EXPLORING LINKAGES BETWEEN ADAPTATION AND DEVELOPMENT

Proceedings of The Scientific and Technical Conference On Adapting to Climate Change in Asia

August 29-30, 2009
Hotel Hyatt Regency, Kathmandu, Nepal

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List of Acronyms

ABC	Asian brown cloud
EWS	Early warning systems
GHG	Greenhouse gases
GCM	General Circulation Model
ICIMOD	International Centre for Integrated Mountain Development
IDRC	International Development Research Centre (Canada)
ISET	Institute for Social and Environmental Transition
NOAA	National Oceanic and Atmospheric Administration (USA)
SEI	Stockholm Environment Institute
UNFCCC	United Nations Framework Convention on Climate Change

The conference: Preface

Substantial research is taking place in Asia on climate change, the impacts it is likely to have on vulnerable populations, and ways to adapt to new climatic conditions as they emerge. The insights gained from the research activities have not, however, been communicated to key policymakers and other actors in a useable fashion, which would support strategy formulation in advance of the December 2009 Conference of the Parties on Climate Change to be held in Copenhagen. The scientific and technical conference hosted by the Institute for Social and Environmental Transition-Nepal (ISET-Nepal), the Institute for Social and Environmental Transition (ISET), the International Centre for Integrated Mountain Development (ICIMOD) and the Stockholm Environment Institute (SEI) was designed to address this communicative lacuna. The scientific and technical meeting was held in conjunction with the intergovernmental Kathmandu-to- Copenhagen Regional Conference hosted by the Government of Nepal.[1]

The goal of the Scientific and Technical Conference on Adapting to Climate Change in Asia was to present and discuss a broad array of results from recent and ongoing projects on climate change across Asia and to locate these results within large conceptual frameworks regarding adaptation processes and challenges. In addition, the conference was designed to serve as a key mechanism for disseminating results from a pilot research project on adaptation to climate change in South Asia supported by the International Development Research Centre (IDRC) and from the recent research that ISET and its partners undertook with support from the National Ocean and National Oceanic and Atmospheric Administration (NOAA). Both organizations also provided support in hosting the conference.

[1] More information on the Kathmandu-to-Copenhagen Conference can be found at: http://www.kathmandutocopenhagen.org/

A unique focus: adaptation

Not many conferences or forums have focused on the results of technical and scientific research on adaptation in South Asia. This one, however, focused on the presentation of key results from a variety of recent research by ISET and ISET-N and their partners, primarily the NOAA-supported research into the communication of climate information to implementation contexts and the IDRC-support research into local adaptation planning. The conference provided the opportunity for researchers to discuss recent findings on methodologies to investigate, and best practices for supporting and guiding, adaptation and to identify significant gaps in knowledge. The resulting exchange of information was an important step in assisting the region in its effort to adapt to climate change as it added to researchers' understanding of the complexities in global and regional climate change processes. The conference also helped give clarity to this emerging field by summarising new insights into the major political, economic and social implications of adaptation to climate change.

Scientific and policy debates over how to respond to climate change are closely interconnected. Climate scientists have long recognised both the importance and complexity of regional climate patterns such as the South Asian monsoon system and the fact that the tremendous spatial variation in precipitation across the region means that projections about how climate change will affect rainfall are bound to be highly uncertain. They also recognise that our ability to both document and project climate change impacts are further handicapped by practical limitations to research: there are simply not enough weather observation stations in the Himalaya and the quality of datasets leaves much to be desired. However, while it is obviously important for regional and global policy to continue to focus on increasing the level of scientific certainty about the impacts of climate change, it is equally essential to affect a shift in policy which acknowledges that empirical exactitude is not within our grasp. Policymakers need to begin to address the societal implications of climate change impacts by identifying flexible practical responses, both autonomous, grassroots-centered strategies and planned, government-level approaches, which do not require exact scientific information as a precondition.

Research conducted by ISET and ISET-Nepal and their partners in multiple contexts across South and Southeast Asia demonstrates that global climate change information and policy is frequently distant and divorced from the daily realities that shape the lives and livelihoods and the responses of ordinary people to climate variability and, ultimately, to climate change. Similarly, local level conceptualisations and perceptions are not rooted in the science of projections, which have proved difficult to communicate in lay terms. As a result, all climate-change stakeholders, whether the Indian villager or the European climate scientist, are making decisions about potential response strategies, whether mitigation and

adaptation in a partial vacuum of information and understanding. The decisions and courses of action adopted at various levels, from the individual household on up to the national government, is based on only a limited view of climate change and determined by the institutions and systems that enable or constrain their actions.

Key messages

The research results presented at the conference highlighted a range of issues central to understanding the impacts of climate change in the Himalayan region as well as in developing effective responses to them.

Probably the most fundamental message which emerged concerned ***the critical role of autonomous adaptation and the systems that enable it*** in regions such as South Asia, particularly in the Himalaya, where the impacts of climate change are both uncertain and dependent on location-specific conditions. The limited data availability, poorly understood monsoon dynamics and complex topography characteristic of the Himalaya present profound challenges for projecting climate change using general circulation models (GCM) outputs. Since it is difficult to identify specific projected impacts, it is also difficult to target responses. Rather than particular response, what is needed are systems such as energy, transport, communication, ecosystem management and others that enable local populations to respond flexibly and adapt as climate conditions change. It is essential to begin the planned development and design of such adaptive systems; in fact, this endeavour represents the primary point at which strategies for supporting adaptation and development intersect. It is equally critical to adopt flexible rather than target-oriented approaches to the management of climate-sensitive sectors such as agriculture, forestry and water resources.

A second fundamental message which emerged had to do with climate change itself. While it may be difficult to use scientific technology to project the specific manner in which climate change will affect local areas in advance, ***the impacts of climate change are already being observed in many regions across South Asia***. Furthermore, it is possible to document these changes scientifically using the extensive historical data available on species distributions, water sources, and other climate-sensitive features.

Other key issues and observations that emerged in the course of discussions are outlined below.

- *Uncertainty is high*: Current projections of climate change results based on GCM scenarios for South Asia exhibit high levels of uncertainty. This uncertainty is inherent in the current context and cannot be resolved rapidly because datasets are limited and our understanding of major regional climatic features such as the monsoon is poor.

