and social groups. O'Brien and Leichenko (2000) point out that certain regions—such as South Asia and Sub-Saharan Africa—have been, to a large extent, "left out" of the globalization process. Not only are certain regions "marginal" in the context of a global economy, but regions within countries differ considerably in terms of the degree to which their economies are integrated into the global economy. In some countries, regional disparities in levels of economic development appear to be accentuated by the process of globalization. As inequality appears in the vulnerability literature as a possible determining factor, it may be important to assess the implications of increasing regional and social inequality resulting from globalization for vulnerable regions and social groups. It may be of particular importance to assess whether, and how, the manifestations of globalization affect adaptive capacity.

Of particular relevance in developing country contexts is the fact that economic and social changes have been making traditional adjustments less relevant, and these changes have generally not been accompanied by increases in governments' capacity to stimulate and assist in adjustments. As one author argues, "vulnerability in the developing world is actually growing because reasonably successful traditional adjustments are no longer

being implemented and societal-organized adjustments are not yet available” (Kates 2000: 9).

As argued in the IPCC’s Third Assessment Report:

Policies that lessen pressures on resources, improve management of environmental risks, and increase the welfare of the poorest members of society can simultaneously advance sustainable development and equity, enhance adaptive capacity, and reduce vulnerability to climate and other stresses. Inclusion of climatic risks in the design and implementation of national and international development initiatives can promote equity and development that is more sustainable and that reduces vulnerability to climate change. (IPCC 2001: 8)

7. Adaptation Issues in the UNFCCC and the Climate Negotiations

Successful adaptation depends upon technological advances, institutional arrangements, availability of financing, and information exchange (Watson et al. 1996: 24).

[The] adverse impacts [of climate change] will severely undermine the goal of sustainable development in many parts of the world, with developing countries, and the poor in developing countries, being most vulnerable. However, it should be noted that some of these projected adverse effects can, to some degree, be reduced through proactive adaptation measures (IPCC 2000b).

Within the United Nations Framework Convention on Climate Change (UNFCCC), there exists recognition of the need to adapt to climate change and to assist those countries that are least able to adapt. Acknowledging that the world is already committed to some climate change, UNFCCC Parties (in particular, developing countries) have been taking the issue of adaptation quite seriously. Thus, adaptation has been regarded as one of the key “developing country issues” in the context of the climate negotiations.

The following are concrete examples of UNFCCC efforts to address the issue of adaptation:

According to Article 4.1 of the UNFCCC, Parties are committed to:

Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures... to facilitate adequate adaptation to climate change (Art. 4.1. (b)); and

Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas,

particularly in Africa, affected by drought and desertification, as well as floods (Art. 4.1 (e)).

Article 4.4 states that:

The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation to those adverse effects.

Articles 4.8 and 4.9 of the Convention make specific reference to developing country Parties, in particular least developed countries. These articles explicitly mention funding and transfer of technology “to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change” (UNFCCC 1992). Special attention is given, in article 4.8, to those countries considered most vulnerable—e.g., small-island countries, those countries with arid or semi-arid areas, etc.

Provisions exist in the Kyoto Protocol for the funding of adaptation activities in the most vulnerable countries. Some funding is to be raised through activities under the clean development mechanism (CDM). In particular, article 12.8 of the Protocol states that:

The Conference of the Parties... shall ensure that a share of the proceeds from certified project activities is used to... assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

In a recent position paper, the Tata Energy Research Institute (TERI) argued that keeping proceeds for adaptation only through the CDM places it at a disadvantage vis-à-vis the other Kyoto mechanisms, namely emissions trading and joint implementation (TERI 1999). It is argued, therefore, that funding for adaptation activities should come from the three mechanisms. It is also argued that developing countries should not carry the burden of financing adaptation activities through the CDM. The same position paper proposes a levy on the *utilization*, rather than the *generation*, of emission credits. implying that Annex B Parties would contribute to the adaptation fund irrespective of which Kyoto mechanism is used.

The proposed creation of an adaptation fund under the Global Environmental Facility (GEF) has been one of the outcomes of recent negotiations. The suggested funding arrangements imply that Parties commit resources for developing countries to the tune of at least US\$1 billion per annum by 2005. The activities included in the adaptation category for the purposes of the proposed adaptation fund would focus on the following:

- avoidance of deforestation
- combating land degradation
- desertification

Among the suggested actions to be taken by Annex II countries are pilot or demonstration projects “to show how adaptation planning and assessment can be practically translated into projects and integrated into national policy and sustainable development planning” (UNFCCC 2000b: 4). This is to be based on the staged approach endorsed by the Conference of the Parties, as well as other relevant sources.

