From Research to Capacity, Policy and Action

Enabling Adaptation to Climate Change for Poor Populations in Asia through Research, Capacity Building and Innovation

REPORT
From The Adaptation Study Team to IDRC
Coordinated by ISET
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ISET-N
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Executive Summary & Conclusions

Adaptation to climate change will involve changes that cut across human socioeconomic systems in ways that affect virtually all aspects of life. Consequently, any attempt to assess priorities, capabilities and research gaps on climate change and poverty reduction risks either becoming fragmentary or massive and without focus. This is particularly true in the diverse cultural, geographic and economic context of Asia where both the direct impacts of climate change and the adaptive responses that emerge will be heavily mediated by local conditions. As a result, this study, although it involved extensive consultation and literature reviews has relied heavily on conceptual and methodological frameworks to help focus its scope and the final conclusions.

Key research issues, areas of high vulnerability and stakeholders to work with have been identified on the basis of the conceptual framework, literature reviews and consultations. A summary listing of these is presented in the table below. It is important to recognise: (1) *that the research issues identified are crosscutting: while they will support adaptation in the high vulnerability areas identified below, they also apply in many regions where vulnerability is less well known or documented*; (2) that *the research priorities* identified here are of particular salience when they *are* taken together as *an integrated package*; and (3) that issues related to *improving information on climate impacts,* the *economics* of adaptation strategies, *governance*, *access* and *equity*, *political viability* and *capacity building* are viewed by the Adaptation Study Team and many of those who participated in the consultations as inherent elements within each research theme. It is also important to emphasise that the issues identified have emerged through a process of intense debate: globally there is little consensus regarding the issues that will be of most importance in adapting to climate change and the spectrum of perspectives often increases at local levels and across disciplines. Even within the Adaptation Study Team substantial differences in approach and emphasis were evident. Given the fact that adaptation to climate change was only recently recognized as a critical issue, this diversity is healthy and represents a strong argument for broad scope of many of the research issues identified.

Purpose & Approach

The purpose of this report is to present the results from a strategic gap analysis the Institute for Social and Environmental Transition (ISET) and other members of the Adaptation Study Team have undertaken for the International Development Research Centre (IDRC) and the Department for International Development (DFID) to identify areas where a strategically targeted research and capacity building programme could support adaptation to climate change. The terms of reference for this project are included at the start of the main report. The approach has involved extensive consultations with a wide range of stakeholders

SUMMARY TABLE: **Research Issues, High Vulnerability Areas & Stakeholders**

SPECIFIC CROSSCUTTING ISSUE AREAS FOR RESEARCH

1 The factors enabling and constraining autonomous adaptation
2 The role of migration in adaptation
3 Management of and production in critical but less researched ecosystems: rangelands, inland and estuarine fisheries
4 Health systems
5 Governance of adaptation across scales
6 Knowledge systems for dealing with uncertainty
7 Social protection systems to support climate adaptation
8 Local disaster risk reduction and resilience
9 Water allocation, management and governance in conditions of relative scarcity and abundance
10 The role of financial mechanisms in spreading risks
11 Livelihood security for small farmers and fishing communities

AREAS OF HIGH VULNERABILITY THAT WERE USED TO IDENTIFY CRITICAL RESEARCH ISSUES

South Asia

1 The Eastern Ganga Basin: A nexus of flooding, drought, extreme storms, poverty and population
2 Major river deltas: A nexus of clear vulnerability to climate change, critical ecosystems and vulnerable populations
3 The arid zones in Pakistan, Afghanistan and western India
4 The Deccan Plateau
5 Coastal regions that are particularly affected by salinity and extreme storms
6 The Middle Hills of the Himalaya
7 The High Himalayan Region

South-East Asia

1 The Mekong Basin
2 Major river deltas
3 Coastal urban and peri-urban areas in central Vietnam, Indonesia and the Philippines
4 Rural coastal and upland areas in the Philippines and north-central Vietnam

China

1 The arid and semi-arid northwest of China
2 The Karst Uplands
3 The Tibet-Qinghai plateau
4 Peri-urban coastal zones

Key stakeholders for the research programme to engage with

1 Research and policy networks
2 Policy making agencies operating across and within sectors at a national level
3 Local and regional governments
4 Private sector organizations, particularly those involved in the innovation and incubation of new technologies, services and institutions
5 Scientific and educational research institutions particularly those with interdisciplinary programmes
6 National and international NGOs
7 Civil society and community-based organizations

accompanied by limited literature reviews all guided using a common conceptual framework developed by the Adaptation Study Team on the basis of prior research. We focus on *the underlying systemic factors* that *enable* or *constrain vulnerable people* in *vulnerable locations* from adapting. The conceptual framework was used as a primary structure for identifying, analyzing and prioritizing research gaps that emerged in the course of stakeholder consultations and the literature review. Since it played a central role in guiding and interpreting results from the consultative process, it is important to present key elements of it as a starting point from which the rest of this report follows. This is done below following a brief summary of topics and issues that emerged during the consultation and literature review.

Issues Emerging from the Consultations &Literature Review

Most current research and pilot activities on climate adaptation focus on: (1) improved modelling and collection of climate and economic data for refining projections of climate change and its likely impacts on populations, ecosystems and the programmes of international donor agencies (i.e. climate forecasting and impact assessments); (2) national planning, that, in most cases, calls for strengthening existing areas of activity (such as drought or flood proofing) where problems may be exacerbated by climate change; and (3) community-based initiatives, mostly catalyzed by NGOs, that involve local agriculture, disaster risk reduction, ecosystem management and livelihood related interventions.

Consultations conducted across Asia highlighted points of convergence and divergence between regions regarding issues of relevance for research on adaptation to climate change. In virtually all regions participants highlighted the

need for (1) improved understanding of climate impacts including the factors influencing the vulnerability of different populations; (2) capacity building of key stakeholders at local and national levels; (3) economic evaluation of interventions designed to support adaptation; (4) access and equity; (5) political viability; and (6) governance and the interaction across scales and sectors of government organizations. As noted above, these elements are inherent in the research themes identified by the Adaptation Study Team. Issues related to the availability, reliability and accessibility of climate information also emerged regularly as participants expressed frustration regarding the inaccuracy of short-term forecasts and lack of location specific information on climate change as a basis for planning. Beyond this, however, the issues raised by different stakeholders converged in an aggregate sense but diverged in terms of detail and emphasis. In many cases this reflected contextual considerations, such as the role of snow melt in the Himalayan region or the institutional structures for planning in China. This said, much of the local level divergence appeared to reflect high levels of uncertainty regarding the nature, scale and timing of climate change processes within specific areas and, partially as a result, the huge array of issue areas that could potentially be relevant as responses to climate change. This is, in many ways, characteristic of the emergent nature of global debates over climate adaptation. Whether at a global or local level, people are in the early stages of understanding what climate adaptation is or could be. As some participants in regional consultations expressed, adaptive capacity may depend on the general development status of local populations. At the same time, many participants in the consultations highlighted very specific issues, such as glacial retreat or sea level rise, that are much more specifically related to climate impacts.

The Conceptual Framework

As previously noted, the conceptual framework used to identify research gaps focuses on the underlying systemic factors that *enable* or *constrain vulnerable people* in *vulnerable locations* from adapting. Adaptation is not "coping." In well-adapted systems people are "doing well", or even thriving, either because they shift strategies in ways that respond to emerging changes or because the underlying systems on which their livelihoods are based are sufficiently resilient and flexible to absorb the impact of changes. As a result, at its core *adaptation is about the capacity of social actors to shift livelihood strategies under stress and to develop supporting systems that are resilient.* Autonomous adaptation depends on the systemic factors that enable people and organizations to take advantage of opportunities available in the new environment or constrain their ability to shift strategies as conditions evolve. Similarly, planned adaptation depends on the ability to: (1) proactively identify and flexibly respond to emerging constraints and opportunities; (2) enable autonomous adaptation processes by supporting the development of flexible, resilient and accessible social and physical infrastructure systems; and (3) establish social protection systems capable of ameliorating impacts on vulnerable groups that face particular constraints in adapting. *Systems that enable communication, access to energy and water, transport and mobility represent the "fertile ground" in which planned and autonomous adaptation initiatives can be successfully rooted. They also underpin the development of social networks and the generation and transfer of new knowledge. Governance considerations such as accountability, transparency, representation and coordination determine equitable access for local populations, particularly vulnerable groups such as women and the poor, to the flexibility and opportunities for strategy shifting or social protection such systems can enable. The nature of governance systems is, as a result, central to both poverty alleviation and adaptation to climate change.*

The above factors represent the conceptual foundations the Adaptation Study Team used to guide this assessment. Priorities also reflect strategic and tactical considerations including links with poverty alleviation, the need to identify tangible courses of action at scale,

economic justifications for investments, the connections between adaptation and mitigation, and the potential for private sector involvement. Support and ownership for the results of the analysis using the conceptual framework were evident in the extensive peer review comments received on the initial drafts of the main and regional reports and in the second round of group and individual consultations conducted by the regional adaptation teams. Ownership was also indicated by the strong engagement of many key counterparts in the multiple consultations.

Analysis

Numerous points of convergence between regions emerged in the consultative process and literature reviews. At the same time, by utilizing the conceptual framework the analysis has moved substantially beyond the fairly general and often widely scattered inputs from the consultations to a much more targeted set of research issues rooted in a more unified understanding of adaptation processes. As a result, the research priorities and areas identified in this report represent a rigorous analysis by The Adaptation Study Team that incorporates inputs from the many individuals and groups consulted. In each region covered by the adaptation study team our approach has been to identify:

1. "Areas of high vulnerability" in which there are highly vulnerable populations living in areas at risk from climate change (in a very few cases, we have noted "hotspots" where large and particularly vulnerable populations are concentrated in areas that are particularly vulnerable to climate change); and

2. Key research themes: Crosscutting issue areas, such as water management, that are central to adaptation and emerge as critical issues in many locations.