- *The impacts of climate change can be evaluated using proxy indictors:* In the absence of robust climate change projections, proxy indicators such as historical versus current plant and animal species distributions, spring and stream flows and other measures can provide direct insights into changes in climate.
- *At all levels, critical information is inaccessible:* Location-specific information on climate change is just as inaccessible to those working at the global level as is global information to local communities. It is partial information and partial understanding that shape perceptions, decisions and courses of action at all levels, from the smallest community, to nation states to global actors, regional and international.
- *Autonomous adaptation is already occurring and can provide a basis for more proactive strategies*: Despite their uncertainty about the climate, individuals and households have already autonomously undertaken numerous practical adaptation strategies. These need to be documented, learned from, and, in cases of success, scaled up.
- *Planned approaches to adaptation are important but will be limited in scope and effect*: Planned adaptive policies promoted by government and non-governmental institutions are likely to be just the tip of the iceberg, but they do need to be formulated so that they support autonomous activities and ensure that they do not become maladaptive. Planned adaptation will require innovative and accountable governance if it is to meet the cross-jurisdictional implications of climate change and to address its pervasive impacts.
- *Adaptation efforts should be at the local level*: Because the impacts of climate change depend heavily on location-specific conditions, adaptation measures should be undertaken at the local level. The focus of national and global policy arenas, in contrast, should be mitigation, or the reduction of greenhouse gas (GHG) emissions.
- *Diversification can promote adaptation*: Alternative production systems, employment opportunities and livelihood diversification can help individuals and households respond to the high variability and uncertainty associated with climate change.
- *There are no single solution and no magic bullets*: Given the complex, systemic interactions that create vulnerability, no single planned adaptive solution or approach will meet all adaptation needs. Instead, package of people-centered, technological innovation and state-facilitated efforts are required. In most situations, a combination of "partial 10% solutions" such as improving communication and transportation networks, providing access to health care, localising green energy production and constructing multi-use flood shelters are more likely than any one solution, however perfect it may appear in theory, to prove resilient to a variety of slow and sudden onset changes. Such solution will be more effective in supporting autonomous adaptation.
- *Work on conceptual frameworks must be carried out in parallel with practice:* Extensive field studies have shown that links exist between mitigation, adaptation and basic development. Potentially very diverse implementation activities can build local-level resilience and adaptive capacity especially in regions such as the Himalaya where uncertainties about the physical and social sciences is great. Hence, as anomalies and surprises emerge from the field, conceptual exercises conducted in parallel must come to aid with new strategies clarified by logically robust frameworks.

DAY 1

CONCEPTUAL FOUNDATIONS

The sessions discussed challenges of sceintific research and emerging issues related to climate change adpatation

Opening session

Moderated by:
Ajaya Dixit ISET, Nepal
Dr. Marcus Moench ISET,
Dr. Stephen McGurk IDRC,
Dr. Madhav Karki ICIMOD, and
Dr. Kai Kim SEI

The speakers highlighted critical issues as well as emerging opportunities associated with climate change. It is expected that climate change policy debate will shift gradually toward the conversion of conceptual and technical knowledge into practical action as key partnerships are formed. It is not necessary for key actors to know exactly which on-the-ground impacts can be directly attributed to climate change in order to be able to provide practical guideposts to decrease human vulnerability. In any case, research suggests that autonomous processes of adaptation are likely to be more important than planned adaptation strategies implemented by national governments or other high-level entities in local-level responses to climate change. Individuals, households, businesses and communities have much more intimate contact with the mix of constraints, opportunities and risks emerging within local contexts than governments do. Faced with these local realities, they react with their worldview they have and adapt within their possible means. While elements of the larger context can be shaped by governments, planned adaptation strategies are often unable to respond to the variations inherent in local conditions; even so the success of individual adaptive measures is situated within that larger context and is influenced by interactions between the local and the global—whether in terms of markets, governance, resource management, or climate variability and change. Governments and global entities can use the rules which govern this larger arena to shape the direction autonomous adaptive responses take and to avoid the pitfalls of maladaptation.

Adaptation is much more than coping with and surviving disasters. It involves at least the ability to maintain and preferably to improve quality of life, wellbeing and environmental sustainability. Currently there is a tendency to see adaptation as a nebulous concept, one requiring the stamp of scientific certainty concerning the impacts of climate change before action can be taken. It has become an excuse for governmental inaction, for failing to deal with the factors that make people vulnerable to climate-related hazards. These include poverty, social and gender inequality, disenfranchisement, poor governance, corruption, ill-conceived subsidies, and unequal access to social, political, economic, and natural resources and capital. Short-term climate variability and long-term climate change are just one more set of opportunities and constraints within which the already vulnerable people cope with everyday living. As decision-makers and politicians debate what adaptation is, who is responsible for promoting it and how to finance it, people on the ground have already begun to respond to complex change processes, including those related to weather and climate.

CHAIR:
Dr. Stephen McGurk, IDRC, India

SPEAKERS:
Dipak Gyawali: ISET, Nepal Adaptation and Development: *Exploring Fundamental Linkages*

Dr. Marcus Moench, ISET *Systems and the Transmission of Vulnerability and Adaptation across Scales*

Dr. Jayanta Bandyopadhyaya, Indian Institute of Management, Calcutta *Emerging Adaptation Challenges to Water Management in South Asia: Need for a New Knowledge System*

Dr. Sara Ahmed, IDRC, India *Climate Justice in South Asia*

SESSION I:

Adaptation challenges

Speakers in the first plenary session focused on interactions between local conditions and higher-level systems, and considered factors that enable as well as constrain both autonomous adaptation at household and community levels and planned adaptation at national and regional. In doing so, the discussion highlighted the links between patterns of vulnerability within households, the transmission of risk and impacts across scales. It also highlighted the connection between adaptive capacity and the development of systems of transport, communication and energy as well as access to markets and information. The session ended with a discussion of the role of climate justice in the decision-making process. The discussion focused on how and by whom decisions regarding livelihoods are made and the repercussions of those decisions for individuals and communities not involved in the decision-making processes.

The session identified the following as critical needs.

Autonomous adaptation and planned development

Adaptation to climate change is embedded in complex socio-political-economic systems. It is about thriving, not merely surviving, in the face of multiple challenges. If adaptation were defined solely in terms of responding to specific projected impacts, society would be locked into specific courses of action that would not reflect or be able to respond to the many factors that determine vulnerability or to the high degree of uncertainty inherent in climate change projections. Most activities promoted in global climate change discourses have focused on planned adaptation–the roles, policies and activities of governments and formal institutions. This focus ignores the reality that most actions are and will be autonomous. Individuals and households are already taking action in response to perceived risks and opportunities related to weather and climate variability. Autonomous actions depend on the kinds of resources (social, political, economic, financial and natural capital, for example) which individuals and households or with inequitable access to one or more resources are particularly vulnerable as they might find themselves locked into specific responses rather than be able to respond in a variety of ways. In the face of high levels of uncertainty, it is necessary to promote strategies that support underlying systems which contribute to resilience and autonomous adaptive capacity. To do so requires implementing knowledge-based approaches which link macro perspectives on systems (the eagle's eye view) with the practical opportunities and constraints individuals and communities face in daily life (the toad's eye view). Community-level perspectives must be introduced into the decision-making process much more effectively, especially for planned development-related issues, than has hitherto been done.

