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A Plan of Action to Support Climate Change Adaptation Through Scientific Capacity, Knowledge and Research[1]

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1. Introduction

Scientific research and knowledge have played key roles in creating widespread recognition of human caused global climate change and galvanizing action to address the problem. They have done so by providing and applying knowledge to answer a few basic questions. First, *are the actions of people changing the climate on a global scale?* Second, *does it matter?* And third, *what to do about it?*

The answers to the first two questions are clearly yes, the supporting evidence having been thoroughly assessed by the Intergovernmental Panel on Climate Change. The third question is being debated in multiple fora, including local, national, and multinational fora, as well as within the Conference of the Parties to the United Nations Convention on Climate Change. The available options are divided into two broad classes of actions, mitigation to reduce emissions of greenhouse gases or to remove them from the atmosphere, and adaptation to reduce adverse impacts and increase beneficial impacts of exposure to climate change. Both of these classes of action are needed to manage and lessen the risks from climate change, and both are being pursued. What concerns us in this paper is how to support climate change adaptation through scientific capacity, knowledge and inquiry.

In the following section, we highlight some of the key lessons for climate change adaptation from scientific research and assessment. We then lay out what we see as priorities for an adaptation science agenda that would be targeted at the needs of adaptation planning, decision-making and implementation. In the final section of the paper, we propose a number of principles that should underlie implementation of an adaptation science agenda.

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2. Lessons for Adaptation

People and the resources they value are exposed to risks and opportunities from variations and changes in climate now, not in some distant future. Research on changes in the climate system due to human influences and the impacts of climate change has most commonly emphasized changes that are expected to occur 50 to 100 years or more in the future, a time frame that is far beyond those in which policy and decision makers typically operate. This may lead some to believe that adapting to climate change is not urgent and warrants low priority when compared to other pressing problems, particularly in the developing world. But current climate variability and extremes impose severe loss and hardship that require adaptation, and observed trends in climate are posing new adaptation challenges now.

Adaptation to climate variation and trends is a regular feature of our lives. From this experience, people have developed knowledge, skills, technology, institutional arrangements and strategies that are an important foundation for adapting to longer-term climate change. Yet, despite such efforts, we remain imperfectly adapted to climate variations, trends and extremes. The devastation and loss of life that can accompany severe storms, floods and droughts are dramatic evidence of deficits in adaptation (see Figure 1). But even less severe anomalies can have adverse impacts on food supplies, water supplies, commodity production, human health, the functioning of ecosystems, incomes and livelihoods. The resulting losses are substantial and have impeded development and undermined poverty reduction in many parts of the world. Climate hazards are real and immediate, not an uncertain risk of the distant future, and their harm to human well being and future prospects are such that they warrant action now.