Decision 11/CP.1 of the Conference of the Parties divides adaptation activities in the following three stages:

- Stage I Adaptation: “Planning, which includes studies of possible impacts of climate change, to identify particularly vulnerable countries or regions and policy options for adaptation and appropriate capacity building”;
- Stage II Adaptation: “Measures, including further capacity building, which may be taken to prepare for adaptation as envisaged in Article 4.1 (e)”
- Stage III Adaptation: “Measures to facilitate adequate adaptation, including insurance, and other adaptation measures as envisaged in Articles 4.1 (b) and 4.4”.

The implementation of articles 4.8 and 4.9 of the Convention depend on the approval of the adaptation fund mentioned above. It is envisaged that adaptation projects will be financed by a share of the proceeds generated by CDM projects (two per cent of the certified emission reductions generated by a project). This is consistent with article 12.8 of the Kyoto Protocol. If the target of US\$1 billion is not reached by 2005, it is suggested that the necessary resources for developing countries would be raised through the application of a levy on Joint Implementation or emissions trading activities. It should be noted that CDM projects in least developed countries (LDCs) would be exempt from the share of proceeds for adaptation (UNFCCC 2000b).

With respect to LDCs, it has been suggested (UNFCCC 2000b) that a separate LDC work programme should be established. This programme would be financed by the GEF and is to focus, among other things, on vulnerability and adaptation needs assessments; national adaptation programmes of action; implementation of concrete adaptation projects; and the establishment of a LDC group of experts to assist in these national programmes.

It is worth noting that the Subsidiary Body for Scientific and Technological Advice (SBSTA), at its twelfth session, requested a report for its fourteenth session on methodological issues regarding climate change impacts and adaptation as related to the UNFCCC (UNFCCC 2000a). This report is expected to take into consideration information provided in the IPCC’s Third Assessment Report, which is due in the first semester of 2001.

8. International Efforts to Facilitate Adaptation

The following international efforts to assess climate change impacts and vulnerability, and to “guide” adaptation to climate change, are worth noting:

- IPCC's *Technical Guidelines for Assessing Climate Change Impacts and Adaptation* (Carter et al. 1994)
- Handbook on methods for impact assessment and adaptation strategies prepared by Feenstra et al. for UNEP (1998)
- The *Compendium for Decision Tools to Evaluate Strategies for Adaptation to Climate Change* prepared for the UNFCCC (1999)

These resources describe approaches, methods and models that can be used for impacts and adaptation assessments and provide a wide range of decision tools used in different sectors. The UNEP country studies summarized in O'Brien (2000) are good examples of the use of some of the assessment methods described in the IPCC Technical Guidelines and the UNEP handbook mentioned above. An excellent discussion of vulnerability assessments and indicators is provided in a recent UNEP paper (UNEP 2000).

Klein and Nicholls (1999) evaluate the IPCC's *Common Methodology* and present a framework for assessing the vulnerability of coastal zones to sea-level rise. The framework used in this work, which constitutes a chapter in the UNEP handbook edited by Feenstra et al. (1998), is centred around the concept of vulnerability. Natural systems are examined for *susceptibility* to the effects of sea-level rise and *resilience* and *resistance* (natural capacity to cope). It is argued that resilience and resistance are affected by human activities (e.g., "planned adaptation") and that socio-economic vulnerability can be determined by technical, institutional, economic and cultural capacity. The authors present three levels of assessment of vulnerability in coastal areas (screening assessment, vulnerability assessment and planning assessment)—each one exceeding the previous one in time required for assessment, level of detail and prior knowledge.

More recently,

Assessments of adaptation strategies for coastal zones have shifted emphasis away from hard protection structures of shorelines (e.g., seawalls, groins) toward soft protection measures (e.g., beach nourishment), managed retreat, and enhanced resilience of biophysical and socio-economic systems in coastal regions. (IPCC 2001: 12)

The same report adds that

Adaptation options for coastal and marine management are most effective when incorporated with policies in other areas, such as disaster mitigation plans and land-use plans. (IPCC 2001: 12)

Clearly, adaptation measures and options vary according to sector, and may be constrained or enhanced by national or local conditions. In agriculture, for example, adaptation options could include adjustments to planting dates or changes in fertilization rates, irrigation applications, cultivar traits and selections of animal species. In the water resources sector, integrated water resource management techniques can be applied to

adapt to the hydrologic impacts of climate change. And to minimize the harmful effects of climate change on human health, the strengthening of public health infrastructure could be seen as an obvious adaptation measure (IPCC 2001).