Results of the consultations and our analysis for each of the regions in relation to such areas of vulnerability are discussed below. Due to substantial overlap in research themes between regions these are discussed in a single unified section following the areas of vulnerability relevant to each region. *It is important to recognize that the research themes identified were derived from close study of the high-vulnerability areas but are not confined to them. As a result, although areas of high-vulnerability are identified below, any programme that is designed on the basis of this report should place greater emphasis on the research themes rather than the specific areas identified.*

Areas of High Vulnerability by Region

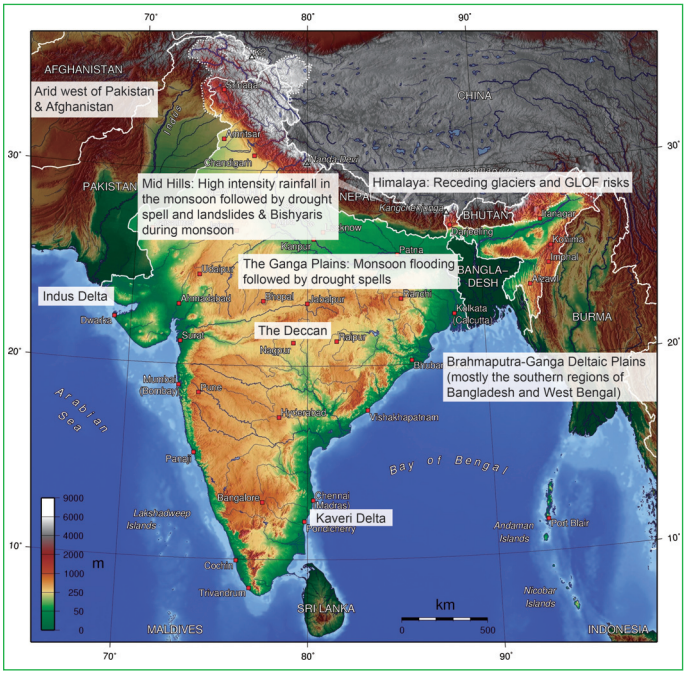
South Asia

Climate change is anticipated to have a major impact across South Asia. Part of this is due to the large proportion of the population engaged in primary livelihoods, such as agriculture, that are directly vulnerable to climate change. Part is also due to a combination of geographic and other features in the natural environment, such as the low groundwater storage in the Deccan Plateau, the regional dependence on monsoon systems and the hydrologic characteristics of the Ganga-Brahmaputra basins that are likely to accentuate the impacts of climate change.

In South Asia, two broad regions have been identified as "hotspots" where large populations of vulnerable people live in vulnerable areas:

The Eastern Ganga Basin: The Eastern Ganga Basin contains one of the world's largest concentrations of poor people who, due to their settlement and livelihood characteristics,

have very specific vulnerabilities to climate change. Exposure to floods, droughts and extreme storms across the eastern portion of the Ganga basin is high. This exposure is compounded by a long history of development activities that have altered drainage and other natural systems. In comparison to many other river basins, the hydrogeologic and topographic characteristics of the Ganga Basin as a whole are likely to accentuate the impacts of climate change. Lower portions in the delta are extremely vulnerable to flooding, sea level rise and the impact of storms. Upper regions in the Himalayan Range are already experiencing changes in snow, glacial melt. The basin as a whole depends heavily on the monsoon system which may be destabilized by climate change. Using our definition of vulnerable people in vulnerable places, the eastern portion of the basin stands out as a "hotspot." Vulnerabilities in this hotspot cannot be understood or addressed, however, without a perspective that encompasses dynamics across the basin as a whole.



Major river deltas: In addition to the Ganga basin, the Ganga-Brahmaputra delta and other major deltas such as the Indus, Kaveri and other large rivers draining the Deccan plateau also qualify as hotspots. Unlike many coastal areas deltas have low gradients making them particularly vulnerable to flooding from upstream areas, sea level rise and the extreme coastal storms that are likely to intensify with climate change. Conditions in deltas also depend heavily on sediment loads that are likely to be affected both directly by climate change and by any river management activities that may be implemented upstream in response to climate or other change processes. The wetland and brackish water ecosystems that characterize deltaic areas and often play major roles in regional livelihoods are highly vulnerable to changes in temperature, salinity, sediment and other natural parameters that almost certainly will be altered by climate change. Drought can also have major impacts by encouraging seawater intrusion over long distances inland. In South Asia, deltas typically support large vulnerable populations whose livelihoods (agriculture and fishing) and place of residence (urban flood plains, low-lying rural areas) are particularly vulnerable to climate change.

Additional areas where climate impacts are also likely to be high and have a significant impact on vulnerable populations but where the specific impacts associated with climate change are less clear or the number of vulnerable people at risk is much lower include:

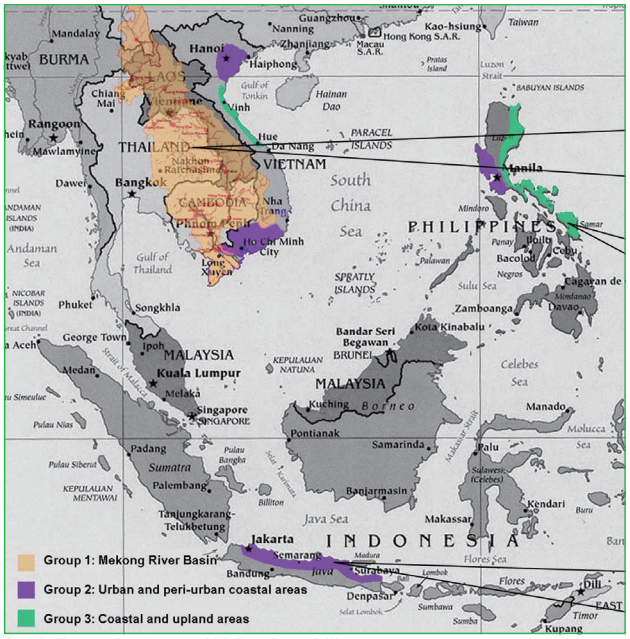
The Arid Zone in Pakistan, Afghanistan & western India: In this region high levels of vulnerability are compounded by existing patterns of water scarcity, conflict and political instability. The primary uncertainty here is the degree to which climate change *per se* is likely to compound existing patterns of vulnerability.

The Deccan Plateau: This area has a large poor and often socially marginalized (tribal) agricultural population that will be heavily affected by climate change *if* variability and drought increase. As with the arid zone regions, the primary uncertainty here is the degree to which climate change *per se* is likely to compound existing patterns of vulnerability.

Coastal regions that are particularly affected by salinity & extreme storms: Although not generally as physically vulnerable as deltas, large sections of the coast of South Asia are vulnerable to a combination of sea level rise, intense storms and saline intrusion into overpumped groundwater aquifers. In such areas, increasing salinity represents a particular threat to poor populations that depend on agriculture, brackish water (estuarine) and marine fisheries and the availability of local water supplies for domestic uses.

The Middle Hills of the Himalaya: This is an area where the scientific information on the impacts of climate change is very limited. This is clearly illustrated by the lack of information on the region in the recent IPCC report (2007). It is probably related to high levels of uncertainty caused by the topographic complexity and climatic complexity of the region. Information on the middle hills is particularly lacking. Impacts could, however, be major particularly in relation to extreme storms (and the erosion/landslides they generate), drought and flooding. In addition the region contains substantial agricultural populations whose livelihoods are vulnerable to climate change.

The High Himalayan Regions: Although populations in these regions are small, snow and ice melt provide a critical source of base flow for regional rivers that supports hundreds of millions of people and the ecosystems especially during the dry season. Understanding the impacts of climate change on this key water source has major implications for vulnerable populations at a regional level.



South East Asia: Areas of high vulnerability

South East Asia

Across South East Asia, climatic changes are expected to severely affect those most dependent on natural resources for their livelihoods, such as poor farming and fishing households. Vulnerable populations living in urban and peri-urban areas near coasts and deltas are also likely to be severely affected. The region is expected to experience increases in frequency and intensity of tropical cyclonic systems, storm surges, sea level rise, and increased flooding, particularly in Vietnam, Philippines and Indonesia. Increased variability in rainfall patterns across the region is already exacerbating flood and drought conditions, with severe implications for livelihoods and food security. Case examples of areas of high vulnerability that demonstrate the complexities facing climate adaptation planning and strategies include:

The Mekong Basin: The great variation in the flow of the Mekong River through seasonal flooding and low water levels both drives and constrains the productivity of the agro- and aqua-ecological systems critical to alternating seasons of rice cultivation and fishing in wetlands and floodplains. These are food and livelihood sources for more than 55 million people throughout the basin, particularly the poor, and the Mekong Delta is a main rice bowl for the region. The eastern and lower portion of the basin is also highly vulnerable to cyclones, storm surges and sea level rise. Additionally, human-induced hydropower systems may exacerbate climate variability effects and fluctuation in water flows and levels with serious implications on people's livelihoods and survival. As a result, this basin and the population within it are particularly vulnerable to climate change.

Major river deltas: These include the Red River, Chao Praya, Irawaddy and other deltas in addition to the Mekong in which many of the larger and denser human settlements and key rice growing areas are located. They are especially vulnerable to the combined impacts of changes in upstream flows and coastal storms, sea level rise, flooding and salt water inundation, affecting crop production, fisheries, and human health. Many people either live in vulnerable locations or depend on vulnerable livelihoods. These are also among the most important rice and fish producing centres of the region. As a result, climate impacts on key ecosystems could have major implications for food prices and, thus, for poverty.

Coastal urban & peri-urban areas in central Vietnam, Indonesia, the Philippines & southern Thailand: Heavily populated urban and peri-urban areas in these locations are low-lying coastal zones whose settlements, already lacking in basic service infrastructure, are extremely vulnerable to storms, flooding, and increases in disease aggravated by poor water quality and sanitation and poor drainage systems. Growing urban poor slums, located in low-lying and marginal areas, have limited social protection and are often least capable to recover from shelter destruction and health problems in cases of typhoons and storm surges.

Rural coastal & upland areas in the Philippines & north-central Vietnam: Extremely poor farmers, dependent largely on fragile lands for agriculture, and small scale fisher-folk inhabit areas located near the eastern coastlines of the Philippines and Vietnam where vigorous cyclones and heavy rainfall produce massive floods and landslides. These have caused unprecedented heavy tolls on lives, shelter, crops and livelihoods. Drought and variable rainfall, and increasing sea level rise and temperatures are expected to further stress agriculture and fisheries production systems on which these populations rely. Vulnerability is exacerbated by lack of access to basic services, early warning systems, disaster management, capital assets, and access to skills training for diversified livelihoods.

