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WHAT ARE ADAPTATION NEEDS AND HOW CAN THEY BE MET?

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1. Adaptation in Developed and Developing Countries.

The fact that adaptation to climate change is imperative and even urgent is now more widely recognized and accepted. That international cooperation is required to formulate and implement adaptation strategies has been accepted in the United Nations Framework Convention on Climate Change (UNFCCC), but the development of understanding about adaptation and movement towards international agreement on what steps should be taken has lagged behind mitigation. This paper reports a variety of current perspectives on adaptation, and summarizes the state of knowledge and thinking as reflected in recent research in a number of developing countries. On this basis it also identifies possible approaches to the development of international cooperation on adaptation in the context of the Climate Convention and the Kyoto Protocol.

Adaptation offers ways of reducing the impacts of climate change in both developed and developing countries. It is has been authoritatively concluded that for the United States and other developed countries the capacity to adapt is high. (National Academy of Sciences 1992). This confidence has to be qualified in three ways. First it applies most to heavily managed socio-economic sectors listed in the National Academy report as farming, managed forests and grasslands, water resources, tourism and recreation, settlements and coastal structures, human migration and domestic tranquility (sic). Systems that are described as sensitive to climate change and where adaptation is questionable are listed as the natural landscape and marine ecosystems. Second, the costs of adaptation remain largely unchartered. (Rothman et. al. 1998, Markandya 1998). It is assumed that the costs will be relatively low in relation to national wealth, but this depends upon the magnitude and rate of climate change which remains uncertain. Third, confidence in the ability to adapt assumes that climate change will be slow and incremental, and will not involve low probability but potentially catastrophic events such as sudden shifts in ocean circulation or the collapse of the east Antarctic ice sheet and a consequent dramatic rise in sea level.

These caveats notwithstanding, the view that developed countries can cope with the necessary adaptation without the need for broad international agreement or action is well established. It is being recognized however that adaptation measures adopted in one country might have consequences for other countries. The applies most clearly in transboundary situations. For example, where adaptations to changing hydrological regimes are required in international river basins. To the extent that adaptation policies and measures may also affect the terms of trade both regionally (e.g. European Union, and North American Free Trade Agreement), and more globally (World Trade Organization) it seems likely that some international agreements or understandings will eventually be required.

In developing countries, the capacity to adapt is known to be much lower in most cases. This is due to a relative lack of financial resources, lesser availability and access to technology, weaker scientific research and development capacity, less effective institutions, social and governmental organization, and less development of skilled human resources. Not only the amount of national wealth but also its distribution is also important. Countries with larger proportions of the population living in poverty also have less adaptive capacity.

This large divergence in adaptive capacity between developed and developing countries is the major reason that the impacts of climate change are likely to be much greater in those regions (i.e. low latitude, tropical regions) where climate change, measured in terms of mean temperature change, is projected to be least. (IPCC 1996. a). Significantly larger changes in mean annual temperature are projected for middle and high latitudes, but the fact that the more highly developed countries with greater adaptive capacity are largely located in these regions is expected to reduce impacts to a more tolerable level.

These circumstances raise at least four important questions about the use of adaptation as part of a more comprehensive and widely available portfolio of responses to climate change. First, it is important to be clear what is meant by adaptation to climate change. Second, there is the issue of the development of national policies or strategies for adaptation and the capacity to implement them. Third, there is the question of responsibility for adaptation and the fair distribution of costs. Four, there is the question of how adaptation fits into the portfolio of response, particularly its relationship to mitigation.

These questions involve international cooperation, at least in the case of the developing countries, and so they have to be addressed within the context of the Climate Convention and the Kyoto Protocol to the Convention, as well as the rapidly developing literature on the science of adaptation. (Washington Group 1999).

2. The Climate Convention Context.

From the very outset of the negotiations on the United Nations Framework Convention on Climate Change in the late 1980s, adaptation to climate change was treated as secondary to mitigation. The ultimate objective of the Convention is stated as the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". What has followed from this initial formulation is an overwhelming concentration on the issues of mitigation: how much mitigation is needed, when, at what rate, and what is the appropriate distribution of responsibility for achieving agreed targets on schedule? The requirement to reach international agreement stems from the global nature of climate change. Since all countries contribute greenhouse gases to the atmosphere, although in unequal amounts, it is imperative that all countries agree on their respective responsibilities in order to avoid the free rider problem. International negotiators have been drawn to this issue like insects to a candle flame.