9. Conclusions and Recommendations

This paper reviewed the vulnerability and adaptation literature, which is rather robust and continues to evolve, as exemplified by the IPCC's Second and Third Assessment Reports. A brief discussion of the adaptation literature revealed that there exist many definitions and different types of adaptation (e.g., "autonomous" versus "planned," etc.). The various adaptation issues appear to have been incorporated into the work of the IPCC, and are, to some extent, being addressed in the context of the climate negotiations. This is exemplified by the proposed creation of an adaptation fund under the Global Environment Facility (GEF).

As mentioned, adaptation measures have received less attention than climate change mitigation, at least in the context of the climate negotiations. There are many possible reasons for this "neglect," one being the fact that developed countries are confident about their ability to adapt to climate change and, because they are responsible for curtailing greenhouse gas (GHG) emissions, tend to focus on finding less costly ways to meet their Kyoto Protocol emissions reduction commitments. However, for some developing countries (especially small-island developing states and some African countries whose GHG emissions are negligible) adapting to climate change is an urgent issue.

Various sources in the adaptation literature, as well as the most recent work of the IPPC, indicate that efforts to address the issue of adaptation to climate change can benefit from a better understanding of adaptation to current climate and environmental stresses. Thus, documenting successes in adaptation and/or coping strategies in the context of semi-arid or arid environments (or in areas experiencing floods, etc.) may be of some value in efforts to address vulnerability and adaptation to climate change.

The IPCC work has highlighted the fact that certain regions, and certain populations within each region, are more vulnerable to climate change than others. In particular, developing countries are thought to possess limited adaptive capacity due to their limited endowments of technology, education, wealth and access to resources. This implies that the poor are expected to disproportionately suffer the impacts of climate change. The connection between poverty and vulnerability creates a need for climate change policies to work in concert with poverty reduction policies, for instance.

An eventual CCKN program on vulnerability and adaptation should focus on developing countries, especially those that are threatened by sea-level rise (e.g., small-island states) or increased incidence of drought (e.g., various parts of Africa). Those countries where the economic importance of climate-sensitive sectors is great and/or where the natural resources base is narrow might be good candidates for impact and needs assessments or

other projects. Countries where adaptive capacity is low due to limited technological and institutional capability might also be good candidates for various initiatives.

The exact size of the adaptation fund under the GEF is still unknown, and there is also some uncertainty regarding country- or project-eligibility for finances from this fund. Nevertheless, it seems clear that there should be activities in countries considered particularly vulnerable and where adaptive capacity is limited. With this in mind, it should be possible for CCKN members to establish in which countries/regions it is most desirable to work on vulnerability and adaptation projects.

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Annex: Overview of the Climate Change Knowledge Network

The Climate Change Knowledge Network (CCKN) brings together 14 organizations from developing, transitional and developed countries. It aims to promote a more effective, sustainable and equitable climate change regime through capacity building, research and communications on issues such as the Kyoto mechanisms, adaptation and technology transfer. The members are as follows:

Core Members

Africa

- Environnement et développement du tiers-monde, Sénégal
- The Southern Centre for Energy and Environment, Zimbabwe

Americas

- The Center for Sustainable Development of the Americas, U.S.
- COPPE/Federal University of Rio de Janeiro, Brazil
- The Institute of Energy Economics of the Bariloche Foundation, Argentina
- The International Institute for Sustainable Development, Canada (in partnership with the International Development Research Centre)
- The World Resources Institute, U.S.

Asia

- The Energy Research Institute, China
- The Global Industrial and Social Progress Research Institute, Japan
- The Tata Energy Research Institute, India

Europe

- The Centre for International Climate and Environmental Research-Oslo, Norway
- The Institute for Environmental Studies, The Netherlands
- The Stockholm Environment Institute, Sweden
- The Kyiv-Mohyla Academy, Ukraine

Associate members

- The secretariat of the United Nations Framework Convention on Climate Change (UNFCCC)
- The United Nations Development Programme (UNDP)
- The United Nations Conference on Trade and Development (UNCTAD)

Further information about the CCKN and its membership can be found on the Network's web site at www.cckn.net.