China

Climate research has attracted considerable attention in China, in part because of the strategic importance of food production and the historical exposure of large rural and urban populations to extreme events (droughts, floods, typhoons). There is reasonable consensus on the broad nature of future climate change in different regions of the country under various global emission scenarios, but high uncertainty as to how these trends will be expressed locally. As a result, the adaptation study team in China identified areas of high vulnerability to investigate key cross-cutting issues. These areas were defined as:

The arid & semi-arid northwest of China: This area is expected to see larger increases in mean temperature than other parts of the country, particularly in the dry summer months. While forecast precipitation is much more uncertain, it may be concentrated in high-intensity events which can be very destructive of the fragile soils in steep terrain that characterize much of this area. Although it accounts for only 9% of China's population, this region is settled by poor marginalized populations that depend on climate-vulnerable livelihoods. These populations also represent a potential source of social instability. As a result, ensuring their ability to maintain productive livelihoods as climate change proceeds is likely to be a strategic priority.

The Karst Uplands: Climate change in this region will mean increased precipitation and higher variability, with attendant risks of drought, flooding, soil erosion and landslides. The region is densely settled and already vulnerable to extreme events.

The Tibet-Qinghai Plateau: Temperature changes are likely to lead to earlier snowmelt and longer snow-free seasons, which will affect late summer soil moisture and require modification of pasture management practices. Although the plateau is sparsely settled, most of the population depends on traditional livelihoods and have a culture that revolves around pastoralism. Key knowledge gaps revolve around options for fodder and pasture management, alternative livelihoods and asset diversification in a relatively unproductive agro-ecosystem that is isolated from markets and infrastructure. Some climate projections also indicate the possibility of more forest cover in this region over time leading to new livelihood options in the long-term.

Urban & peri-urban coastal zones: This is a dynamic area of high population density with high levels of vulnerability to coastal storms, sea level rise, disease vectors and other climate change impacts. It is also a zone of increasing wealth accumulation, but with large numbers of disadvantaged persons who have either been displaced by development or have recently migrated and lack access to basic social welfare benefits. It is a region of rapid and poorly planned development, where key natural buffer systems are being converted to urban and industrial uses (e.g. wetlands, floodplains, deltas).

Critical Gaps & Strategic Points of Entry for Research

Although most issues related to climate change and poverty have regional or location specific dimensions, results from the consultations and our analysis indicate research, capacity and experience gaps are common across much of Asia. It is important to recognize that *the research issues identified are cross-cutting: while they will support adaptation in the high vulnerability areas, they also apply in many regions where vulnerability is less well known or documented*. It is also essential to recognize that *the research priorities* are of particular salience when they *are* taken together as *an integrated package.* This package has emerged based on regional priorities and a common conceptual starting point that takes vulnerability and systems perspectives as its starting point. Finally, it is important to recognize that issues related to *improving information on climate impacts,* the *economics* of adaptation strategies, *governance*, *access* and *equity*, *political viability* and *capacity building* are viewed by the Adaptation Study Team and many of those who participated in the consultations as inherent elements within each research theme. These macro issue areas can't be analyzed until much more information is available regarding the specific courses of action that may be required to support adaptation. As a result, they are not listed as key research issues in their own right. The key research priorities identified are:

The factors enabling & constraining autonomous adaptation: Autonomous adaptation processes – responses to the impacts of climate change by individuals, households, businesses and other entities – are likely to be more common and wide spread than "planned" adaptation measures. Most research and policy dialogue, however, focuses on planned strategies. Key specific entry points on the factors enabling and constraining autonomous adaptation include: (1) research on the degree to which economic diversification in household and regional livelihood systems actually mitigates the impact of climate change on populations and vulnerable communities within them; (2) research to test the link between penetration of (and access to) basic energy, water, transport, finance, health, communication and other infrastructure and diversification within livelihoods or the ability to shift strategies as conditions change; and (3) research to identify opportunities for encouraging the diffusion

of technologies that have low carbon footprints to support diversification and mobility in areas undergoing rapid economic development.

The role of migration: Migration and population mobility are increasingly recognized as central to autonomous processes of climate adaptation. This factor emerged in the literature review, the consultations and our own analysis based on the conceptual framework. Key research entry points on this include: (1) services for supporting migrants and for mitigating the negative impacts migration can have on vulnerable groups such as children, women and the aged; (2) improve understanding of the necessary assets that may enable migration, particularly of poorest groups, who may lack needed financial capital, skills, knowledge and capacities, and identify actions and policies that may support them; (3) evaluate the role of remittances in adaptation (climate proofing of infrastructure and livelihood diversification); and (4) migration policy in the context of climate change. Another potential point here would be assessing the ways that migration enhances or reduces climate vulnerability in both origin and destination areas: while remittances improve adaptive capacity, migrants may face new sources of vulnerability in destination zones. Additional points highlighted in regional analyses include: (a) how climate variability has affected migration patterns; and (b) the role of informal trans-local and transnational social networks in facilitating access to remittances. The issue of migration has particular policy sensitivity in China, where long-standing restrictions on social benefits for migrants remain in place despite the dependence of urban industrial economies on high levels of migration.

Management of & production in critical but less researched ecosystems: Management of critical ecosystems (arid zones, wetlands and uplands) and the goods and services they produce could play a central role in climate adaptation. Specific points of entry for research on this include: (1) livestock in arid, semi-arid and upland ecosystems; and (2) wetland and estuarine fisheries and related production systems. Key knowledge gaps revolve around options for fodder and rangeland management, options for management of riparian areas in major river basins and options for managing brackish water estuaries. Gaps also include alternative livelihoods and asset diversification in relatively unproductive agro-ecosystems that are isolated from markets and infrastructure. The research issues in this domain go beyond questions of natural science to include social issues of benefit sharing and household roles, as well as institutional issues of resource tenure and local governance in the face of changing environmental, economic and policy conditions.

Health systems: Climate impacts will increase health risks to diarrheal, vector-borne, and other infectious diseases, heat stress, and food and nutritional insecurity, directly affecting the capacity of individuals and families to adapt to climate change. While the potential implications of climate change for human health emerged in many of the consultations, likely impacts and implications for vulnerability and adaptation are poorly understood as are the potential avenues for addressing them. Key entry points on this include research to: (1) more clearly identify potential direct and indirect impacts of climate change on human health on different gender and social groups; (2) identify barriers to successful health-related planned and autonomous adaptation strategies for responding to climate change stressors; and (3) develop and test social, technological, institutional and policy measures to overcome such barriers and facilitate anticipatory health planning.

Governance of adaptation across scales: (1) identify institutional mechanisms that may facilitate more effective linkages horizontally between different departments and vertically between local, meso, and national levels; (2) explore how intermediate levels of government

(between the village and the state) may facilitate infrastructure, institutions and services that can enhance adaptation; and (3) understand the constraints, opportunities, conditions and forces for developing effective governance mechanisms for transboundary management of resources in contexts of climatic variability. It was recognized that governance mechanisms will influence settlement patterns, infrastructure and institutional support systems, all of which have implications for the vulnerability of poor and marginal populations. Specific points of entry for research on local governance and the links with climate adaptation could include: (a) the role of local government entities in urban areas and rapidly growing peri-urban areas in activities that are directly related to climate adaptation; (b) the role of local governments in supporting or constraining migration and services to migrants; and (c) the role of local governments in supporting economic diversification either directly or through the provision of basic social and physical infrastructure systems. Because governments differ greatly between regions, points of entry and particular issues related to governance are often region specific.

Knowledge systems for dealing with uncertainty: The design of institutions and infrastructure design in fields such as water resource management are based on specific or probabilistic information. To suit changed climate conditions knowledge systems that have greater capability for dealing with uncertainty are essential. Specific points for research and action on this topic focus on: (1) introducing a better understanding of uncertain climate conditions into the basic principles of water resource analysis and engineering design; (2) economic analyses of the costs and benefits of disaster risk reduction or, for that matter, any investment in adaptation.

Social security & protection systems to support climate adaptation: The ability to adapt to climate change will be heavily affected by social differentiation, that is the wide array of gender, ethnic, economic and other social characteristics that lead to discriminatory treatment within all social systems. Key points of entry for research and experimentation on this include: (1) basic research to improve understanding of the factors that differentiate access to social security mechanisms; (2) mechanisms, institutions and policies to strengthen reach and accessibility of formal social security mechanisms to poor and marginal groups, including women; (3) mechanisms that enable both internal and international mobility for climate-affected populations including the legal ability to change locations of residence; (4) standard working conditions for mobile and vulnerable portions of the populations; (5) understanding the role of informal social security mechanisms in autonomous adaptation strategies; and (6) the development of appropriate and effective micro-credit and micro insurance models that are relevant to cultures, practices and socio-political contexts.

Local disaster risk reduction & resilience: Poor people are vulnerable to further impoverishment as a result of increasing frequency of extreme climatic events, such as heavy rainstorms, floods, typhoons and storm surges. Current approaches to disaster management and infrastructure engineering may be less appropriate when climate becomes more variable. The issue is not simply engineering standards. Instead it has more to do with the whole approach to engineering (safe fail instead of fail safe designs, for example) coupled with institutional mechanisms for local risk reduction, disaster preparation and limited self-reliance. Innovative engineering and infrastructure construction approaches need to be balanced with new approaches to risk assessment and organizational, institutional and social communication methods (awareness-building, warning measures, hazard specific responses, credit and strategic reserve facilities for recovery). Some innovations are emerging, but there is need for research on how they can be better integrated at the local level to address

diverse and context-specific conditions. This emerged particularly clearly in the China consultations but was present in all regions.

Water allocation, management & governance in conditions of relative scarcity & abundance: At the heart of the discussions on livelihoods, vulnerability and adaptation to climate variability in both the hotspots and areas of high vulnerability is the question of water – too little, too much or of poor quality. Key entry points for research on this include: (1) Water management strategies that are resilient and able to flexibly respond to or moderate large fluctuations in water availability/flows; (2) production systems, such as inland and deltaic fisheries and aquaculture that are both environmentally important and may create alternative livelihoods for people as climate change progresses; (3) approaches to agriculture that are resilient under highly variable water supply conditions. This issue, while present in all regions, emerged particularly strongly in the South Asia regional report.

The role of financial mechanisms in spreading risks: Given the increasing pressure on traditional risk sharing strategies (borrowing from family, friends, social networks) and the exploitative nature of moneylenders, particularly during disasters when the poor are even more vulnerable, access to financial institutions for micro-credit, insurance and financial services may play a key role in climate adaptation. Key entry points for research on this include: (1) how micro-finance can be linked to larger social support systems that strengthen livelihood/disaster risk resilience rather than increase the risk/debt burden for the poor; (2) the efficacy of financial incentives that facilitate risk sharing/transfer, such as low-cost premiums and flexible repayment rates. This issue, while present in all regions, emerged strongly in the South Asia regional report. It was also present in the South East Asia analysis as part of social security mechanisms.