Nevertheless the Convention does recognize the eventual need for adaptation and this is specified in Article 4.1 of the Convention as well as in Article 4.4 which provides that "Annex II Parties 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". According to one commentator, "this provision is the clearest expression of the acceptance that the Convention is as much about adaptation as it is about mitigation". (Yamin 1998)

Over the first five years of the life of the Convention, up to the signing (but not yet ratification) of the Kyoto Protocol in December 1997, the overwhelming amount of attention has continued to be devoted to mitigation. Five considerations help to explain the reluctance to address adaptation:

- adaptation has been thought of as a long term strategy that can be delayed until the effects of climate change are more evident and less uncertain.

- adaptation has been so broadly defined that the potential range of adaptation measures is extremely large, and there is neither adequate information on the costs of adaptation nor a basis for the determination of priorities.

- the Annex II Parties are concerned not to expose themselves to substantial and ill-defined demands for assistance under Article 4.4 and have provided guidance to the financial mechanism, the Global Environmental Facility, (GEF) that severely restrains the provision of assistance for adaptation.

- the GEF was initially established in response to a developing country demand for international funding to meet the additional costs of responding to the need for global environmental protection. A criteria for GEF funding therefore has been that global environmental benefits be demonstrated. In the case of adaptation, the benefits fall overwhelmingly in the place or country where the adaptation measures are taken, and for this reason it can be argued that additional funds above and beyond normal development assistance are not justified.

- much development activity already takes present day climate into account as well as its associated probable future variability and extremes. Since it is not now possible (and may never be so) for atmospheric science to distinguish with certainty between normal climate variability and climate change, on a local or regional scale, it follows that it is not possible to distinguish between adaptation measures (and their costs) to normal climate and to climate change.

Two of these five considerations, lack of urgency, and lack of global benefits have lost some of their initial force.

- the recent dramatic increase in the costs of weather-related natural disasters has helped to create a sense of urgency. While it cannot be scientifically proven that the magnitude of currently experienced climate variability and extremes are linked to climate change there is certainly a possibility that this is the case. Atmospheric scientists generally agree that such a pattern is consistent with the changes that may be expected as a result of the destabilization of the atmosphere and the intensification of the hydrological cycle caused by climate change. The cost of weather-related disasters in 1998 exceeded the costs of all such disasters in the decade of the 1980s. (Annan 1999).The high losses of 1998 can be attributed to the unprecedented strength of the 1997-98 El Nino event. Here again a link to climate change is possible but not proven. Despite these necessary qualifications, the link between climate change and current extreme events is sufficient to give cause for alarm.

- the argument that adaptation measures do not yield substantial global benefits is offset by the recognition that the costs of adapting to climate change have in effect been imposed by the historical emissions of greenhouse gases largely from the Annex II Parties to the Convention. Indeed the acceptance of a responsibility to assist in meeting the costs of adaptation in Article 4.4 is tacit recognition of imposed costs. (Fankhauser 1996).

The remaining three reservations about adaptation are addressed in this paper, beginning with the issue of the broad definition of adaptation.

3. What is Meant by "Adaptation to Climate Change"?

The Framework Convention does not define adaptation, and there is a lack of a formally agreed general definition. The closest thing to an authoritative definition may be found in IPCC (IPCC 1996 b) where it is stated that, "Adaptation refers to the adjustments in ecological, social or economic systems in response to actual or expected climate stimuli, their effects or impacts. It refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change".

Clearly the scope of adaptation is very wide indeed. A useful taxonomy/anatomy of adaptation has been developed. (Smit, Burton, Klein and Wandel. forthcoming.) The scope is dramatically reduced however if a distinction is made between adaptation to climate and adaptation to climate change (Burton 1997). Adaptation to climate has always been an essential part of the evolution and survival of both natural and human systems. So adaptation to climate change is not something that starts from scratch. It is an incremental process that builds upon a long history of prior adaptation.