A package of interventions

Only such a package of interventions will work, which address with each of its items a portion of the social justice, environmental degradation and climate change challenges and are sensitive to local conditions. Uniform, one-dimensional solutions to climate change have not succeeded because they do not acknowledge that adapting to the uncertainties of climate change requires having diverse response options. One dimensional approaches are unlikely to be any more successful in the future. Successful adaptation in a gradual process, one which must take place in both the short- and the long-term if it is to integrate general, global and local, context-specific factors. It requires a trial and error period that might not fit planned responses and must consider questions of equity—who gains and who loses. In a world of limited natural and financial resources, adaptation responses, both planned and autonomous, will require individuals, households and governments to make trade-offs between different activities.

If, on the other hand, adaptation is defined as specific responses to specific impacts rather than flexible responses to uncertain impacts, stakeholder may be locked into courses of action that will prove maladaptive. Since climate change will alter the frequency, intensity and duration of climate-related hazards like floods, relying solely on infrastructural solutions that treat climatic conditions as stationary will prove impossible. In fact, when "500-year" floods begin to occur with more frequency and at unpredictable intervals, structural measures such as embankments may prove to be devastating. The August 2008 breach of the Koshi River embankment in Nepal, for example, displaced almost 3.5 million people in Nepal and Bihar and caused considerable losses of property and other assets, even though the flow in the river was lower than the average flow for the month. The severity of the impact was exacerbated because the implementation of the silver bullet solution—embankments—encouraged communities to settle in high flood-risk areas without any consideration of what to do if this measure failed. Why it failed was complex: the embankment could not cope with the natural dynamics of the river, particularly sedimentation, it was very poorly maintained, and Nepali and Indian institutions did not work together to address weaknesses. The lesson learned form the disaster is a crucial one: adaptive strategies must consider both the dynamics of natural systems and the limitations of human institutions. Adaptive strategies that employ a combination of people-centered activities, including livelihood diversification, access to a variety of financial risk-spreading instruments, and the restoration of riparian vegetation as flood barriers, in conjunction with flexible, technological strategies are better suited to reducing vulnerability than reliance on a specific targeted response.

Study of the transmission of vulnerability across scales

It is essential that we increase our currently limited understanding of the transmission of vulnerability across scales especially in the case of climate change, whose global processes have very different implications for different localities. For example, poor households in Manila, who eat rice imported from Viet Nam, will experience food and economic insecurity if harvests in Viet Nam decline. Vulnerability incorporates both first-order, direct impacts on regions as well as their ripple effects as changes are transmitted through systems and across scales. Unless the processes of this transmission are analysed in a manner which integrates global climate science and local knowledge and observations, responses at all levels may be maladaptive,

REDD (Reducing Emissions from Deforestation in Developing Countries) strategies in Nepal suggest how poor understanding of the transmission of vulnerability across scales may result in maladaption. As a world leader in community forestry, Nepal has had great success in increasing forest cover through plantation and sustainable exploitation. However, these forests might prove to be a liability: forest fires may increase if preliminary climate projections for Nepal's Middle Hills—drier non-monsoon seasons and more variable monsoon rains—prove true. In fact, the prolonged drought from November to May 2009 contributed to the flaring up of numerous forest fires across the country. A telling NASA image taken on April 24, 2009 showed over 3,000 ignition points. Continuing to increase forest cover area without considering climate dynamics could increase fuel loading and thereby the frequency and intensity of fires. This change would in turn impact regional climate by changing air quality and, with the production of aerosols, the Asian monsoon system. At the same time, at a micro-level, changes in forest cover and fire dynamics would affect local livelihoods based on forest products.

The Philippine and the Nepal examples highlight the need to look carefully at the transmission of vulnerability across systems and scales beyond conventional boundaries and their potential feedback loops in an effort to prevent maladaptive strategies.

A human rights perspective

While participants in the conference raised the importance of looking at climate change from a human rights perspective, they emphasized that it should not focus solely on the need for assisting affected communities but also recognise that individuals and households are active stakeholders whose voices should be a central part of the decision-making process. Climate change is, fundamentally, a political and socio-economic issue. Incorporating a human rights perspective into the climate and development discourse needs to address five questions, the first three related to distributive and the fourth and fifth to procedural climate justice.

- Who defines categories of vulnerability for countries, communities, households and individuals?
- Who decides what risk will be examined and whose knowledge and adaptive capacity counts?
- How will social and gender inequities be addressed?
- Who is allowed to frame the climate change and development problem?
- Who determines the nature of planned adaptive policies and funding mechanisms?

In addition, non-governmental researchers who engage with communities on issues of climate adaptation must address the following three key questions.

- How should climate scientist and adaptation researchers incorporate the above five considerations into their work?
- How should they build their capacity' to deal with these considerations, especially those gender and social inequities?
- How should researchers build equitable partnerships with the communities and vulnerable populations they study?

The idea of incorporating a human rights perspective into climate change is a relatively new one building upon the concepts of sustainable livelihoods (health, water, food, etc.) and ecological justice. An example presented at the conference serves to highlight the importance of these concepts. In its effort to develop an integrated floodplain management framework in Bangladesh, IDRC is helping more than 150 community-based organisations (CBOs) to examine social and gender inequities in terms of the management, governance of and access to fish and water resources. In the past, while the poorest and women did belong to CBOs and could fish, they were not involved in decision-making processes. It was more affluent males who decided how to spend group earnings and thus had a disproportionate impact on the livelihoods of other members. Women and the poorest were not able to direct activities in ways that would enable them to respond effectively to the impacts of flooding and other climate-related events. CBOS are now exploring equity issues and slowly changing their approach.

Filling knowledge gaps

Our knowledge of the Hindu-Kush Himalaya Region is very limited. The hydrological and cryological impacts of climate change, and the relative contributions of human behaviour or natural processes as well as the wide variability of the many observed changes and need better research and analysis. These mountains serve as a water tower for Asia – the Ganga, Bramaphutra, Indus and Mekong rivers all originate here – but we know little about the fluctuating groundwater levels within them that constitutes the 'water' within those towers, the different types of spring sources where the groundwater becomes surface flows and contribute to streams and rivers, or the dynamics which influence the diverse microclimates they harbour. Since our current modeling capabilities do not have either the specificity or the sensitivity required to address changes and uncertainties at the watershed level, the downscaled climate projections of GCMs that attempt to understand the complexities of the Hindu-Kush Himalaya system contain major uncertainties.