Livelihood security for small farmers & fishing communities: (1) better understand how livelihood security of small-scale fishers and farmers may be threatened by climate change combined with other stressors; (2) explore mechanisms that could strengthen their adaptive capacities including research on agriculture and fisheries production systems, particularly in increasing saline or flood prone environments; instruments for tenure security and equitable access to other productive assets and infrastructure; and means to enhance accessibility to scientific information on climate and weather patterns relevant to local levels; (3) identify the potential and needs for livelihood transitions such as skills upgrading and education; and (4) understand the factors and conditions that work to under-represent and exclude the voices of small producers in national and intermediate level planning for adaptation. This last point includes the effects that interventions to ameliorate the impacts of climate change on other populations (such as the construction of flood control structures upstream) might have on downstream livelihoods and wellbeing.

Key Actors & Capacity Needs

Capacity development, particularly the diffusion of concepts and experiences regarding effective strategies for adaptation, was identified as an issue across many regions. The issue of knowledge varies by region. In China, for example, a pervasive challenge is the way that knowledge and learning are structured in China's expert-driven society. New approaches to shared learning and expertise will be needed. These approaches will recognize the value of diversity, rather than uniformity, in local and regional response strategies to foster resilience. Most of all, these new approaches will have to build practical local strategies for experimentation, local and scientific risk assessment, and systematic sharing of research results. Specific additional areas of importance for capacity building are implicit in the research areas already noted above.

Key actors that will be particularly important in catalyzing effective adaptation include:

Policy making agencies operating across sectors at a national level: Because many of the research issues focus on topics (such as migration or infrastructure) that have major cross-sector policy implications at national and regional levels, agencies charged with policy making at this level represent key entry points for supporting both planned and autonomous adaptation. Key agencies would include economic and planning agencies, such as the Planning Commission in India and the National Development Reform Commission (which already has coordinating authority and a climate mandate) in China.

Sector-specific organizations: Because much adaptation is likely to occur through autonomous processes that are constrained or enabled by communication, transport, financial, energy and water resource and ecosystem conditions, the sectoral government and non-government organizations that have specific engagement with those systems will be of particular importance as counterparts.

Research & policy networks: Due to the wide array of issues involved, actors that need to be influenced, partnerships that involve diverse coalitions of NGO, academic, private sector and government actors are likely to be of particular importance in supporting adaptation. This includes regional or sub-regional partnerships for fostering cross-regional learning, technical support and capacity building, in addition to the high priority that needs to be placed on national level networks to influence policy. Opportunities also exist to move beyond 'national' actors, and strengthen capacities of research of sub-national universities and 'local' governments to respond to adaptation needs and knowledge priorities.

Local & regional governments: In all areas, the factors that constrain and enable both autonomous and planned adaptation will be heavily influenced by location specific conditions. As a result, efforts are needed to improve connections between sophisticated high-level research and local governments so that the knowledge generated through research enables improved practice.

Private sector organizations, particularly those involved in the innovation & incubation of new technologies, services & institutions: Business incubators have specific experience in taking small innovative initiatives and driving them to scale using appropriate operational models.

Scientific & educational research institutions, particularly those with interdisciplinary programmes: These organizations will be among the most important for implementing any research programme. These include regional, sub-regional and national networks of research organizations engaged in climate change adaptation research. While existing work on climate change adaptation has been concentrated mainly in meteorological, agriculture, forestry, and hydrology departments, it will be important to also engage with social science, health, and economics departments.

National & international NGOs: Such organizations may play a particularly critical role in the innovation and incubation of technologies, strategies and pilot initiatives for climate adaptation and social protection.

From Research to Capacity, Policy & Action

Enabling Adaptation to Climate Change for Poor Populations in Asia through Research, Capacity Building & Innovation

REPORT
From The Adaptation Study Team to IDRC
Coordinated by ISET
July 2008

Terms of Reference

As outlined in the contract prepared by IDRC:

> The overall objective, or purpose, of the research support Project has been to build a research programme that addresses the needs of vulnerable populations in developing countries in Asia to minimize the expected impact of climate change and exploit any opportunities that may emerge as a result of climate change to enhance their livelihoods.
>
> The specific objectives of the Project are to conduct regional consultations in Asia involving relevant local, sub-regional and national authorities, research organizations, non-government organizations (NGOs) and different community groups, international agencies, regional development banks, and the private sector who are currently involved in climate change activities or will likely play a pivotal role in enhancing adaptive and mitigative capacity, on order to:
>
> a) understand local, national and regional priorities, identify the major knowledge gaps and information needs as recognized by a range of stakeholders, as well as the constraints to make optimal use of existing and new knowledge and of known good practices;
> b) assess the current status of regional national and local research capacities, and ongoing and planned initiatives to conduct climate change-related research;
> c) identify some of the leaders considered to be the main "agents of change" (social entrepreneurs) and assess their knowledge and information needs; and
> d) identify some of the most successful initiatives put in place by local communities and governments to cope with severe climatic variation and past extreme climate events.
>
> The project will use the results of these consultations to propose an action-research and capacity development programme to minimize the anticipated adverse impact of climate change and build resilience within the most vulnerable populations in Asia.

The Adaptation Study Team's approach to the terms of reference evolved rapidly in close consultation with IDRC during early consultations on project activities. First, it rapidly became clear that the Adaptation Study Team should not be directly involved in formulation of the research programme but that our activities should focus instead on identifying key thematic areas where an action research and capacity building programme could play a catalytic role in supporting adaptation. Actual formulation of the programme itself was better for IDRC to undertake in direct consultation with DFID. Second, the need for a conceptual framework to focus the consultative process was highlighted during preparation

for the project inception meeting and during the very first consultations with stakeholders. Since adaptation to climate change is a relatively new subject, in the absence of such a framework, the array of issues, priorities, knowledge gaps and information needs expressed by stakeholders would rapidly become a never ending laundry list. As a result, the Adaptation Study Team utilized the results from prior research along with inputs from key stakeholders to develop a strong guiding conceptual framework. At the request of IDRC and DFID, this framework focuses strongly on the links between poverty and adaptation to climate change. The framework was discussed extensively during the project inception meeting and in subsequent consultations with numerous stakeholders.

In addition to the above, initial consultations highlighted inherent limitations related to objectives (b), (c) and (d) above. Again, due to the recent nature of debates over adaptation to climate change, while there is a huge array of research and capacity on issues that may be relevant, relatively little research has been undertaken that focuses on adaptation *per se*. Many issues fall in arenas such as health, migration or water management where extensive capacity and a long history of research exist, but little of it has been directly focused on adaptation to climate change. As a result, the number of institutions and leaders who could serve as "agents of change" falls at two extremes: (1) the very small number of actors who already work directly on issues of adaptation to climate change[1]; or (2) the huge array of individuals and institutions working in relevant fields. Similar issues apply to objective (d). Very few initiatives designed specifically to support climate adaptation have been implemented and the history of such initiatives is very short so their success or lack there of can not be demonstrated. At the same time, massive programmes for flood control, drought relief, food security, health and so on have been implemented over much of recent history that have implications for adaptation to climate change.

Given the above (and as outlined in ISET's original proposal to IDRC), the Adaptation Study Team's core objectives under this project have been: (1) to assess, in a manner that builds ownership by regional stakeholders (particularly the communities most vulnerable to climate change), existing challenges, knowledge and activities on climate adaptation in Asia; (2) to conduct a strategic gap analysis that indicates where additional research could contribute substantively to addressing the overall adaptation challenge; and (3) to identify critical research themes that IDRC and DFID can use as input for framing an action-research and capacity development programme for climate change in Asia. *In sum, the core objective of the analysis has been to identify and build ownership for major areas where research over the coming decade could contribute substantively to policy and implementation programmes for adaptation, particularly as those relate to the poor and other vulnerable communities.* Our assessment has, in essence, highlighted strategic gaps in the existing knowledge basis.

[1] All of whom appear already to be well known within the donor community.

Approach to the Assessment

Adaptation to climate change is a new subject but human adaptation is not a new activity. Innovation and exploration, the foundations of adaptation, have been a constant activity throughout human history. In terms of our understanding of the process it is underpinned by such fundamental questions as: Why do people live where they live? How to they make decisions on their lives? What influences the decisions they make? What causes some people to thrive (or at least do well) and others to fail? These are questions that cut across all academic disciplines and require an interdisciplinary approach in order to understand in relation to adaptation. It means the potential starting points for identifying critical research, capacity and experience gaps (our core mandate under the project) is almost infinite. In order to ground our own analysis and to respond to the core parallel interest of IDRC and DFID in addressing impacts on the poor and other particularly vulnerable populations, we have taken the concept of "vulnerable people in vulnerable places" as a central starting point. Our goal is to identify critical points where research, capacity building or additional experience could assist particularly vulnerable people in particularly vulnerable places to "adapt" to climate change. The conceptual framework and strategic/tactical considerations we have used in framing the review all take this as a core starting point.

In conjunction with extensive inputs from stakeholders across Asia, the above set of considerations has been used to identify "areas of high vulnerability" (geographical and thematic clusters) where climate change has particular implications for vulnerable people in vulnerable locations. The conceptual framework and inputs from stakeholders have also been used to identify specific gaps where targeted research, capacity building and experience building could, by targeting key actors or audiences, make catalytic contributions to the development of effective strategies for adapting to climate change. The research themes are particularly well illustrated by issues within the areas of high vulnerability but, in virtually all instances, are cross-cutting and not confined to the narrow areas of high vulnerability we have identified.

The Process

The consultative review process on which this gap analysis has been based was shaped by the urgency of the issues involved and, therefore, limitations on the amount of time available. Resources for direct consultation were also limited and, to be frank, the level of response was far beyond that initially anticipated when the process was designed. In addition, rather than large-scale "consultative meetings" the team felt that open discussion in smaller meetings and one-to-one interactions would be more productive in eliciting perspectives on critical research issues that would push the envelope of knowledge rather than limiting

our focus to topics already central to the dialogue. Finally, rather than producing a broad laundry list of potential research themes (the common outcome of many consultative processes), our objective has been to produce a much more tightly targeted list that conceptually and strategically focus on a cohesive set of themes. For these reasons, the gap analysis was never intended as an all-inclusive process. Instead it has involved deliberate attempts to first identify and then focus down on a set of core themes. As a consequence, many readers will find that the issues they view (with potentially complete justification) as being central to adaptation are not reflected here.