It is sometimes claimed in the new research and policy literature on adaptation to climate change that adaptation is a new field about which there is little knowledge or experience. This is true if it is applied strictly to anthropogenic climate change. It would be a mistake however to assume that an entirely new field of science has to be created. In each of the socio-economic sectors at risk from climate change there exists both theoretical and practical knowledge concerning response to climate and climate variability and extremes. (Washington Group 1999). The character of this knowledge differs from sector to sector. In agriculture, for example, there is a great deal of practical knowledge and local experience in every farming community which individual farmers use in making day to day decisions about choice of cultivars, timing and method of cultivation and the like. This is augmented by a considerable body of knowledge encompassed in crop models which describe the response of many different types of crops to a wide range of climatic and weather variables. Similarly in the design of infrastructure including residential, commercial and industrial property, bridges, highways, drainage channels, docks and harbours and the like, weather and climate variables are taken into account in design standards which are often officially approved and for which construction companies are held responsible to ensure proper implementation. In water management, transport, forestry, tourism and recreation, health protection, and coastal zone management, factors of climate variability and extremes are always an element in design and decisions, either in formal or informal ways.

In order to develop a science of adaptation to climate change it is necessary to build upon this existing knowledge in increments that allow for a new and probably wider range of variability and extremes that has previously been considered. There is one important new element which does suggest that the science of adaptation to climate change requires more than incremental changes to the sum of previously employed methods for adapting to climate change. Risk management for climate and weather variability and extremes has previously been carried out in quite a compartmentalized way. Those concerned with weather and climate variability in agriculture have been able to develop their science quite separately from those similarly engaged in other sectors such as forestry, water resources, building and infrastructure design and so forth. Different weather variables with different underlying causes affected different sectors. Thus farmers are more concerned about the likelihood of frost or drought, and less concerned with the heating and ventilating of large buildings for human occupation. The sciences of agronomy, hydrology, forestry, architecture, construction design and engineering, the human health sciences and so forth have all developed their own approach and terminology for risk assessment. Now they are confronted with a common risk to which they are all vulnerable, admittedly in different ways and to different degrees. This common source of threat is forcing a convergence methods and terminology towards what might be called integrated risk assessment for climate change. This process is only beginning, and its momentum can be seen in the growing field of integrated assessment modeling.

4. The Identification of Adaptation Needs and Their Assessment.

Within this broad conception of adaptation to climate change it becomes necessary to specify in each country and each locality what adaptation needs are and to prioritize them. In developed countries it has so far been assumed that the various socio-economic sectors will have the capacity to adapt and that little or no overall planning or policy is required. To the extent that preparatory action is thought necessary this has tended to focus upon research for future adaptation heavily linked to climate impact studies.

In developing countries the search for adaptation needs and the development of priorities has received a little more attention. This stems from the fact that the need for adaptation is likely to be greater and the capacity is known to be less. It is also true that developing country governments have some hopes and demands that the developed country Parties to the Framework Convention will assist in meeting the costs of adaptation. It is therefore in their interests to be able to demonstrate that adaptation needs exist and can be assessed. This has been recognized in the decisions of the Conference Of the Parties to the Convention (COP). The Global Environment Facility (GEF) has been designated the financial mechanism for the Convention and carries out its functions under the guidance of and accountable to the COP. At the first meeting of the Conference of the Parties (COP-1) held in Berlin in 1995, it was agreed in Decision 11/CP.1. that adaptation would take place in developing countries in three sequential stages to deal with short, medium and long term strategies. The stages are specified as follows:

-Stage I: Planning. This covers studies to identify impacts of climate change, particularly vulnerable countries or regions and policy options for adaptation and capacity building.

-Stage II: For particularly vulnerable countries/regions identified in Stage I, measures, including capacity-building to prepare for adaptation, as envisaged in Article 4.1 (e).

-Stage III: Measures to facilitate adaptation, including insurance, and other adaptation measures as envisaged in Article 4.1 (b) and Article 4.4.

At the fourth meeting of the COP (Buenos Aires 1998) it was agreed to move from Stage I to Stage II, within the context of communications made by the Parties to the Convention Secretariat.