CHAIR:
Dipak Gyawali, ISET, Nepal

SPEAKERS:
Dr. Sarah Optiz-Stapleton, ISET-International *Downscaling Rohini and Jaipur Results*

Dr. Mark New, University of Oxford, UK *Climate Change Scenarios for Nepal*

Dr. Arun B. Shrestha, ICIMOD, Nepal *Impact of Climate Change on Water Resources in the Hindu-Kush Himalaya*

Dr. Rajiv Sinha, Indian Institute of Technology, India, *Hydrological Variability and River Response to Climate Change: Implications and Challenges for the Ganga River*

SESSION II:

Climate science in South Asia: Results from recent research

This session addressed the results of research on climate change projections for and impacts on South Asia. It highlighted the need for diversifying livelihoods and focusing on adaptive strategies as well as on uncertainties in the climate change projections, the modeling needs and the gaps in the data needs for the region. The speakers identified the following issues as needing attention.

Overview of climate modeling

The most robust projections of climate change are based on GCMs which attempt to mathematically model the interactions between the ocean, the atmosphere and the land at large scales, typically on the order of 100 to 300 km. They are only representations of reality, not reality itself. Though they are commonly misconceived as certain predictions of the future, they in fact represent the possible responses of the earth's systems to possible human choices. There is a high degree of uncertainty in climate change projections because our understanding is limited: our understanding of both natural processes and what energy consumption and greenhouse gas emission choices we will make in the future is limited.

To project potential climate change impacts on smaller scales such as the city or a watershed level (on the order of tens of km), projects need to be downscaled using one of two ways: dynamic regional climate model (RCM)) and statistical downscaling. Each method has different advantages and disadvantages.

Preliminary climate projections for Nepal

A review of the projections of 15 GCMs and two RCMs makes it clear that temperatures in Nepal will rise. The increase projected ranges from 0.5 to 2.0 °C with a multi-model mean of 1.4 °C by the 2030s and rises to 3.0 to 6.3 °C with a multi-model mean of 4.7 °C by the 2090s. Projections of future precipitation patterns, in contrast, vary greatly, indicating that there is little certainty, although, the majority of the models do, however, predict an increase in the incidence of heavy rainfall events.

Sources of climate uncertainty in South Asia

Data and capacity are limited: Factors like the number of years, quality and availability of data, the distribution of observation networks, computational capacity and time limitations determine the reliability and functionality of any given climate change model. The paucity of data, the lack of institutional capacity to correct and verify data, and the short duration of records limit the validity of GCMs for the Hindu-Kush Himalaya region.

GCMS and RCMs yield a range of values: The level of uncertainty in climate projections can be qualified, in part, through a comparison of the projections of multiple GCMs and RCMs. Each model represents the physical climate system in a slightly different way and produces slightly different results. Since together these models can provide a wide range of values for variables such as precipitation and temperature, our sense of uncertainty over what climate change will bring is heightened.

Mountain systems are poorly understood: Climate models lack the resolution and capability to accurately capture topographical influences on precipitation and microclimates, especially in extremely complex and poorly understood mountain regions like the Hindu-Kush Himalaya, whose dynamics are further complicated by the Asian monsoon system. To quantify and qualify the dependability of any model requires identifying the uncertainties inherent in it as well as those associated with the region it is applied to. Even RCMs, whose resolutions are greater than those of GCMs, are unable to capture the differences in the amounts of precipitation which fall on the ridges and the valleys below in the Middle Hills of Nepal.

The Asian monsoon season is too complex to represent accurately in a model: No GCM or RCM currently captures the characteristics of monsoon climatology, its spatial distribution, intensity, duration, onset, breaks, and completion. The difficulty in modeling the monsoon has three main reasons: our incomplete understanding of the phenomenon itself, our inability to represent its interaction with tele-connection patterns such as the El Niño Southern Oscillation, and the complexity of regional topography.

We cannot be certain about impacts on hydrological and cryospherical processe: Precipitation patterns in the Middle Hills of Nepal are poorly understood and their projections, highly uncertain. We need to quantify a number of phenomena, including the timing their and volume of surface flow, inter-basin transfer as it is impacted by runoff from rainwater, groundwater interflow, and snow and glacier melt. As revealed in a recent conference entitled 'Kathmandu to Copenhagen: The Way Forward for Nepal,' the contribution of snow and glacial melt in the High Himalaya to river flow is relatively small. Unlike glaciers which are shrinking dramatically, snow cover is not expected to reduce as much given the high altitude at which precipitation occurs. Only after more research into the contribution of annual snowmelt is done can we say with any certainty how river base flows will be impacted. Until we better understand the hydrological and cryospherical processes themselves, it will be difficult to determine the impacts of climate change on them.

The value of climate modeling and ways forward

Despite the significant uncertainty associated with climate projections, climate modeling does play a critical role in increasing our understanding of the dynamic interactions between global and regional climate systems. Though they do not capture future precipitation patterns with certainty, existing techniques do provide fairly coherent climate change projections with respect to temperature, extreme temperature events, and evaporative stress. In addition, using projections from multiple models provides a range of useful information that can be incorporated into a decision-making process so as to prevent the adoption of potentially maladaptive strategies that are based on only a single event or model.

Identification of knowledge gaps

Large-scale climate processes and feedback mechanisms must be understood better before they are incorporated into GCMs. The tendency of non-climate experts to pick and choose the single projection that fits their agenda must be replaced with an understanding that only reliance on the outputs of multiple models can reveal the range of possibilities the future holds. While statistical downscaling does provide a good preliminary estimate, there is also a need to produce more RCMs, increase their resolution, better understand their responses, and better incorporate local processes like the type and extent of vegetation change dynamics in order to capture local variations.

Focus on building adaptive strategies

If we wait until climate science has been perfected before crafting adaptation responses, we will miss our window of opportunity to take proactive steps that build resilience against multiple shocks and slow-onset, creeping events. Because specific impact projections are uncertain, response strategies should not make them their primary focus. Instead, strategies need to focus on building the adaptive capacity and resilience of people so that they are able to respond to changes as they occur. The presentations highlighted the need to diversify livelihood systems so that rural populations do not depend solely on climate-sensitive sectors, such as agriculture, for their survival. River management strategies need to emphasise the natural drainage and flood- buffering capacity of riparian areas rather than rely on structures that are designed for specific but impossible-to-predict maximum and minimum flow stages and sediment loads.