The review process was structured as follows: First, the team spent substantial time developing an overall conceptual framework and set of initial themes to guide and catalyze consultative inputs. Second, a series of small group and one-to-one consultations were held in different regions. Our strategy in initiating these consultations was to telescope in through the networks of organizations IDRC, DFID and all of us as individuals are in contact with. At least four group consultations were carried out in China, South East Asia and South Asia respectively. These have been complemented by a large number of one-to-one interviews and visits to vulnerable regions. There was also engagement in other regional meetings such as the EEPSEA meeting held in Bali. Limited reviews of the published and grey literature were carried out at the global level and for all the regions. Third, outputs from these initial consultations were used to identify geographical and thematic "hotspots" defined in relation to both our guiding concept of "vulnerable people in vulnerable locations" along with a set of strategic or tactical considerations that may influence the choice of research topics. Although used extensively in the process of exploring research gaps, as a result of subsequent consultations the "hotspot" concept has now evolved and except in a few very specific cases where conditions appear to strongly justify designation as a "hotspot," been replaced by the concept of "high vulnerability locations."

The analytical and consultative process was used to identify the key research themes, actors, capacity needs and target audiences identified in this final version of the report. The Adaptation Study Team sought to build widespread ownership for the analysis reported here through widespread review of an initial draft version of the report and a second round of consultations undertaken following preparation of the initial draft.

It is important to note that the objective of building widespread ownership has been particularly complicated in relation to the equally important objective of narrowing down to a clear set of gaps where strategic investment in research could make a catalytic difference. The challenge is twofold. First, the easiest way to build broad ownership would be to produce an extensive list that contains most of the issues stakeholders already view as important. Second, our overall mandate has been to identify "gaps." This is an exercise that inherently involves shifting the focus away from areas where substantial work is already going on (and is often funded from multiple sources) to areas that are less well represented in regional, global and thematic debates over adaptation. As a result, many of the issues many people view as central or that they are currently working on often do not emerge as strategic gaps.

EVOLUTION OF THE HOTSPOT CONCEPT

Comments from IDRC and DFID on ISET's draft report requested clarification of the "hotspots" we proposed in our study as a tool for assessing research issues. In responding to this request we realize that there may be some confusion about the way in which we

employ the term, and its function in our analytical methodology, resulting in part from the term's rather narrow geographical connotation.

In our initial approach to the research gap analysis we used the shorthand term "hotspots" to refer to a confluence of geographical and social vulnerability factors. While focused on regions, the concept was never intended in a purely geographical sense. As the consultative and analytical process proceeded, it became more and more clear that the social and physical factors contributing to vulnerability to climate change generally do not converge in a manner that permits designation of specific geographical zones as clear "hotspots." Key issues, instead cut across regions. As a result, the geographical definition of hotspots is not a key analytical conclusion of our work. Rather, we have used the concept as an intermediate tool by which to interrogate partners in consultations and interviews. In order to identify adaptation research issues, we asked participants in consultations and interviews to identify areas of high climate impact and concentrations of vulnerable people. Their responses indicated spatial and social *contexts* of high vulnerability that subsequently allowed us to focus our attention to field evidence. We used the identification of these spatial and social contexts to explore specific problems and research issues based on the experience in these areas. It is these research issues to which we devoted our analytical attention. The specific geographical contexts in which they occur is often not central to the research issues themselves.

Climate factors are of course generally linked to geography, but the issues that result from contexts of high vulnerability may or may not be place-based. For example, while some of the adaptation issues linked to large, densely populated river deltas in Asia are well-defined geographically, the issues associated with rural-urban migration are widely dispersed both in source and destination areas. Indeed, we found that some important knowledge gaps are in cross-cutting issues that, while they find expression in areas of high vulnerability, have only a very limited geographic interpretation (e.g. role of private sector in adaptation; or the lack of tools for economic analysis of adaptation options).

Neither should readers interpret the geographic areas we have identified as providing an overarching or primary criterion for sorting research issues and knowledge gaps. The point is not that the most important research issues occur only in such areas, but that the identification of contexts of high vulnerability provided a way to articulate from field experience the research issues that would be important to poor and vulnerable people. The important analysis was of the research issues and knowledge gaps, not of the "hotspots", which are only loosely defined as a means to help frame the issues.

For these reasons, the final report has used a somewhat different terminology from the initial draft. In general, we refer to "areas of high vulnerability" where key issues related to adaptation to climate change appear particularly evident and researchable. A very few areas have, however, been identified as qualifying for the more emotive "hotspot" designation. These are areas where: (1) multiple considerations make large-scale impacts from climate change highly likely; (2) multiple factors contribute to vulnerability and appear likely to limit the ability of local populations to adapt to the specific impacts anticipated as a consequence of climate change; and (3) vulnerable populations are large. Even where this designation is used, however, it is important to recognize that the "hotspot" concept is not tightly defined and that many of the most important research issues are cross-cutting rather than geographically defined.

THE CONCEPTUAL FRAMEWORK

Adaptation is not "coping." In well-adapted systems people and the environment are "doing well" despite (or because of) changing conditions. This starting point in conjunction with a focus on vulnerable people in vulnerable places underlies our analysis of research gaps. In many ways, concepts of adaptation (whether in society or ecosystems) have their basis in early work on ecosystems and subsequent analysis by leading thinkers such as C. S. Holling and Lance Gundersen of the parallels within interlinked socio-ecological systems (Gunderson and Holling, 2002). Our conceptual framework owes a debt and draws heavily in ways that are often not explicitly cited here on their work and that of the many contributors to the Resilience Alliance.

What is adaptation? At its core *adaptation* is about the capacity to shift strategies as conditions change and to develop systems that are resilient and sufficiently flexible to respond to change. Vulnerable people are those whose lives and livelihood systems lack resilience and who are unable to shift strategies in ways that maintain their well-being as conditions change. This is closely related to the IPCC definition that defines vulnerability in terms of the degree to which systems are *susceptible to* and *unable to cope with* the adverse impacts of climate change. Our conceptual framework, however, explicitly recognizes the roles poverty, gender, ethnicity, health, access to social networks and other factors play in vulnerability and adaptive capacity. It is, as a result, closer to the Hyogo Framework view of vulnerability as a "set of conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of a community to the impact of hazards"[2]. This emphasizes how the many factors that contribute to social exclusion contribute to social vulnerability.

Adaptation occurs through both "planned" and "autonomous" mechanisms. Most work to date focuses on planned interventions by governments and other actions that are designed to address very specific, "known" climate impacts. "Autonomous" adaptation, in contrast, involves actions that individuals, households, and organization undertake on their own in response to the opportunities and constraints they face as a consequence of climatic change and other stresses. The capacity of populations to shift strategies, the foundation of autonomous adaptation, is within our conceptual framework, seen as heavily influenced by *access to* and *the resilience of*: (1) underlying infrastructure, knowledge, communication, economic and other systems; (2) relationships within those systems; and (3) assets, particularly convertible assets. Resilient and flexible systems for communication, banking, health, energy, water, transport and mobility enable people to take advantage of opportunities and respond to constraints. They represent the core "railway tracks" that enable strategy shifting. They also underpin the development of social networks and the generation and transfer of new knowledge. Access to such systems is, as a result, one of the foundations for adaptive capacity. Access is, however, not just a function of the systems *per se* but also how they are governed. Governance considerations determine whether or not local populations, particularly vulnerable groups such as women and the poor, are able to take advantage of the flexibility and opportunities to shift strategies that such systems can enable.

One final element is central to our conceptual framework. That is the need for social protection. As global development experience amply documents, even when substantial attention is paid to their governance, the poor, women and other vulnerable groups are

[2] The Hyogo Framework 2005-2015, adopted by the UN at the World Conference on Disasters in 2005

often unable to access or benefit from such systems. Although society as a whole may adapt residual vulnerability will remain high. Social protection systems (a term we use interchangeably with social security systems) represent, as a result, an essential "safety net."

Autonomous adaptation and the role underlying systems may play as enabling or constraining factors has received much less attention globally than planned interventions but, due to the highly variable and difficult to predict impacts of climate change, is we believe likely to be much more widespread than planned interventions.

Tangible Implications

The conceptual framework we have used for this gap analysis has very tangible implications in relation to questions of adaptation to climate change and the basic resources needed for survival and the maintenance of economic activities.

First, virtually all "adaptive" activities depend on access to resources such as energy, water and other services from productive ecosystems either directly or through social and institutional networks. As a result, in a very practical manner, the ability to adapt to climate change is directly related to systems for *energy* (and thus to approaches for mitigating GHG emissions), *water*, and *ecosystems* management.

Second, the strengthening of social and physical infrastructure systems is conceptually a key entry point enabling adaptation. Such systems can be seen as gateways that enable people to shift strategies within an ever-evolving institutional environment.

Third, the nature of institutions, organizations and networks represents a key factor enabling or constraining adaptation. Whether the proximate issue relates to disaster risk reduction, land use planning, migration network support or water management numerous practical points of entry for supporting CC-A exist. Conceptually, however, institutional issues are co-dependent on the functioning of the underlying systems.

Fourth, questions of access, and thus of governance, cross cut all of the above systems.

Fifth, social protection is essential. Systems that enable proactive and autonomous forms of adaptation are unlikely to be sufficient, particularly for vulnerable groups. The creation of safety nets is thus essential if poverty is to be addressed in conjunction with efforts to adapt to climate change.

Strategic & Tactical Considerations

In addition to the core conceptual framework used for framing our analysis of critical research, capacity building and experience gaps, our analysis has been informed by a variety of strategic and tactical considerations. None of these considerations has dominated but all have been considered in the identification of key research gaps. Most importantly, however, these considerations have been used to help tighten identification of research entry points. They have, in effect, served as a point of reference for prioritizing the myriad of potential research themes.

First, as IDRC and DFID have made clear in their guidance for the programme, *the links with poverty and social exclusion are a central consideration*. Both organizations focus on global poverty alleviation as a core element in their mandates. Many of the factors contributing to the ability of society to adapt to climate change at local and global levels will primarily be of benefit to wealthy populations and sections of society that already have preferential access to the benefits of development. Women, socially marginalized communities, children and economically disadvantaged groups are far less well positioned to benefit from many interventions intended to support adaptation. While we have not ignored the factors of benefit to all communities as they have emerged in our analysis, identifying key areas where research on climate adaptation could contribute to reductions in poverty and vulnerability has been a major strategic consideration.