Up to October 1999 there has been remarkably little support to developing countries under Stage I or II. This has been explained by one commentator in terms of "the reluctance on the part of the GEF to finance adaptation measures" (Farhana 1998). This reluctance is said to be "fuelled by donor concern about responsibility for adaptation costs". (Farhana 1998). The reluctance stems in part from the GEF's constitutional mandate to fund actions that result in "global environmental benefits". Because adaptation benefits are overwhelmingly concentrated in the place where the measures are taken they generate no easily quantifiable global environmental benefits (Werksman 1993).

(a short summary of GEF support for adaptation will be added including the Caribbean project and others).

Potential adaptation measures in developing countries have also been studied under other arrangements. Prominent among these are the US Country Studies Program, (Smith et. al. editors 1996), the Country Studies supported by the GEF through the United Nations Environment Programme. (Republic of Cameroon 1998, Government of Pakistan 1998, Republic of Estonia 1998, Government of Antigua and Barbuda 1998.) In addition the Netherlands has supported a number of Country Studies, and one project has been carried out in Uganda in association with the World Resources Institute and supported by the US. Agency for International Development (Bwango, Wright, Elias, and Burton. in press).

A review of these studies reveals no case in which a specific adaptation measure is identified that clearly applies to climate change alone, and does not also yield additional or co-benefits by the reduction of damages from known climate variability. Most of the studies have focused primarily on the potential impacts of climate change and have devoted little attention to adaptation beyond the creation of long lists of needed adaptation measures. In the course of the Uganda study, a useful distinction emerged between cross-cutting measures relating to a variety of government policies and programmes that are multisectoral, and single sector measures. These sectoral measures may be further subdivided into general and specific. In the case of Uganda the following cross-cutting measures were proposed at a workshop attended by government experts and policy makers, university based scientists and environmental non-governmental organizations: (Republic of Uganda, 1997)

1. *MULTI-SECTORAL AND CROSS-CUTTING MEASURES.*

- strengthen Uganda's meteorological services so that they may provide reliable medium to long term advisories with respect to drought and floods.
- strengthen the Early Warning Information capacity, especially for food security and short-term climate prediction.
- incorporate climate change and variability information and projections into Uganda's long-term development plans, such as the National Environment Action Plan (NEAP), the Water Action Plan (WAP), the Forest Action Plan (FAP), the Poverty Eradication Action Plan (PEAP), and the Decentralisation Process.

- carry out an inventory of existing practices and policies used to adapt to different climates in all line agencies and sectors, so as to begin more detailed identification of adaptation measures for evaluation and adoption.
- ensure that the Uganda Disaster Preparedness Committee (UDPC) includes in its work plan long term hazard reduction related to climate change and climate variability.
- promote awareness of climate variability and change and potential response alternatives throughout Ugandan society.

2. *SECTORAL MEASURES.*

General.

- review agricultural policies to find ways of reducing existing vulnerability, and avoid creation of new vulnerability.
- renegotiate the Nile Waters Agreement to include climate change response plans on the utilization of Nile River waters.
- review the Uganda Forest Action plan to ensure that climate variability and change have been considered.

Specific.

- reduce reliance on monoculture planting of bananas (matoke).
- expand irrigation and increase irrigation efficiency
- both the Uganda government and communities should begin to adopt contingency planning for both droughts and floods, aimed at managing current climate variability especially in the most vulnerable districts
- ensure that development on potential dam sites along the Nile River and other basins is controlled to ensure future development without encumbrances.
- encourage water conservation at all levels of the community using appropriate methods including the use of market based systems.
- enhance and strengthen the Uganda Tree Seed Project to ensure that original biodiversity is protected against climate change and climate variability to guard against irreversible species disappearance.
- reduce geographic fragmentation of forests to ensure that forest types can freely migrate in the face of climate change.
- encourage off-site biodiversity protection so as to avoid species extinction.