Avoiding maladaptive strategies

Because of the lack of certainty, any strategy whose effectiveness depends on specific climate projections is likely to be maladaptive. For example, there is a high risk of maladaptation if rural development strategies only promote climate-sensitive sectors such as agriculture or forestry or structural solutions. More specifically, as illustrated above, the promotion of "key" crops like rice, increasing forest cover, and constructing embankments may prove maladaptive if the potential for mass failure of those solutions, very much probable with climate change, are not internalised.

CHAIR:
Dr. Mark New, *University of Oxford*

SPEAKERS:
Dr. Daanish Mustafa, Kings College, UK *Vulnerability and Adaptation*

Dr. Fawad Khan, ISET, Pakistan *Cost Benefit Analysis of Disaster Risk Reduction in Urban Regions*

Dr. Bidya Banmali Pradhan, ICIMOD, Nepal *Impact of Brown Clouds in the Hindu-Kush Himalaya region*

Dilip Singh, ISET, India *Shared Learning Dialogue Process and Outcomes from Indore*

SESSION III:

From impacts to strategies: Methods for moving from concepts to practices

This session addressed social and institutional issues related to climate change adaptation. It focused on the wide array of emerging processes and techniques that are able to generate new knowledge on climate change impacts and to translate it into practical courses of action. Methodological approaches addressed in the session included vulnerability mapping, shared learning dialogues (SLDs), community-based strategies and economic analyses including cost- benefit analyses (CBAs).

The speakers highlighted the following issues.

Using shared learning dialogues to integrate local and large-scale knowledge

SLDs use iterative processes of learning and sharing with communities, policymakers and scientists to increase knowledge and understanding of the multiple factors contributing to vulnerability by providing a cross-sectional view. The information exchange SLDs assist in the designing of initial studies and the preparation of climate resilient plans. For example, recent SLDs conducted in the city of Indore in India revealed that the capacity of local institutions to deal with water issues is limited, that wastewater infrastructure is decrepit and water-logging, widespread. Other SLD work across India and Nepal has resulted in the development of local adaptation plans of action that reflect (a) global information on climate change; (2) location-specific hazards and other conditions; and (3) the multiple dimensions of vulnerability in local communities. The SLD process has also assisted in evaluating the costs and benefits of risk management strategies under changing climate conditions. It is important to combine SLDs with other techniques, including sectoral studies and vulnerability assessments (including indexing) and to secure the support of local organisations in identifying strategies and options.

It is important to note that the selection of SLD participants must be chosen carefully since who participates has a great impact on the outcomes. In particular, issues of social and gender inequity must be considered so that the voices of all are heard.

Using indexing to provide a snapshot of vulnerability

Vulnerability is a complex and dynamic beast, but elements of vulnerability can be captured using indexes and other semi-quantitative methods as long as they are contextualised in a qualitative manner. The choice of qualitative criteria as a whole does effect vulnerability scores, but no one variable particularly impacts it. A vulnerability index cannot be used as a stand-alone determinant of vulnerability; it should be complemented with other methods such as vulnerability mapping, which is

subject to abuse and can lose nuances, and SLDs, which can help re-incorporate nuances. It also must itself be complemented by qualitative analysis. Indexing does, however, provide a skeleton of baseline conditions, or a 'geography of vulnerabilities,' which enables the identification of development of strategies that address the causes of the vulnerabilities.

Cost-benefit analysis of adaptation strategies

CBA is a key tool for evaluating alternative strategies for adapting to climate risks and for enabling decision-makers to determine trade-offs and to prioritize among alternative investments. Since, to be effective, CBA must be carried out with specific local knowledge regarding the relationship between potential strategies and the physical/social/institutional context in which implementation will occur, SLDs and vulnerability assessments approaches are also central to any attempt to evaluate the cost effectiveness of risk management and adaptation strategies. SLDs and vulnerability assessments generate the local information and instill the sense of ownership required to evaluate the technical and social effectiveness of strategies. They also contribute to a better understanding regarding the distribution of costs and benefits among different communities.

The common insights that emerged across the three methods described above were as follows.

Communication among locals, policy-makers and researchers is poor: Communication of information about different aspects of vulnerability among locals, policy-makers and researchers is currently poor but can be improved with SLDs. In particular, SLDs, with their iterative structure and multi-level approach, can correct misinformation, provide missing information, and present new information as well as reconcile the qualitative and quantitative schools of thought. SLD could also remedy the tendency to reduce vulnerability to a single factor.

Diversification is key: Diversification can reduce vulnerability and increase adaptive capacity and livelihood resilience. Diversification away from climate-sensitive livelihoods like rain-fed agriculture, which depends on the increasingly unpredictable monsoon, for example, will boost the resilience of farmers. Attempts at diversification must consider both local opportunities as well as macro-level conditions such as the demand for labour or access to resources in the global market. The impact of crop failures due to drought, for example, can be mitigated if households are able to buy food from distant areas using remittances from family members working abroad. More than the income-generating power of any one particular livelihood, it is a diversity of livelihoods, each of which makes a small contribution to resilience that is important.

Mitigation and adaptation work together: Adaptation and mitigation are closely linked. In some cases, strategies for adaptation such as livelihood diversification depend directly on the availability of and access to reliable sources of energy, and, in other cases, adaptive strategies will prove ineffective unless GHG emissions are reduced. To promote adaptation and resilience, therefore, requires a consideration of mitigation, particularly the responsibility for it.

The nature of these links is dynamic and complex, as is illustrated by the "Asian brown cloud" (ABC), a dense brownish cloud of pollution the size of the continental United States hovering over Asia. The Himalaya block the passage of particulates, so pollution is extreme, so extreme that it may reduce rainfall and thereby affect water budgets at local and regional levels. Clearly, there are complex but as yet poorly understood connections between the emissions which have created the ABC and the adaptive options locals have: water-dependent strategies may be ruled out. To better understand the links between adaptation and mitigation, we need to further investigate how aerosols affect the albedo of glaciers, suppress photosynthesis, and alter cloud production, temperature, and other factors. Since 80 per cent of the ABC is generated anthropogenically, largely from vehicle exhaust and the burning of biomass, a change in lifestyles is needed to reduce emissions. Assessing the impact of ABC on vulnerability will require collecting much more quantitative and qualitative data as our knowledge of its social aspects is very limited.

DAY 2

ADAPTATION IN PRACTICE

Adaptation in practice was discussed in two main sessions each having two concurrent sub sessions. The first sub session focussed on adaptation efforts in rural areas, while the other on urban areas. The areas covered included the coastal regions of Gujarat and the Nepal Tarai. The issues discussed included communication systems, migration and vulnerability.