Second, our analysis has explicitly considered the degree to which research, capacity building or new experiences could lead to *tangible* courses of action that are replicable at scale. Discussions with many key actors both over the course of this analysis and separately in many global and regional forums have highlighted severe frustrations with the highly abstract and poorly grounded nature of much global dialogue on strategies. Organizations often talk in grand terms about adaptation or related fields such as disaster risk reduction – but they rarely specify what that actually might involve in an applied sense. If research on adaptation is to inform major global investments, then it must move beyond buzz-words to tangibility. Furthermore, potential solutions to emerging problems – or at least the conceptual possibility of such solutions – must be evident. Many potential avenues for research on climate adaptation, while related to real "tangible" problems may not lead toward practical solutions. We have, as a result, placed a premium on points of entry that contribute to tangibility because, at least conceptually, they could lead to practical solutions.

Third, the manner in which research could potentially contribute to understanding the *economic basis of investments* in adaptation has been a consideration. Economic and financial considerations are a central factor guiding public and private sector investment patterns in virtually all walks of life. They have, however, emerged as particularly central point of concern in global debates over investments in climate adaptation. The global scientific community is, as documented by the recent IPCC report, increasingly clear regarding the likely impacts of climate change and the need for investing in adaptation. Finance ministries, multilateral organizations and global investment banks, the institutions that will ultimately control much of the investment, have economic considerations as their core mandate. Research, capacity and experience that can address this mandate is consequently of central strategic importance.

Fourth, the research that clarifies the *links between adaptation and mitigation* has been viewed as both conceptually and strategically important. As outlined in the conceptual framework, basic systems supplying energy, water and other basic resources are central to adaptation. As argued in a parallel review we are conducting on *desakota* systems and ecosystem services, economic diversification into non-farm livelihoods is a common autonomous strategy individuals, households and other entities are adopting as they adapt to climate change. Economic diversification, transport, communications systems all require energy inputs. Furthermore, many avenues for adaptation to climate specific impacts – whether pumping groundwater for irrigation in drought-affected areas or to power cooling systems as temperatures in urban cores rise – are highly energy intensive. As a result, the availability of energy and nature of the systems that supply it are of central importance on both conceptual and applied levels to adaptation. Clarifying this linkage is, in addition, of great strategic

importance. If mechanisms for adaptation to climate change drive increases in energy consumption, then the benefits from investment in mitigation may well be lost. Furthermore, where clear links between adaptation and mitigation can be demonstrated, it may be possible to tap many of the new investment mechanisms that are being developed to transform global energy systems in ways that benefit both adaptation and mitigation objectives.

Fifth, the degree to which research could *catalyze direct involvement of the private sector* was a major strategic consideration. Ultimately, adaptation will occur through the institutions and organizations that shape the structure of daily life. Many of these organizations are in the private, not the public, sector. Engaging the private sector requires strategies that respond to the rationale and incentive systems facing private sector actors. Research that reflects these rationales and incentives could, as a result, prove particularly strategic in catalyzing adaptation.

Sixth, the degree to which research in key areas could contribute to *North-South and inter-societal engagement* was a strategic consideration in our evaluation of research gaps. Adaptation to climate change will involve a broad array of challenges with many potentially divisive elements running across the spectrum from global to local levels. This may be particularly true given the large flows of finance that may form a central feature of the post 2012 architecture. Governing those flows in a civil manner will require shared understanding and the existence of solid relationships. As a result, engagement is essential both within and between societies. Research, capacity and experience gaps that are likely to encourage engagement have, in consequence, been seen as strategically attractive.

The Literature

Using the above conceptual framework and strategic considerations as a starting point, key knowledge gaps identified through the literature review. These are summarized in the table below.

TABLE: **Gaps in the literature**

1	Research on Autonomous adaptation processes and the factors enabling or constraining them represents a major gap in the literature.
2	More work is needed for bridging the gap between the climate adaptation and DRR communities. An increased focus on meso scale institutions, which is outside the purview of both communities, may help to break institutional resistance that prevents deeper interaction.
3	Existing literature does not adequately address the beneficial role migration and livelihood diversification may be able to play as central elements in autonomous or planned adaptation processes.
4	There is limited literature on the role of social networks in adaptive processes. In particular, understanding is needed on the impact of social networks on behaviour in community and institutions, the role of innovators within those networks (agents of change), and how information is accepted (or rejected) and applied.
5	Little work has been done on the role of meso-scale institutions in adapting to climate change and how those institutions could enable interaction across scales to influence policy.
6	Understanding thresholds of behavioural change, internally, externally and with the environment would improve our understanding of adaptive capacity thus allowing targeted efforts to build such capacity.

Historically, most work on climate adaptation has been done from a global and large-scale perspective. This is due to the nature of the field and its roots in the climate change community, the tools of that community (primarily climate models) and its physical sciences background. Because of this history most adaptation research has focused on centrally planned strategies, primarily engineered systems. Yet the impacts of anthropogenic climate change are likely to be highly uneven over relatively small scales, leading much adaptation to be autonomous.

Until recently the generally held concept of how adaptation to climate change should progress was one where large scale, engineering oriented projects like dams and dykes were planned for areas where climate models show that there would be negative impacts such as rainfall amount, temporal distribution, and intensity and sea level. The application of this "top-down" approach is likely due to the foundations of the study of climate change being based in the physical sciences and at the global scale. This approach is perpetuated by the limitations in the climate models used to project future impacts, the results of which

are far less robust at ever decreasing scale. Within this frame the concept of autonomous adaptation was seen as being a reactive process, ancillary to adaptation efforts or, as stated by Abramovitz et al. (2002:10), as "essentially an unconscious process of system-wide coping". As a result, with notable exceptions (Few et al., 2006; Moench and Stapleton, 2007; Tacoli, 2007), autonomous adaptation has not been studied in the context of climate change. Research on autonomous adaptation processes and the factors enabling or constraining them thus represents a major gap in the literature.

Venturing beyond the climate community to the field of disaster risk reduction (DRR) one can find more work on the intersection of how people adapt autonomously to environmental change. In the DRR literature, due to the diffuse and varied nature of the hazard risk, autonomous adaptation is seen as a key response that is often undertaken proactively by individuals to improve their quality of life. Since similar processes are likely to occur in response to climate change, there is a good deal of potential synergy between the climate adaptation community and the disaster risk reduction (DRR) community. A major hurdle in uniting knowledge and technical expertise between the DRR, development and humanitarian, and climate change communities, however, is the lack of common language and understanding of each other's research methods. The climate change community has little conceptual and research experience with the social, political and economic dynamics that contribute significantly to vulnerability and is even less well equipped to offer tangible adaptation strategies. Likewise, the DRR, development and humanitarian communities lack understanding of physical climate processes and of climate model capabilities and limitations. Additionally, climate negotiators will be very unlikely to listen to arguments from outside the climate change framework of mechanisms and concepts with which they deal (Christoplos, 2008). As a result, a key gap in is the absence of substantive literature bridging the climate adaptation and DRR communities. More work is needed in bridging the gap between the climate adaptation and the DRR communities. An increased focus on meso scale institutions, which is outside the purview of both communities, may help to break institutional resistance that prevents deeper interaction.

Adaptive behaviour focuses on reducing hazard exposure both directly and through institutions such as insurance that are targeted at aspects of economic or social vulnerability. Some of the most common autonomous adaptation strategies taken by individuals to address these vulnerabilities are, however, migration and livelihood diversification. Yet there has been limited work on migration (Tackle, 2007) and livelihood diversification (Hun et al., 2003; Moench and Dixit, 2004; Smucker and Wisner, 2008) within the context of climate change. Understanding thresholds of human behaviour in the face of climate change, such as when a temporary migration becomes permanent or when livelihoods are transformed, should lead to improved projections of potential adaptive responses and the ability to plan the appropriate institutional response. Overall, existing literature does not adequately address the beneficial role migration and livelihood diversification may be able to play as central elements in autonomous or planned adaptation processes.

The role of social networks in adaptive processes represents another major gap in the literature. Existing literature on social networks demonstrates the strong role they can play in the diffusion of technologies and practices, in obtaining access to labour and other markets, in migration, and in social protection. Social network analysis dates to the 1960s largely within the fields of sociology and social psychology. With the further development of techniques in collaboration with mathematics statistics and computing led to its rapid development and application in economics and marketing (Coulon, 2005). The value and

limitations of social networks in adapting to change is illustrated by cases in Bangladesh and Africa. In Bangladesh, such networks played a key role in the diffusion of aquaculture technologies (ADB, 2007). In Africa, however, the effectiveness of social networks as a mechanism for adaptation was limited by the nature and position of the individuals involved (Ziervogel et al., 2006). How such factors affect the effectiveness of social networks in enabling or constraining adaptation is poorly discussed in the literature. As a result, further research on role of social networks, agents of innovation and acceptance of new ideas by a community within the context of autonomous adaptation to environmental change would likely produce results that could greatly improve acceptance of new ideas and thus shorten adaptive response time. In particular, understanding is needed on the impact of social networks on behaviour in community and institutions, the role of innovators within those networks (agents of change), and how information is accepted (or rejected) and applied.

Although autonomous adaptation involves action taken at individual and household levels, such adaptation is constrained by institutional processes (Adger et al., 2005). The need for institutional support (from local to international) is recognized within the context of discussions of autonomous adaptation. Institutions can play an essential role providing information and framing the issues associated with climate change. They also can act to support individuals and communities where attempts at autonomous adaptation fail. Because most autonomous adaptation will occur at a local level in response to local conditions, the role of meso-level institutions in enabling or constraining change at the local level is particularly important. Little work has, however, been done to understand the role that institutions, such as provincial and county governments, could play (Krishna, 2003; Christoplos, 2008). Work at the meso-scale could also play an important role toward improving interaction between the DRR and climate adaptation communities. The climate community tends to act at the national and international scale and DRR at the community and household scale. Overall, little work has been done on the role of meso-scale institutions in adapting to climate change and how those institutions could enable interaction across scales to influence policy.

Finally, it is important to recognize that successful adaptation to climate change will be an emergent property of a complex system of interactions across multiple scales and between multiple agents (Burch and Robinson, 2007; Ruth and Coelho, 2007). Understanding thresholds of behavioural change, internally, externally and with the environment would improve our understanding of adaptive capacity thus allowing targeted efforts to build such capacity.