When this three-fold grouping of adaptation measures is applied to other adaptation studies almost invariably examples of all three types are identified. Probably the most comprehensive study of climate change impacts and adaptation needs yet made at the national level has been completed in Antigua and Barbuda. (Government of Antigua and Barbuda 1998), largely because the country is small. (170 square miles and 64,000 total population in 1991). No part of the national territory was excluded from the study, and the six sectors examined account for virtually all the economic activity and environmental resources of the country. The study embraced coastal zones, fisheries, agriculture, (including forestry and livestock), water resources, human health, and human settlements and tourism.

For each of these sectors detailed studies of potential impacts were made and a substantial list of more than 60 adaptation needs was identified. No attempt was any attempt made to establish priorities for adaptation between sectors, although some preliminary screening of adaptation measures was carried out within sectors.

The report concludes that the major sources of impacts are likely to be hurricanes, sea level rise and drought. It is not possible to say with confidence to what extent hurricanes may increase in frequency and severity, or how rapidly sea level rise may occur, nor how much more frequent and intense the recurrent droughts may become under climate change. It is clear however that all three of these phenomena now cause substantial damage to the economy, and that present adaptation measures are insufficient. Antigua and Barbuda presents a clear "win-win" or "no regrets" adaptation case where augmentation of present measures is needed, which will yield higher benefits the more rapidly that climate change related impacts intensify. The water resources and human settlements and tourism sectors illustrate the situation.

The requirements for water already press hard on available supplies, especially in the dry season, and in recurrent drought years. There is competition among users for available water and when supplies are short municipal uses and the commercial hotel sector receive supplies at the expense of agriculture. The high seasonal and inter-annual rainfall variability increase the difficulty of efficient management. According to the report "there is no national water resources management policy or strategy to cope with the stressed water situation and the possible impacts of climate change". (p.137). A general sector-wide adaptation approach is proposed which would require the launching of a Water Resources Management Action Programme which would include but not be limited to the following components:

- more efficient management of existing supplies and infrastructure.
- institutional arrangements to limit future demands, and to establish integrated water resources management.
- strengthen water resources monitoring and information systems.
- promote conservation.

In addition a large number of specific measures are proposed including:

- installing a displacement device, which reduces the water the toilet tank will hold.
- using low-flow faucets.
- rehabilitation of watersheds.
- construction of new reservoir capacity to capture and store excess flows produced by altered precipitation, run-off patterns, and storms.
- construction of deep wells.

These are in addition to the existing plans of the Antigua
Public Utilities Authority (APUA) which call for more desalination capacity; exploration of deep acquifers; automatic water transmission control; and reduction of unaccounted for water through leakage and waste control and reducing the number of illegal connections.

Hurricanes and tropical storms constitute the major risk to human settlements and infrastructure, including commercial buildings and tourist hotels. Even a small increase in the frequency and/or intensity of such storms could have severe effects on the economy of Antigua and Barbuda. Hurricane Hugo (September 1989) caused an estimated EC$154.1 (East Caribbean dollars) in direct damage, including EC$130 to buildings. This amounted to 17.6% of GDP, or in the order of five or more years economic growth at current average rates. Hurricane Luis (September 1995) had worse consequences and direct damages are estimated at EC$364.5 million or 30.5% of GDP, (in the order of 10 years of economic development).

Seven types of adaptation measures are proposed to reduce the vulnerability of human settlements and infrastructure to climate change as follows:

1. Hazard Mapping. The objective is to identify on maps the areas which are most vulnerable to the effects of climate change.
2. Flood control. This measure includes the cleaning of watercourses and drains, and the prevention of filling in of the natural drainage system.

3. Land Use Controls and Enforcement.
    - zoning regulations to demarcate specific area for different types of land use, such as building densities and height limits within each zone.
    - building codes and planning and infrastructure standards.
    - set-back requirement for the coastal zone.

4. Retrofitting Existing Structures. Refurbish old structures to bring up to standards of the building code but most importantly to strengthen their resilience against the hazards of global warming, hurricanes and droughts.
5. Capacity Building. This involves strengthening institutions such as the Development Control Authority and other agencies responsible for environmental management. It also involves improvements in inter-agency coordination.
6. Improvement in forecasting and early warning systems so as to increase preparedness capability.
7. A public education and information systems programme, to sensitize the public on the issue of global warming and its effects.