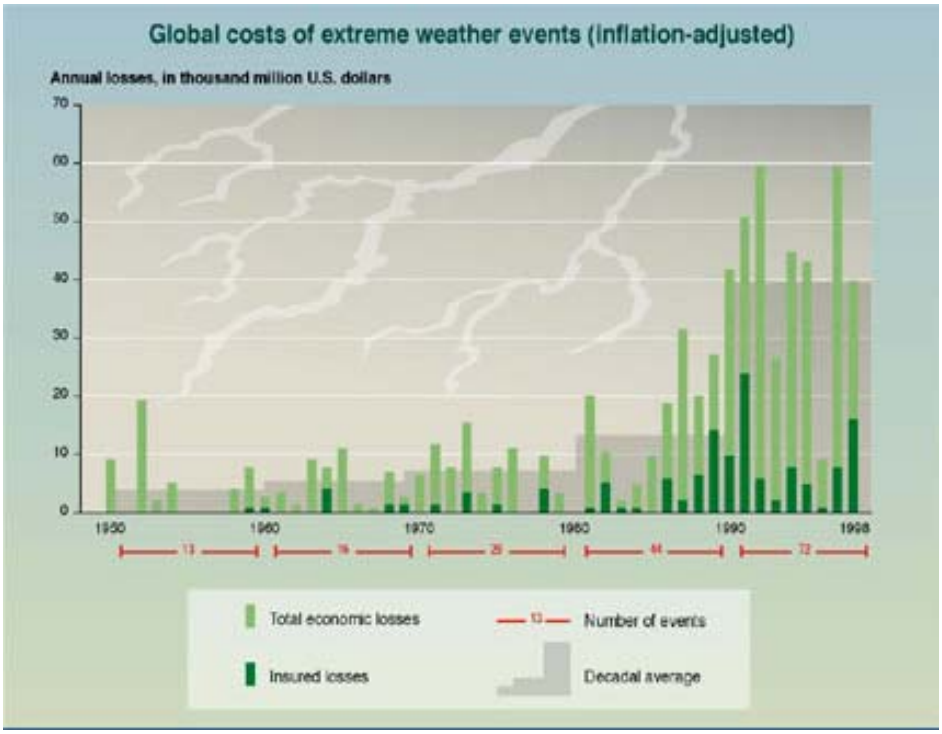

Figure 1. Source: IPCC Synthesis Report, 2001

Vulnerability to climate hazards is complex and shaped by many interacting processes. While exposure to climate stresses has been a focus of much of the research on climate hazards, it is but one of many determinants of vulnerability. Social, economic, institutional, technological, governance and other conditions of an exposed place or population determine the likelihood that exposure to a climatic phenomenon would result in harm, the severity of the resulting harm, and the potential for recovery. Differences in these conditions between developed and developing countries underlie the far greater harm and loss of life from severe weather that occurs in the developing world. These differences also give rise to greater vulnerability in the developing world to climate hazards generally, and not just to extreme weather.

The climate is changing, the exposures are changing, and the risks are changing. Statistical analyses of climate observations show that the world has warmed over the past century. The warming is due, at least in part, to human activities that have increased the concentrations of greenhouse gases in the atmosphere. Other changes have been observed, which may or may not be related to human-caused climate change. For example, long-term changes in precipitation have been detected in some parts of the world (see Figure 2). The warming trend will continue, as projected by global climate models. Other trends may also continue, while new ones may emerge as forcing of the climate system accumulates. Some of the trends have already triggered adaptive responses. Further adaptations will be needed to respond to the changing exposures and risks from climate stresses.

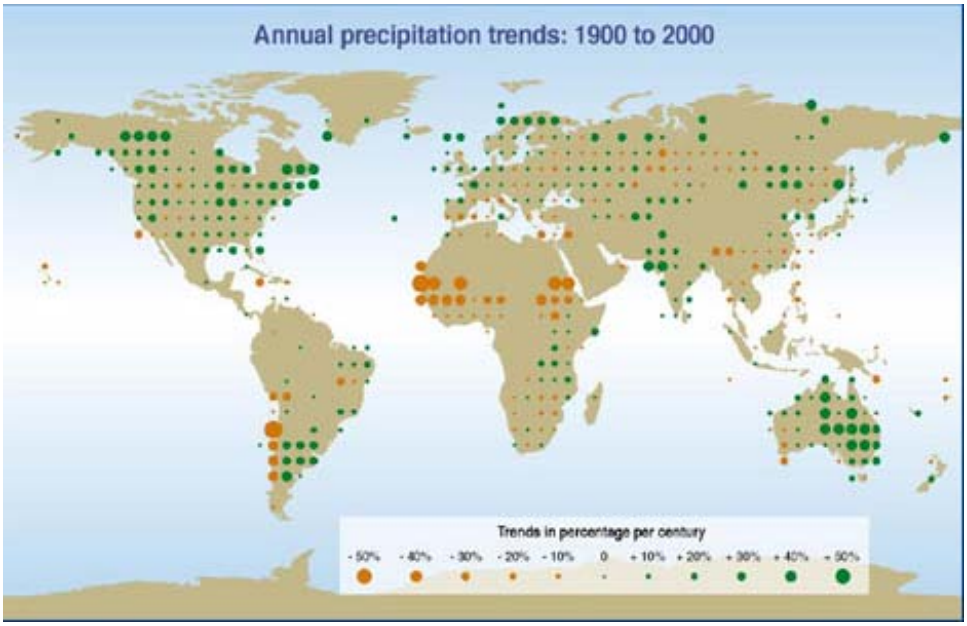

Figure 2. Source: IPCC Synthesis Report, 2001

Vulnerability to climate hazards is also changing because of rapidly changing social, economic, institutional, technological, and governance conditions. These changing conditions will strongly influence the sensitivities of systems to climate stresses, capacities to cope and adapt, and ultimately the consequences of climate change. The changing conditions will have mixed effects on vulnerability, some positive and some negative, and these effects will vary for different places and for different people in a place.

Taking into consideration measures that would alter conditions favorably so as to reduce vulnerability of different groups, and not just measures that are narrowly focused on climate impacts, can broaden adaptation options and strategies. This approach, sometimes called mainstreaming adaptation, can yield broad based benefits that go beyond reduced climate change impacts and contribute to poverty reduction, sustainable development and more resilient environmental systems. To be effective, mainstreaming adaptation needs to engage a broad range of decision makers, public agencies, civil society organizations, private sector stakeholders and vulnerable groups, as well as members of the science community.