In one sub session of the second session findings from a study on adaptation to too much and too little water in the Hindu-Kush Himalayas currently being carried out in Nepal, India, Pakistan and China were presented. In the other sub session participants discussed climate change issues in China, Eastern Himalaya, food security issue in Bangladesh and the role community based institutions can play in adaptation.

SESSION IV:

Overview of case studies of the integration of climate information into planning processes

Sub-Session a: Rural areas

CHAIR:
Dr. Marcus Moench

SPEAKERS:
Nafisa Barot and Kaushik Raval, Utthan, India *Adaptation in Coastal Regions*

Ajaya Dixit, Anil Pokhrel and Kanchan Dixit, ISET, Nepal *Nepal Case Study*

Dr. S. Janakrajan, Madras Institute of Development Studies, India *Tamil Nadu Case*

Rohit Magotra, Ekgaon, India *Communication Systems*

Shashikant Chopde, ISET, India *Ecosystems and Adaptation*

Sub-Session b: Urban areas

CHAIR:
Dr. Rajiv Sinha

SPEAKERS:
Dr. Gopalakrishna Bhat, TARU, India Vulnerability Mapping in Urban Areas

Dr. M.S. Rathore, Center for Environment and Development for Resource Analysis and Policy, India *Jaipur Migration Assessment*

Dr. Dinesh Kumar, Institute for Resource Analysis and Policy, India *Climate Adaptation in Gujarat*

Dr. Simon Thuo, GWP Eastern Africa, Uganda South-South Cooperation Insights from Africa

Replicable shared learning processes

Because SLDs are iterative, they develop understanding; information is clarified and interpretation, misinformation exposed and new information generated. SLDs help participants identify a diverse array of location-specific strategies all of which are consistent with available projections on the impacts of climate change. In Nepal, for example, SLDs revealed whether locals saw a particular embankment intervention and other interventions were beneficial or not by generating a map of up to three pluses and minuses across transects. The approach yielded information that locals wanted and also gave researchers insight into the bases for their responses. By quantifying in ratings the qualitative data produced by SLDs, the strategy identified the limitations inherent in embankments (because flows are uncertain and climate variability is expected to increase) and pointed out that smaller distributed approaches at the community level yielded greater benefits at less cost. Participants looked at both costs and benefits and generated many ideas about how to address problems such as flooding. The SLD process is critical in determining what concerns prevail, assessing their intensity and impacts and identifying what strategies work, and, ultimately, in framing pathways towards sustainability and resilience.

Strengthening basic systems

Strategies that strengthen basic systems, including energy, transport, and communication as well as ecological, financial and other systems, can increase resilience. The status of these systems either enables or constrains individuals and communities from adapting. Without infrastructure, such as energy and roads, and the capacity to design and maintain it, securing a good standard of living is virtually impossible. If locals are to be able to change their strategies in ways that reduce exposure to hazards and move towards resilience they must have knowledge of and access to such systems. Studies have shown that Nepali subsistence farmers, for example, can only diversify their livelihoods if they can access energy, transport, communications and finance systems that extend beyond the local level. This lesson is no less applicable to similar regions. The capacity to shift strategies is heavily influenced by access to underlying infrastructure, knowledge, communication, and education systems; relationships and interconnectivity within those systems; and assets, specifically convertible ones. The resilience and governance of these systems, along with social protection, are key factors governing the ability to adapt.

Strategies consistent with climate change

Rather than promoting strategies which focused narrowly on sectors or physical infrastructure sensitive to thresholds, it is important to enhance those social and physical capacities that can respond to climate change. Local development must be examined through a climate lens to reduce reliance on pathways that are sensitive to specific-climate conditions and to support those which are not. Strategies for adaptation should not be seen as a subset of existing development pathways; an altogether new pathway is called for.

Importance of strategies that emerge at the community level

Community-level, bottom-up strategies can address livelihood issues but must be sensitive to issues like fundamental changes in farming systems, the introduction of exotic species, and the desirability of

migration. Climate variability has stressed traditional agriculture practices, whose success relies heavily on the timing and intensity of the monsoon. A pilot study in Eastern Uttar Pradesh revealed that 70 percent of the land within nine agricultural zones where 90 percent of the population are small or marginal subsistence farmers or landless has been affected by salinity and drought. In other areas that were historically drought-prone, such as the Rohini Basin, flooding is now the major concern. Land stress, unpredictable flooding and more frequent drought conditions have jeopardised food security and increased migration. Time and spatial management of crops can prove to be useful adaptive strategies; farmers advance or postpone plantation and harvest as appropriate and have begun to practice crop layering so that flooding only damages the lower levels.

In some cases, like the deltaic region of Tamil Nadu, new strategies have proved effective. In areas where salinity ingress has degraded agriculture production and contamination and over-fishing have reduced fishing hauls, locals have begun to raise emus. Emu farming will serve as a new source of long-term income and has stimulated social interaction. While there are drawbacks–the initial expense is great; the gestation period, long; and special training, essential–sale of emu eggs and meat yield good returns. The farmers' choice to adopt this strategy raises questions about the impacts of introducing exotic species, whether animal or plant, on land and diet. When a new crop is involved, questions to consider include the impact its growing cycle will have on migration patterns.

Significance of communication systems

Proactive risk reduction strategies will enable communities to make wise adaptive choices based on clear, understandable information. SLDs convert scientific knowledge into forms that can be grasped by local communities and thereby help transform concepts into actions. They also put policy-makers in touch with local realities and help make sure policies are appropriately designed.

The implementation of early warning systems (EWS) has helped communities reduce the risks associated with floods and cyclones. A pilot study conducted in Tamil Nadu first mapped existing communication systems, including, but not limited to, FM radio stations, television, digital satellite radio and cellular systems, to establish EWS. Other pilot projects have evaluated the accessibility, reliability, and effectiveness of various existing systems for use in EWS. For example, in both Tamil Nadu and Eastern Uttar Pradesh short message service (SMS) was used to send weather forecasts. The results were mixed, with delays in messaging and language barriers the chief obstacles. SMS and village information centers have the potential to communicate valuable information to farmers and community members, but they need to be improved considerably if they are to actually reduce loss and vulnerability. SLDs proved to be a critical tool in sharing information and in determining the effectiveness of EWS.