The Regions

Vulnerability to the impacts of climate change varies greatly across Asia. Using our definition of vulnerable people in vulnerable places, specific locations in South Asia, South East Asia, and China have been identified as having particularly high levels of vulnerability. *It is important to recognize that the "high vulnerability areas" discussed below were used to identify research issues and are not, in themselves central to the analysis. Instead, as emphasized in the concluding section on research gaps, most research issues are crosscutting: they apply in many regions in addition to the specific high vulnerability areas identified.*

South Asia

Précis

The South Asia region, which extends from Afghanistan through Bangladesh, is climatically and socially diverse and is characterized by poverty, conflicts and extreme, often unpredictable, climatic variability. While floods, droughts and high intensity storms are normal features of life the degree to which people have adapted to climate change varies tremendously across the region. This is in part due to the diversity of governance systems, levels of development, urbanization and social stratification but also due to impact of development activities on the hydrological systems that are at the core of livelihood strategies for millions of poor and vulnerable people.

Within several regions standout as highly vulnerable: (1) **the Eastern Ganga Basin** which covers India, Nepal and Bangladesh and has intense climate dynamics from glacial melt to flash floods and increasingly, drought (delayed

SUMMARY TABLE: **Areas of High Vulnerability**

AREAS OF HIGH VULNERABILITY THAT WERE USED TO IDENTIFY CRITICAL RESEARCH ISSUES
South Asia
1. The Eastern Ganga Basin: A nexus of flooding, drought, extreme storms, poverty and population
2. Major river deltas: A nexus of clear vulnerability to climate change, critical ecosystems and vulnerable populations
3. The arid zones in Pakistan, Afghanistan and western India
4. The Deccan Plateau
5. Coastal regions that are particularly affected by salinity and extreme storms
6. The Middle Hills of the Himalaya
7. The High Himalayan Region
South-East Asia
1. The Mekong Basin
2. Major river deltas
3. Coastal urban and peri-urban areas in central Vietnam, Indonesia and the Philippines
4. Rural coastal and upland areas in the Philippines and north-central Vietnam
China
1. The arid and semi-arid northwest of China
2. The Karst Uplands
3. The Tibet-Qinghai plateau
4. Peri-urban coastal zones

monsoon rain); (2) **the densely populated major river deltas** which are characterized by flooding, sea level rise, saline ingression and degradation of wetlands; (3) **Semi-arid Southwest Asia** from the south-western provinces of Afghanistan and Pakistan to central India which faces severe water scarcity; (4) **The Deccan Plateau** where rain-fed agriculture is the mainstay of the population and current climate trends show a decrease in the crucial July rainfalls.; (5) **The Middle Hills of the Himalaya** where scientific information on climate change is particularly weak but populations have potentially very high levels of vulnerability; and (6) **The High Himalaya Region** where snowmelt plays a key role in summer water availability and groundwater recharge for much of South Asia.

Cross-cutting issues important to adaptation to climate change in South Asia include: water management; links between disaster risk reduction and climate change; health, particularly the spread of infectious diseases plus the "incubation" of new diseases (e.g. bird flu, chikungunya); migration and urbanization; effective governance; and how infrastructure and knowledge systems can shift in ways that enable adaptation.

Priority Research Themes in South Asia focus on:

- ***Water management***; Further research is needed on avenues for effective water management that can respond to high levels of uncertainty and variability in data-limited environments. The role of traditional and new institutions for water management under changing climatic conditions is particularly important as well.

- ***Migration***; A better understanding of the role migration and remittances play in enabling adaptation to climate change is of central importance since this is emerging as a common autonomous adaptation strategy.

- ***The role of financial mechanisms in spreading risks and enabling adaptation***; More research is needed to understand how new institutions for micro-credit and insurance can enable diversification, build climate resilience and spread risks in different cultural contexts.

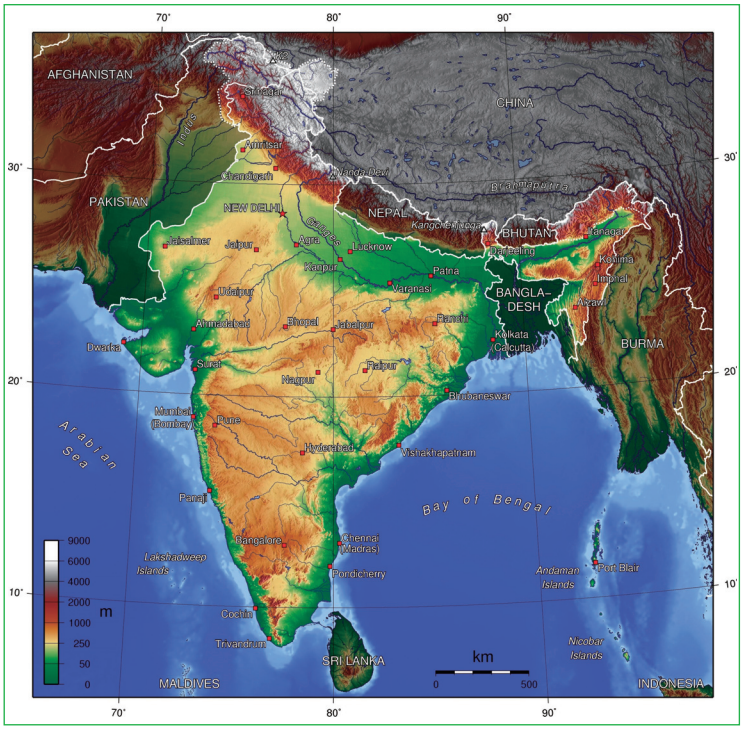
- ***Managing rangelands and enhancing livestock productivity***: Information is needed on what is the specific role of livestock as an asset and income source that buffers variability in other climate-sensitive livelihood activities and the degree to which livestock contribute to or undermine the resilience of livelihood and ecological systems in the context of climate change.

- ***Infrastructure and Knowledge Systems: Linking Adaptation-Mitigation:*** Research is needed in understanding how access to key infrastructure systems may increase resilience to climate change, particularly for marginalized groups. Additionally more could be learned of the degree to which improvements in energy, communication, transport, and other infrastructure systems can enable the growth of social networks, remittance flows and other institutions that enhance adaptive capacity.

Existing Approaches to Adaptation Research in the Region

The South Asia region, which includes countries from Afghanistan to Bhutan (see map), is characterized by poverty, conflicts and extreme, often unpredictable, climatic variability. While floods, droughts and high intensity storms are typically seen as *normal* features of life, the degree to which people have adapted to existing climatic conditions to say nothing

of ongoing change varies tremendously across the region. This variation is partly due to the diversity of governance systems and the different degrees of development, urbanization and social stratification which, in turn, determine access to adaptive mechanisms (technology, knowledge, and resources). The variation is also a result of the widespread but differing changes in the hydrological systems which are at the core of livelihood strategies for millions of poor and vulnerable people in South Asia. Overlying this physical, agro-ecological and institutional diversity are the high security risks and conflicts which prevail across this region and pose a particular challenge for identifying key strategic entry points for research and capacity building on adaptation.



While there has been a gradual recognition that disaster risk reduction has to be framed in the context of climate variability (as opposed to the more conventional high impact, low frequency disasters such as earthquakes), there is little conceptual understanding of what climate adaptation means or the difference between coping and adaptation mechanisms. Where activities that are explicitly intended to support adaptation to climate change do exist, they are *ad hoc* and uncoordinated at different scales and levels, focusing on short-term disaster recovery (from extreme climate events) rather than on long-term climate resilient development. Most commonly attention is given to first order interventions[3] at the local level, neglecting the need to simultaneously create conditions that enable and support autonomous adaptation processes. Adaptation project activities in all areas generally concentrate on water and agriculture sectors, rather than considering equally important cross-cutting issues related to financial mechanisms, communication, health systems and operational or training capacities in areas that can contribute over the long term to climate adaptation.

In addition to the sectoral focus of most adaptation activities in this region there is an overriding emphasis on scientific climate models and technical, predictive scenario building rather than on finding innovative and informative ways to bring scientific information (such as reliable information on monsoons to farmers or early warning systems) to the people who are going to be most affected. In practice, adaptation is generally seen as a technical, instrumental and linear process, something to be 'administered' to vulnerable people, rather than an opportunity for strengthening cross-cultural learning or providing institutional support, such as access to markets, to community-based or other autonomous adaptation processes.

[3] First order interventions are those that address the projected direct impacts of climate change at local levels. This might, for example, involve measures to protect local agricultural production systems from the impact of climate change as opposed to preparing for second order impacts on food prices emerging due to the impact of climate change on global agricultural production.

To the extent that strategies for adaptation are emerging, planned adaptation measures largely focus on climate-proofing infrastructure, such as flood defence and drainage systems, reservoirs, wells and irrigation channels. These are critical, but adaptation is about far more than infrastructure. Indeed, infrastructure can only enable people to manage risks and limit vulnerability – it does not provide immunity from the vagaries of climate. Successful adaptation as it relates to infrastructure is not only about *where* it is built and how it is designed, but about *who* controls it and *who* has access to the benefits.

Adaptation strategies also need to address risk management capabilities, particularly of the poor and vulnerable. At present, planned social protection measures are limited in their design and outreach: credit/insurance schemes for farmers typically do not consider rural women as they rarely own land in their name, nor do they cover small and marginal farmers or the landless; they overlook culturally embedded, informal institutional practices (access to credit in Afghanistan and Pakistan, for example, is rooted in the moral obligations of Islam) and often end up creating opportunities for rent-seeking.

Specific Issues Raised in the Consultations

Consultations in South Asia revealed that most development organizations have little knowledge regarding both the impacts of climate change and the factors likely to support effective adaptation. As a result, capacity at all levels (from the implementation and management of programmes to the restructuring of institutions in the face of climate change) needs to be enhanced. Many of the participants in consultations pointed out that there is a big gap in understanding the social context underlying adaptation. There has been too much focus in the recent past on technical aspects and the physics of climate change rather than understanding how society is organized and how different groups respond to climate-induced disasters or other changes. The participatory planning approach which builds on local knowledge, indigenous practices and gender equity is important in this respect.

Discussions in the consultations emphasized the need to link various programmes on poverty/vulnerability reduction and disaster risk reduction with adaptation related initiatives. This was seen as important for a combination of substantive and political reasons: unless adaptation contributes to development, there will be little political support for adaptation initiatives and investments. The importance of working towards the development of an integrated national plan was also expressed. At present there are multiple sector specific plans led by different actors often with overlapping (in some cases contradictory) agendas and working with the same constituencies but with little knowledge of each other or coordination during implementation. Groups participating in the consultations emphasized that there is critical need to mainstream climate policy into development policy and planning. The role of agencies like the Planning Commission in India was highlighted as important in this regard.