3. Recommendations for an Adaptation Science Agenda

The lessons outlined above, as well as others, are a sufficient basis to begin taking actions to adapt to climate change and reduce vulnerability. But there remain important gaps in our knowledge and further research and assessment need to continue even as we act. We outline below the research questions and general areas of research that we consider important for informing adaptation decisions. They are based upon our experiences in climate change research and assessment, which include work conducted with partners from multiple disciplines, multiple countries, and a wide mix of public and private sector stakeholders. But direct input from intended users of the outputs of the research is needed to help elaborate and prioritize the agenda.

Goals. The adaptation science agenda should have two primary goals. One is to generate and provide scientific knowledge, working in partnership with decision-makers and other stakeholders, that can be used to decide and implement vulnerability reducing adaptations. A second goal is to build capacity and partnerships for generating, evaluating, integrating, communicating and applying knowledge for adaptation.

Target Decision-Making. The adaptation science agenda needs to serve a wide diversity of decision contexts. But to be effective, individual projects will need to target the knowledge needs and processes of specific decision contexts and be designed accordingly. Because adaptation actions are often local, the science agenda should include strong elements that are focused on local decision-making contexts. Research that is targeted at higher levels of decision-making is also needed, as decisions made at higher levels can facilitate or hinder decisions at lower levels. Emphasis should be given to livelihoods, places and sectors that are highly vulnerable, and to decision contexts that affect large numbers of people, such as development planning and poverty reduction strategies.

Changing Vulnerability and its Causes. How is vulnerability to climate stresses of a group of people, a place or system changing and how will vulnerability change in the future? How do climate stresses interact with and relate to other causes of vulnerability? Answering these questions requires investigation of the status and dynamics of exposures, sensitivities, and capacities; the environmental, social, economic, institutional, technological, and governance conditions that influence them; and interactions among these variables to create conditions of vulnerability or resilience. The non-climatic factors deserve substantially more attention than they have received thus far.

Lessons from Past and Present Adaptation. How have people responded to reduce or manage their vulnerability to climate stresses and with what degree of success? In what ways is adaptation to climate change similar to adaptation to current variability, extremes and trends? In what ways is it different? What lessons from past adaptation is transferable to future adaptation and which are not? Investigation is needed of the strategies, institutional arrangements, decision processes,

implementation processes, and specific actions that have been used to cope with, adapt to, and recover from climate hazards. The performance of adaptive responses should be evaluated in terms of risk reduction, costs, benefits, and the distribution of outcomes among different segments of the population, paying particular attention to consequences for poor and marginalized people. What factors facilitated and increased the performance of adaptive responses, and what factors were a hindrance? Can this knowledge be used to create conditions that facilitate future adaptation?

Characterizing, Quantifying and Prioritizing Sources of Uncertainty. What are the sources of uncertainty regarding consequences of climate change and of adaptations to climate change? Can they be characterized and quantified? What implications do uncertainties have for making adaptation decisions? What is the relative importance of resolving the different sources of uncertainty? What criteria should be used to judge relative importance?

Use of Information in Decision-Making. What information do people use to make decisions about adaptation and how do they use it? How does uncertainty, and the ways in which uncertainty is communicated, influence decisions and decision processes? What information sources do people find credible? How do they integrate information from different sources, some of which may be contradictory? How can knowledge about these processes be used to better design decision support research and communication of risks and response options?

Connections to Sustainable Development and Poverty Reduction. What are the connections between vulnerability and adaptation to climate stresses with sustainable development and poverty? Is it possible to integrate climate change adaptation into sustainable development planning and poverty reduction?

Case Study Research. Two general research approaches are available to answer the above questions. The first is a case study approach in which detailed primary data, both quantitative and qualitative, is collected through focus group discussions, participatory exercises, interviews, surveys and other techniques. The primary data collection is complemented by secondary data collection and both types of data analyzed. The output of a case study is a multidimensional characterization of the vulnerability and adaptation options for the selected case. The accumulation of case studies from different types of systems in different places, under different social-economic-political circumstances, and under different combinations of stresses, would produce a rich body of knowledge to compare and use to test hypotheses and derive lessons that can be generalized from the specific contexts of individual cases to other cases.

Quantitative Modeling. The second general approach is quantitative modeling. Models have been developed and applied to provide estimates of impacts or system sensitivity in response to changes in climate variables, holding constant other forces acting on the systems. Some limited investigation has been done of how simple and moderately complex systems respond to multiple stresses, for example simultaneous changes in climate accompanied by changes in technologies and demands for food, water and land. System models have included some attempts to account for adaptive responses and differences in adaptive capacities, but this is an area that is still under-investigated. Even less far along is the modeling of the responses of systems of high complexity to climate and multiple stresses (e.g. regional food security and public health).

There is need for adapting, calibrating and validating existing models for application in more regions. There is also a need for developing and testing new models of complex systems that couple human and environmental components and account for multiple stresses. Greater efforts

are needed to incorporate more realistic treatment of adaptation responses and adaptive capacity into system models of all levels of complexity.