Proactive and reactive strategies

Both proactive and reactive elements are needed. People will not adopt strategies unless they feel that they respond to current problems; at the same time, strategies must be consistent with future changes. A crisis necessitating a response introduces an opportunity to build pro-activity and to gain knowledge about how to prevent crises in the future. Any successfully adaptive strategy will build in sustainability and equity and build on existing knowledge. In the coastal zones of Tamil Nadu, where salinity ingress,

sea-level rise, degraded water quality and over-fishing have created actual and projected stressors on economic resources, future projections of sea rise suggest further agricultural decline. A number of livelihood diversification initiatives have been launched by local NGOs, as measures of adaptation, including lobster- and crab-fattening, computer learning centers (capacity building), and crop diversification. Lobster fattening, in particular, builds on existing practices, growing juvenile and small adult lobsters to market size and enhancing returns for old lobster fishers and providing the possibility of incorporating new ones. The diversification initiative is both proactive and reactive in the sense that it responds to a present crisis as well as prepares locals for future problems. Other practices, such as building houses on stilts, educating children, and reducing dependence on groundwater also demonstrate how proactive and reactive responses overlap to address present and future needs.

The underlying condition: climate change

Climate change issues generally underlie other major existing problems, including groundwater depletion, pollution, urbanisation, salinisation, and population growth. In many cases, it serves as an additional stressor on already strained systems. For example, monsoon variability and drought are responsible for groundwater overdraft and with it increase stress on water resource-dependent activities like domestic and industrial consumption and agriculture. Similarly, climate variability and flooding obviously have a hand in exacerbating existing drainage issues. More complex interactions also exist. For example, the increase in temperatures likely to accompany climate change will lead to higher rates of oxidation in soil already degraded by the over-use of fertiliser. These are just a few examples of how climate change and existing issues compound stress on both ecosystems and on the livelihoods that depend on them. It is important to take into account current conditions as well as projected temperature increases and the ripple effects from those increases when exploring livelihood diversification options.

Moving forward

The pilot projects presented during this session provided examples of potential adaptive strategies and introduced concepts and questions that need to be explored before wider replication occurs. How to strengthen core infrastructure and environmental systems, for example, is one critical area where further investigation could identify mechanisms to address the impacts of climate change while at the same time meet basic development aspirations.

SLDs are essential because they integrate diverse information on climate, local conditions, social vulnerabilities and the technical, institutional and economic dimensions of potential strategies for building resilience. They increase understanding of vulnerabilities, climate variability, and adaptive and maladaptive strategies and are able to communicate nuances. They are particularly important in generating new insights, building local ownership of adaptive strategies, and identifying development strategies that are consistent with climate change but at the same time avoid maladaption.

SESSION V:

Documenting and assessing too much and too little water in the Hindu-Kush Himalaya

Sub session a: Linking planned and autonomous adaptation: a policy perspective

CHAIR:
Dr. Daanish Mustafa

SPEAKERS:
Julie Denkins, ICIMOD, Nepal *The Need for Documenting Adaptation Strategies*
Madhukar Upadhya, ISET, Nepal *From Coping to Adapting in the Kosi Mid-Mountains, Nepal*
Ihsan Uddin, AKRSP, Pakistan *The Importance of Local Institutions for Adaptation*
Dr. Praveen Singh, Winrock International, India *Adapting to Water Stress and Hazards: The Case of Kosi River Basin in Bihar, India*
Ajaya Dixit, ISET, Nepal *Linking Planned and Autonomous Adaptation: A Policy Perspective*

Sub session b: Challenges related to vulnerability and adaptations

CHAIR:
Dr. Jayanta Bandyopadhyaya

SPEAKERS:
Ms. Lu Ciazhen *Poverty, Vulnerability and Adaptation in Rural China: Case Study in Yunnan*
Dr. Shiraz Wajih, *Adaptive Agriculture Through Self-Managing Community Institutions*
Dr. Ahsan Uddin Ahmed, *Climate Change and Food Security*
Dr. Nakul Chettri, *Impact of Climate Change on biodiversity in Eastern Himalaya*

Documenting adaptation strategies

Participants discussed the unprecedented rates of change in the region and the need for documenting local adaptive strategies. They highlighted the need to assess whether or not these strategies are working and why. They stressed that filling the gaps in our knowledge of this area presents an opportunity to focus on the root causes of vulnerability and to tracking existing and past policy processes and how they enable and constrain adaptation. Local responses, it was pointed out, are not just reactions to local-level challenges as higher level systems and processes (including international market structures and their dynamics) often enable or constrain the ability of families to make responses. As a result, national and global policy frameworks have substantial implications for local adaptation processes. Participants also emphasised that while communities have been adapting to change and variability for centuries, knowledge about how has been partially lost due to a failure to record what was done. The documentation and compilation of adaptation strategies is needed in order to ensure that the progress made is not lost in the rush to keep up with the exponential rate of change occurring.

Issues of institutions and governance

Participants emphasised the importance of knowing who the decision makers are and what political imperatives constrain them from or drive them to incorporate climate change knowledge into their policies. The importance of identifying incentives for mainstreaming climate information which can build the resilience of the vulnerable was also highlighted. In addition, participants pointed out that as decisions are also made by individuals, businesses, and communities in response to local conditions, government decision-makers are not the only key policy actors. Effecting communication among all policy-makers including those in the market and in civic movements is crucial.

Governments need to introduce climate change risks into their actions in key areas, such as disaster risk reduction. However, their strategies of risk reduction need to be shifted from events-focused and often maladaptive engineering approaches to other strategies. There appears to be little memory or learning from experience as policies continue to emphasise structural solutions that do not respond well to the uncertainties of climate change and variability. For example, government policies in Nepal centre on its abundant water resources, forgetting that seasonal and spatial distribution vary greatly. They also ignore issues such as drought, water-logging, sedimentation, sand-casting, loss of flood plains, and potential and actual breaching of embankments. Instead of blindly addressing the complexities of climate variability through top-down, technological approaches that repeatedly fail, policy-makers must listen to the very different ideas which are emerging and be held accountable if they do not.

From coping to adaptation, an important shift towards resilience

Changes in the availability, timing, volume and accessibility of water increasingly continue to hinder the livelihoods of those who depend on it for agriculture or other purposes. In Nepal clear problems are emerging in several areas of the country. In the Tarai, rainfall appears to be increasing. In parts of the Middle Hills, however, evidence suggests that rainfall is decreasing, seasonal patterns are changing and variability is growing. The causes of this shift are uncertain but the patterns are consistent with

those which have been projected to occur as climate change progresses. Plainly put, a major issue for Nepal and other similar regions is having either too little or too much water at the wrong times. Sometimes both shortages and excesses wreak havoc in the same year. Signs of increased variability in precipitation include the drying up of springs, the inability to predict the timing of rainfall, and the decrease in the incidence of frost. These changes impact the planting of crops, result in shortages of water for domestic uses and increase the number of flash floods. With the frequency of local and regional problems such as water-logging and forest fires increasing, some communities have been forced to relocate and migration patterns and frequency have changed. If individuals, household and communities are to do well, they must adapt to, not simply cope with, water stress. When communities and individuals rely on one source of income, such as agriculture, vulnerability is high. Having a variety of income sources, rather than the size of an individual income source, seems to enhance resilience.