The Pakistan Country Study concentrated on three sectors - water, agriculture and forests. (Government of Pakistan 1998). Within these three sectors the Pakistan study is one of the most sophisticated yet undertaken, especially in its use of socio-economic scenarios of future growth and development and its treatment of adaptation to climate change in the context of economic development. Pakistan, like Egypt, has a hot and arid climate that would support a much lower population were it not for exogenous river flow that permits extensive irrigation. Pakistan has the world's largest contiguous irrigation system in the Indus Plains with year round cropping in much of the area. Water potential, waterlogging and salinity, and water use efficiency are the current as well as the future key issues. Population growth has been rapid, from 32.5 million in 1947 at the time of independence to an estimated 140 million in 1997/8 and projected to reach in the order of 229 million by 2020 (medium growth variant).

A number of climate change scenarios were employed in the study. In general "the results show that while the total water storage in the system remains insufficient, the water resources operation under various climate scenarios shows that the problem will become more acute in the future. The problem will become more serious if the increase in precipitation is coupled with the decrease in precipitation. … The net overall capacity of the system to supply water in time will decrease in Pakistan unless some urgent actions are taken". (Government of Pakistan. p.xiv).

The adaptation strategy for the water sector may be summed up as "the conservation and efficient use of water in an informed an efficient manner". (Government of Pakistan p. xviii.). The report concludes that water managers will be force to re-evaluate the whole system operation and revise the allocation of water for agriculture in various irrigated areas. Adaptation options include; "mitigating the hazards of floods; altering streamflow regime by the construction of reservoirs; alleviating economic damages of waterlogging and salinity; augmenting supplies and re-allocating the available resources".

In the case of agriculture the Pakistan study reports that the production of major crops like wheat, rice, cotton and sugarcane has to be doubled by the year 2020 to meet the requirements of the country's growing population. It is concluded that such expansion of production and the water that will be required as an input can be achieved. This will require adapting very high efficiency irrigation systems and improved agronomic practices. "The use of sprinkler and drip irrigation systems couple with chemigation facility is a good example". "The climate change would further demand to increase the annual growth rate in agriculture of around 0.1% and 0.2% for the periods 1997-2020 and 2021-2050 respectively". Government of Pakistan p.xx).

The most general conclusion emerging from the Pakistan study, confirms earlier results from Uganda and Antigua and Barbuda, and is consistant with conclusions emerging from other research as for example in the U.S. Country Studies Program, as well as the more limited adaptatioin studies that have been completed in developed countries. Adaptation to climate change requires a great deal of action that is needed in any case. The threat of climate change implies that these actions should be accelerated if the same level of risk is to be

maintained. Since the level of risk currently practiced in many countries is no longer consistent with sustainable development it is clear that climate change adds yet more force to the argument. But adaptation to climate change is not limited to the simple acceleration of development activities that are required in any case. Changes in policy and management practice and innovations in monitoring, forecasting and research are also needed.

5. The Assessment of Adaptation Measures.

Attempts to measure the costs of adaptation to climate change are few and far between. In the impact and adaptation studies cited the common pattern has been that major emphasis is placed upon impacts, and then lists of possible adaptation options are generated. In some cases a preliminary screening of measures has been carried out, but nowhere to date has a thorough assessment of adaptation been made. This is not for lack of methodology or guidelines on how to proceed, nor for a lack of theory on costing. It is simply a matter of time before well grounded estimates of adaptation costs become commonplace.

A compendium of decision tools to evaluate strategies for adaptation to climate change has been prepared for the Secretariat of the Framework Convention (Stratus Consulting 1999). Despite the use of the word "stategies" in the title most of the tools in fact refer to the evaluation of specific projects. Nine tools are described that can are applicable to multiple sectors, including benefit-cost analysis, risk analysis, expert judgment, and a range of screening techniques. A further 23 tools are described for selected sectors; water 5, coastal zones 5, agriculture 11, and human health 2. These largely consist of models (both physical and economic) and some more general methodologies.

A more detailed description of the application of benefit-cost analysis has also been prepared for the Global Environment Facility (Smith et. al. 1997). In addition guidelines for impact and adaptation assessment have been prepared and widely disseminated in country study programmes (Feenstra et. al. editors. Carter et. al. editors 1994, Benioff et. al. editors).