Combining Case Studies and Quantitative Modeling. Case study and quantitative modeling approaches have seldom been satisfactorily integrated in climate change research. The two approaches, when combined, can potentially provide a more complete assessment of vulnerability and adaptation. The results of case study research can provide data for calibrating and validating quantitative models, as well as provide added context for interpreting modeling results. The latter is particularly important when there are processes acting within or on a system that cannot be adequately modeled. Decision support methods can usefully combine quantitative modeling with focus group discussions to explore scenarios and adaptation options.

Observational Data. Both case study and quantitative modeling approaches would benefit from more complete implementation of the Global Climate Observation System (GCOS), which is very incompletely implemented in the developing world. Consideration should be given to the design and implementation of complementary systems for collecting social, economic and environmental data that can be spatially referenced and associated with spatial climate data.

Analyses of Climate Data and Detection of Trends. Statistical analyses of observational data are needed to detect changes and trends and to investigate their causes. This information can be used to identify the changes in climate hazards to which people and systems are presently coping with and adapting. The information can also contribute to better climate predictions, which can be useful for planning future adaptation strategies.

Regional Climate Change Scenarios. Adaptation planning would benefit from knowledge of how the climate will change at spatial resolutions that are much finer than the relatively coarse resolutions of general circulation models (GCM). A variety of methods are possible for downscaling the projections of GCMs to finer spatial scales. These include regional climate modeling, statistical downscaling, and simple scaling procedures. Each has advantages and disadvantages, all are subject to uncertainties imparted by the GCM projections that are used as a starting point, all introduce their own uncertainties, and none is demonstrably better than the others for all users and all possible uses. Research is needed to evaluate the importance of spatial scale as a source of uncertainty relative to other sources in terms of impacts and implications for adaptation decisions.

4. Principles for Implementing an Adaptation Science Agenda

A number of fundamental principles should underlie implementation of an adaptation science agenda. First, the need for scientific capacity, knowledge and research that is targeted at adaptation decision-making is greatest in the developing world, where vulnerabilities are greatest. Developing countries and their scientists and experts should decide and execute an adaptation science agenda that is appropriate to their needs. This implies an approach that looks at climate change vulnerability and adaptation in the context of multiple stresses and goals, for example the Millennium Development Goals, and that emphasizes current and near term climate vulnerabilities.

Second, substantial investments are needed in scientific and technical capacities in the developing world. Capacity building programs in climate change and global environmental change, such as those of START, the Inter-American Institute for Global Change Research, the Asia Pacific Network for Global Change Research, the Stockholm Environment Institute, the Third World Academy of Sciences and others have demonstrated real benefits from such investments,

particularly those that are based on a "learning-by-doing" approach and engagement with stakeholders. The GEF funded project Assessments of Impacts and Adaptations to Climate Change (AIACC) is a good model of this approach and similar efforts are needed on an expanded scale. There are also a number of strong centers of excellence in developing countries that can and should play expanded roles in building and extending capacity to others.

Third, the research and assessment process should engage stakeholders in substantive ways in all phases of the work, from selection of objectives, to project design, implementation, interpretation and communication of results, and application of knowledge in adaptation actions. Scientific knowledge can be used in decision-making to reduce vulnerability, but only if it is relevant to, available to, understood by, and has credibility with those who would need to act. It is also necessary that scientific knowledge be combined with other sources of knowledge and experience. The participation of stakeholders can help to achieve these outcomes. Which stakeholders and how to engage them will vary depending upon the specific objectives of a project and the intended uses of the outputs.

Fourth, implementing an adaptation science agenda requires multidisciplinary teams. Applying the knowledge, expertise and methods from multiple social and physical sciences can provide more complete understanding of climate change vulnerability and adaptation that would yield more effective adaptation actions. Multinational teams should also be encouraged so as to promote regional approaches to adaptation, sharing of expertise and capacity, and sharing of information.

Fifth, an important objective of assessments should be to build processes and networks that partner scientific, decision-making, practitioner and stakeholder communities to identify, generate, communicate and apply the knowledge needed to make good decisions and manage risks effectively. Networks should be established at a variety of levels that correspond to the decision-making contexts, and should include international networks to facilitate the exchange of information about adaptation. Climate change is a continuous process that will be experienced as changes in variability and extremes that may not follow gradual and predictable paths. Discrete, one-time adaptation actions will have limited effectiveness in this context. But the partnerships that are built in the process of assessment and implementation of actions are valuable capacity that can be continuously used. Building and sustaining these partnerships *is* adaptation.

Finally, implementing an adaptation science agenda and supporting capacity building in the developing world will require investments by developing country governments as well as donor organizations. The scale of required resources is large. The Conference of the Parties should consider how the Convention might facilitate the financing of science and capacity building that is targeted to adaptation decisions.