Moving forward

Numerous factors, in addition to climate change, debilitate the resilience of communities across the Hindu-Kush Himalaya. These include population growth, ecosystem degradation, rapid urbanisation, and changes in cultural and social systems. The increasing interdependencies between national, regional and global markets and the unprecedented rate of change also make it difficult for vulnerable people to adapt. In the face of these challenges, adaptive measures need to be identified that enable people to do well. Local adaptive strategies, knowledge gaps, and policy processes must be documented in order to establish the social memory necessary for learning and for guiding activities in the future. In creating this memory it is critical to identify those mechanisms that can hold policy-makers accountable. Many current problems emerged as a consequence of maladaptive policies such as total reliance on "hard" engineering structures for flood control adopted by governments with an assumption that they only had right answer. We now need to consider how to create the incentives needed so that new policies will be more adaptive to the changing context and that governments will be held accountable for their mistakes.

Climate change and food security

The heat waves, droughts, variability in precipitation, sea surface temperature (SST) anomalies, and other phenomena associated with climate variability have stressed global-, regional-, and local-level environments. In South Asia, droughts, flooding and changes in water availability have affected food production and SST anomalies have impacted fishing. In China, for example, SST anomalies have created such rough seas that fisher-folk cannot always reach their fishing grounds of are forced to forfeit catch in order to return safely.

Where agriculture is concerned, recent research indicates that some South Asian countries will likely see a reduction in the production in food crops while others may experience an increase. Facilitating food trade and improving access to regional food markets could address this imbalance and potentially increase food security. However, increasing reliance on trade would also expose local populations to fluctuations in the global market, as recent hikes in grain prices demonstrate. Promoting national and

regional food banks as a safety net might be a solution to both possibilities. To be effective, however, this macro-strategy would need to be implemented in conjunction with strategies designed to diversify livelihoods into income-pursuits. Diversifying food production at the local level would also promote resilience. Overall, addressing food security concerns requires adopting a combination of solutions, each of which addresses a fraction of the problem.

Informal and formal water sectors

In many regions water availability, access, and quality are central issues that directly affect livelihoods, especially as water needs are often supplied through informal systems. In Indore, for example, the municipal utility only provides water for 10 to15 minutes every other day. The city does not have a secure source of supply, is handicapped by weak infrastructure and poor governance, and cannot afford to supply water to all. As a result, local populations depend heavily on private sources of supply like water tanker markets and local wells. Because population growth is high and climate change will make supplies still more unpredictable, the city's ability to provide water is unlikely to improve. To deal with the problem, the role that informal systems can play in water management planning under changing climate conditions must be assessed.

Autonomous and planned adaptation

Participants discussed a range of issues related to the links between planned and autonomous adaptation and their significance for governance issues. Autonomous adaptation is already occurring informally through systems such as water markets, livelihood diversification and migration, but our understanding of how these processes work must be improved so that this knowledge can better guide policy planning. Where planned adaptation is concerned, planning requires the transparent communication of information so that diverse groups of stakeholders can get involved and express their ideas. In addition, our understanding of cross-border dynamics must improve as both natural and social systems, like watersheds, fisheries, forests, markets and social networks cross jurisdictional boundaries.

Ways forward

Presentations and discussions at the conference clearly demonstrated the fundamental importance of developing strategies that can assist populations in South Asia to adapt to climate change. While the scientific ability to project location-specific impacts of climate change is, in most cases, limited, these changes are occurring at a scale and speed that fundamentally threaten lives and livelihoods. People must adapt, and, in many cases, already have. Most adaptation to changes in local environments has been autonomous. Some strategies may ultimately prove to be maladaptive but this dynamic response capacity can serve as an entry point for identifying more suitable strategies.

Discussions at the conference highlighted four core areas where action is required.

1) *Strengthen scientific understanding of climate change by documenting actual changes rather than relying primarily on GCMs or their downscaled versions*: Making projections about the impacts of climate change in South Asia using models is not easy as data is limited; monsoon system dynamics,

poorly understood; and the topography and its relationships with socio-political systems, complex. Investing more resources in modeling capacity is unlikely to make the projections more certain without significant new data emerging over time. Thus, while it is important to continue to use modeling to project trends in climate variability, it is even more crucial to make direct observations of actual changes on the ground. Such observations are feasible using proxy indicators derived from the extensive historical data available on species distributions, water sources, agriculture and other climate-sensitive regional attributes. What needs to be done next is to conduct research into synthesising this data, developing specific climate change indicators and analysing actual changes.

2) *Improve conceptual and applied understanding of avenues for strengthening adaptive capacity at the household, community, and national levels through interventions that strengthen basic systems as well as target specific projected impacts*: Research findings presented at the conference clearly demonstrated the wide array of strategies local populations currently use to adapt to floods, droughts and other impacts of climate variability. These strategies are often enabled or constrained by the nature of basic energy, transport, communications and financial systems. They are also influenced by the condition of environmental systems and by educational and other factors that govern human capacities. These findings suggest that basic systems represent a critical point of entry for strengthening the adaptive capacity and resilience of local populations as climate changes. We need to improve our understanding of the linkages between local systems and adaptive capacity and resilience in order to identify those exact points where planned interventions to strengthen such systems will actually contribute to climate adaptation.
3) *Gain experience in supporting adaptation through local adaptation planning processes and the implementation of pilots*: Additional knowledge is essential but this knowledge must be tested and put into practice if it is to have any practical meaning for populations affected by climate change. Since the impacts of climate change are and will remain heavily dependent on location-specific conditions, interventions must be planned, tested and implemented at local levels. The development of local adaptation plans and the implementation of associated pilot projects is an essential next step.
4) *Expand knowledge of and implementation experience in key areas such as climate-adapted approaches to water management and water infrastructure design, renewable energy, transport infrastructure, agriculture and the built environment*: Many engineering and management strategies in key sectors have been developed under the assumption that climate conditions are stationary, that they fluctuate about a stable mean condition where variability and extremes can be described statistically. Climate change processes mean that such assumptions are no longer valid. They call for changing approaches to design and manage in diverse fields to emphasise flexibility and functionality under conditions that are inherently unpredictable. Strategies or designs that depend on specific-climate conditions or thresholds need to be avoided. The retooling of the knowledge systems that underpin design and management traditions is a critical terrain for research and experimentation.

The above sections summarise key observations which emerged from the presentations and discussions at the conference. The accompanying document *Shifting the Response Terrain* highlights in a much more specific manner some of the most crucial issues related to climate change adaptation discussed at conference.

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