More theoretical groundwork on the potential costs of adaptation has been developed in a number of papers (Fankhauser 1996, Callaway, Naeess, and Ringius 1997, Mendelsohn 1997, and Yohe 1991) . Methodological questions in the costing of adaptation are also addressed in the work of the Intergovernmental Panel on Climate Change (IPCC) and elsewhere, (……).

In a practical demonstration of the application of benefit-cost methods Smith and others (Smith, Tol, Ragland, and Fankhauser. 1998), report of three case studies consisting of flood prevention measures on the Meuse river in the Netherlands, the augmentation of storage capacity by 25% in a proposed water supply reservoir in the western United States, and adaptation to sea level rise by a 1 meter increase in the height of a bridge between New Brunswick and Prince Edward Island, Canada. In all three examples there is a case to be made in theory for precautionary or anticipatory adaptation measures involving changes in project design. In each case however the benefits of such measures only justify the cost in the most severe assumptions about the occurrence of extreme events and the most favourable (to the project) discount rates. Discount rates greater than 5% result in virtually zero present value for avoided climate change impacts in the middle and latter part of the next century. In order for the bridge raising and the dam enlargement to be justified it is necessary to assume a 100% probability of a 1 meter sea-level rise, or a 10% decrease in precipitation respectively.

This literature does not negate the argument that precautionary or anticipatory adaptation merits consideration, especially in long-term infrastructure investments. The same group of experts (Fankhauser, Smith, and Tol 1998) have proposed three "simple rules" to guide adaptation decision. They argue that adaptation measures should be considered now and not delayed until more concrete evidence of climate impacts is available; that measures to increase flexibility and robustness in project design can be justified, and that public (governmental) action to facilitate adaptation is needed because without it autonomous adaptation will either not take place or will be less than optimal.

However the literature also strongly suggests that there is likely to be little justification for massive investment in adaptation measures in the short term. Adaptation measures it seems can be justified but at the project level the costs will be limited to marginal increases in the aggregate costs of projects justified in their own right regardless of the amount and speed of climate change.

This conclusion seems likely to be robust at the level of projects (specific adaptation measures) and to some extent within sectors. As has been shown however, in the cases studies of adaptation completed to date, there is an arguement to be made for a more strategic approach to adaptation. None of the adaptation literature so far addresses the costs of multi-sectoral and cross cuttings measures that are being advocated to strengthen the capacity to adapt. In the case of specific adaptation measures it seems reasonable to make assessments in terms of the marginal increment that can be justified in project design to reduce potential losses from climate change related impacts. Where broadly based national programmes of water management, (Pakistan), coastal zone management, (Antigua and Barbuda), and management of floods and droughts, (Uganda), are involved it is not so clear how the benefits of incremental strengthening or acceleration is to be measured. Yet, at this stage in the evolution of the climate change issue, it is most probably the strengthening of national capacity to adapt, and the modification of existing development plans to take climate change into account that is most urgently required.

6 Finding a Way

Gradually the reasons for the past lack of attention to adaptation are being removed. Studies have shown that some marginal increments in investments in adaptation measures at the project level can be justified. The same studies show that the costs of such measures are not likely to be large at least in the short term. Even the difficult question of how to distinguish between the impacts of normal climate variability and anthropogenic climate change is proving not to be intractable and reasonable decisions can be made upon the basis of projections and models of climate change and its potential impacts and reasonable and transparent assumptions. The remaining questions have to do more with mechanisms for adaptation, and to what extent adaptation can be effectively addressed by itself (a protocol for adaptation?), or can be addressed simultaneously in some combined way with mitigation.

In the Kyoto Protocol adaptation funding is specifically linked to mitigation for the first time. Clause 12 which defines the Clean Development Mechanism (CDM) provides for a levy on mitigation agreements under the CDM to provide for the costs of adaptation in vulnerable developing countries. Negotiations are currently underway on the subject of the precise rules for implementation of the CDM, in anticipation of the day that the Kyoto Protocol will be ratified and go into force.

While these negotiations are naturally focused on the mitigation aspects of the CDM a number of important questions arise with respect to adaptation. Seven of these have been addressed by Farhana Yamin (Yamin 1998). This paper addresses an additional four questions.

1. The Kyoto Protocol recognizes three mechanisms for international cooperation in the reduction of greenhouse gas emissions. These are;

- joint implementation (JI) between Annex B Parties (the developed countries) (see Article 6) which involves transfers of emission reduction units (ERUs) created by emission reduction or sequestration actions in one Annex B country to sources in another Annex B country in return for financial and other assistance.

- International emissions trading (IET) between Annex B Parties (Article 17) which involves transfer of assigned amount units (AAUs) between Annex B countries.

- The clean development mechanism (CDM) (Article 12), which involves transfers of certified emission reductions (CERs) created through emission mitigation projects implemented in developing country Parties to Annex B Parties in return for financial and other assistance.

It is only one of the three mechanisms, (the CDM) which carries the adaptation levy. Other things being equal this would seem to bias the choice in the direction of JI and IET, and hence reduce the extent to which the CDM is used, and accordingly reduce the potential funds to be generated for adaptation. Accordingly the question is whether in the interests of equity and in the generation of adaptation funds, the adaptation levy should not also be extended to all three of the mechanisms? Clearly this is a matter for governments to decide, but the answer presumably in part depends upon the need for adaptation assistance.

2. Even if the adaptation levy were to be extended to all three mechanisms, it is not clear how much money is likely to be generated for adaptation, and whether this is likely to be adequate. Preliminary estimates suggest that even with the most favourable assumptions the CDM is not likely to generate more than $XX in the near term. (Haites 1999). There are as yet no estimates of the costs of aggregate adaptation needs in developing countries, (there are none in any country), although research suggests that the open ended need for funds that has been imagined is unlikely to materialize provided that reasonable and transparent assumptions are made about impacts and the pace of climate change.

3.Given that a case has been made for proceeding to Step II adaptation and that this was agreed at the COP 4 meeting in Buenos Aires in 1998, where will funds for adaptation come from in the event that the ratification of the Kyoto Protocol is delayed or postponed indefinitely? One possibility is that the size of the resources made available by the donor countries through the GEF could be increased to enable progress to be made in the implementation of Stage II adaptation, without reference to the level of the mitigation effort.

4. If the Kyoto Protocol comes into force as proposed, and assuming that funds for adaptation are generated by the CDM or all three mechanisms, what is a possible formula for allocation of the funds among the more vulnerable countries? Studies to date have tended to assume that funds would be allocated on a project by project basis as and when feasibility studies are carried out. There is some preliminary work underway on the development of a vulnerability index to guide such a process, but it seems to be some time (probably years) away from completion and acceptance. An alternative or additional approach would be to develop a formula or guidelines linked to mitigation efforts. One of the stumbling blocks in the implementation of the Framework Convention has been the unwillingness of the developing country Parties to make any commitments to the reduction of their own emissions. On the other hand the developed country Parties have been slow to respond to the need for adaptation assistance. One way forward might be to develop a comprehensive approach to mitigation and adaptation in which developing countries would commit to some reduction in greenhouse gas emissions (and incidentally qualify to participate in JI and IET), while the developed countries would commit to a more flexible approach on assistance for adaptation.

5. This raises the question of the proper relationship between mitigation and adaptation. As it stands the more effective the CDM, and the more it is used, the more funds can be expected to be generated for adaptation assistance. In fact logic suggests that the reverse relationship should obtain. The more mitigation is undertaken presumably the less need for adaptation. A more appropriate relationship would therefore be one in which adaptation funds are increased in an inverse relationship to the achievement of mitigation targets and schedules. This logic stems from an economic optimizing perspective in which mitigation and adaptation are seen as competing alternatives in a zero sum game. The more of one then necessarily the less of the other. In terms of practice, rather than theory, it seems closer to the truth to suggest that the global community, as well as individual countries, will find it difficult to achieve enough of either. There is a prospect that climate change will not be slowed at a fast enough rate to prevent significant impacts. The precautionary principle might therefore be extended to the development of a mixed strategy of mitigation and adaptation neither of which would be dependent upon the other for its financial support or its agreed pace of implementation.

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