Participants in several of the consultations emphasized that since many of the impacts of climate change will occur at local levels, local governments will play a crucial role in implementing programmes for adaptation to climate change. Regional (district) and local level institutions do not, however, currently have the power, resources or decision-making authority to implement adaptive measures. As a result, capacity building is urgently required. One approach for this that emerged in several consultations would be to establish climate cells at the district level. Developing local level leadership is also important if micro-level realities are to be captured and considered during policy-making. There is, however, a major disconnect between actors working at policy-making and at local levels. Creating incentives

for institutions to bridge this divide is a major challenge but essential in order to enable effective adaptation.

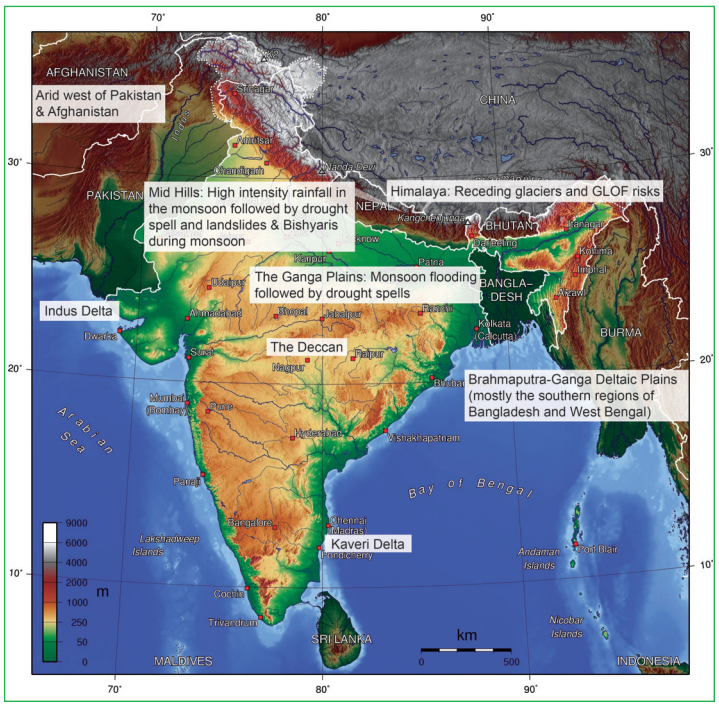
Gaps related to climate information management, communications and advocacy emerged in most of the consultations. The need to develop creative strategies for communication with different sets of audiences in languages they can understand was regularly emphasized. This applied both to the communication of scientific information to local populations and the communication of local knowledge upward. The importance of mechanisms for maintaining dialogue among researchers, policy-makers and the public was also expressed. Related to this, there was considerable discussion around modelling and data collection and the need for results from this to be made available, particularly to researchers. Reconciliation of different modelling output remains a challenge given the substantial differences between results from separate modelling activities. Data availability and access continues to remain an issue and was highlighted.

The need for empirical research which can predict the impact of climate change on food and water security (agriculture, water supplies) was emphasized. It was recognized that gaps in relevant data are a reality but need to be addressed through an iterative process in which data can be sequentially refined. Homogenization of the available data and identification of hydrological and other outliers are other key issues that emerged in most consultations. Participants at the Kathmandu regional consultation cautioned that the hotspots highlighted should focus not only on vital ecosystems and the physical impacts of climate change, but also consider the human and social dimensions.

The Sri Lanka consultation highlighted the fact that it was crucial to recognize the exact impact of climate change on coastal areas. Vulnerability mapping should focus on sea level rise and saline ingress for the entire coastal region of the island, as well as on the many other low-lying coastal zones and deltaic areas in South Asia. The need to focus on understanding the impacts of climate change in the health sector, particularly the growing number of vector-related disease outbreaks, was also highlighted in several consultations.

Individuals involved in the Pakistan consultation in particular, but also in other consultations felt that the role of the private sector needs to be viewed in the context of general investment in the country. Where general investment opportunities are large, the private sector is likely to play a greater role supporting adaptation (through, for example, economic diversification as well as investment in climate related businesses *per se*) than when such general investment opportunities are minimal. At the same time, the growth of the private sector may increase competition over access to basic resources such as water, thus exacerbating the impact of climate change on the poor and other vulnerable groups. As a result, the role of the private sector in different contexts requires critical evaluation. The importance of micro-insurance and loan mechanisms (micro-credit) in the context of climate change were also discussed. Micro-credit was noted as of potentially great importance as a mechanism enabling local populations to access the capital required to shift out of climate sensitive livelihoods.

Where vulnerable areas are concerned, participants in the consultations highlighted the Eastern Ganga Basin and other deltaic areas as combining specific climate impacts with large populations of poor and vulnerable people. Other areas of particular vulnerability including arid and semi-arid areas, coastal regions, high mountain areas and middle hills in the Eastern Ganga Basin were also widely discussed.



Our Analysis:

Areas of High Vulnerability

Based on our initial regional consultations in Sri Lanka and Nepal, one-on-one interviews in Bangladesh, India and Sri Lanka, small group discussions in Nepal and Pakistan, a review of secondary literature and ISET's extensive experience in South Asia, two critical hotspots that stand out as a consequence of multiple factors including the presence of specific impacts from climate change and high vulnerable population densities have been identified: (i) the Eastern Ganga Basin which covers India, Nepal and Bangladesh and has especially pronounced climate dynamics from glacial melt to flash floods and, increasingly, drought due to delayed onset of the monsoon; and (ii) densely populated major river deltas such as those of the Indus, Ganga-Brahmaputra and Cauvery rivers which are characterized by flooding, sea level rise, saline ingression and degradation of wetlands, all of which affect livelihood security. Critical issues within these hotspots are inherently linked to dynamics within the larger basins of which they are a part and, as in the case of the Eastern Ganga Basin and the Ganga-Brahmaputra delta, are part of the same system and could be seen as one large area of high vulnerability. In addition to the above hotspots, the second round of regional consultations in Pakistan and Nepal provided an opportunity to revisit a larger array of potential hotspots that were identified during the first phase of the consultations. As a result, the following have also been identified as areas of high vulnerability:

- Semi-arid southwest Asia, including southwestern provinces of Afghanistan and Pakistan and parts of the western states of Rajasthan and Gujarat in India.
- The Deccan Plateau
- The Middle Hills of the Himalaya
- The High Himalaya Region

These areas are indicated on the accompanying map and discussed in further detail below.

The Impoverished Arc of the Eastern Ganga Basin – A hotspot

The Eastern Ganga Basin stretches across Nepal, India and Bangladesh. In India, the basin includes the states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal. The region is one of the most politically and ecologically diverse in the world (Table 1). It is also one of the poorest. Indicators of basic economic development and access to key services lag far behind those in other regions (Table 2).

In addition to high levels of poverty, the region is likely to be stressed by a complex range of impacts as climate change proceeds. These include declining snow cover and glacial retreat, potential increases in overall precipitation, higher variability and potentially more intense extreme events, rises in sea level and changes in temperature. In combination with existing social vulnerabilities, these factors will reshape hydrologic and ecosystem dynamics in the

TABLE 1: **Matrix to indicate the diversity of political and hydro-ecological factors in the Eastern Ganga Basin**

Geographical Region	Country	Political/Administrative Unit	Hydro-ecology
Western Plain	India	Punjab, Haryana, Himanchal Pradesh, Uttarakhand and Delhi	Less rainfall, deeper groundwater, lower sediment load in rivers
		Rajasthan	Dry
Central Plain	India	Uttar Pradesh	Medium rainfall
Eastern Plain	India Nepal Bangladesh	Bihar	High Rainfall punctuated with intense rainfall events (cloudbursts), high groundwater table, high sediment load
Northern Mountains	India	Uttarakhand and Himanchal Pradesh	Lower rainfall, rapid changes in snow cover and snow melt
	Nepal		Diverse rainfall, including areas with intense rainfall events (cloudbursts), flash flooding, high sediment loads, rapid changes in snow cover and snow melt
	China		Rain shadow
Southern Region	India	Jharkhand	Low rainfall
Coastal Region	India	West Bengal	High rainfall, both high and low groundwater tables, water logging, storm surges combined with flooding, salinization/salt water intrusion
	Bangladesh		

TABLE 2: **Basic Development Indicators**

Country	State	Population Million	Population (%) without access to			
			Latrines	Electricity for lighting	Banking Services	Improved drinking water
India*	Punjab	26.6	43.2	8.1	51.5	2.4
	Himanchal	6.6	66.6	5.2	40.5	11.4
	Delhi	17.1	22.0	7.1	49.0	2.8
	Rajasthan	64.6	71.0	45.3	71.1	31.7
	Uttar Pradesh	190.9	68.6	68.1	55.9	12.2
	Bihar	93.8	80.8	89.7	78.7	13.4
	Jharkhand	30.0	80.3	75.7	69.9	57.3
	Uttarakhand	9.5	54.8	39.7	40.2	13.3
	West Bengal	87.9	56.3	62.5	63.2	11.5
	Above nine states**	**527.0**	**66.6**	**62.4**	**62.9**	**16.5**
Nepal		**25.0**	**60 .0**	**60.0**	**40.0**	**18.0**
Bangladesh		**41.0**	**85.7**	**68.8**	**75.0**	**3.3**

* *Based on Census of India 2001* ** *These are computed values* *Population in India's Ganga Basin 440 million*

basin in ways that substantially increase the vulnerability of populations residing there and will compound the already high levels of exposure to floods, extreme storms, drought, landslides and other natural hazards across virtually all parts of the basin. Despite decades of investment in structural flood control, irrigation and other measures to mitigate the impact of extreme events, the frequency and intensity of such events is widely recognized as a major factor contributing to endemic poverty in the region: the loss of livelihoods, an increasing mortality, morbidity and outbreaks of disease, invasive species and loss of ecosystem and biodiversity. Impacts are particularly high on poor rural populations that depend primarily on poorly diversified agricultural systems for their livelihoods. The limitations inherent in depending on climate vulnerable livelihoods, particularly agriculture

are intertwined with prevailing social and economic conditions of exclusion and gender differentials to push large sections of the population further into marginalization, endemic poverty and debt traps.

Overall, given the combination of geographic, hydro-ecological, economic, demographic and social conditions, the Eastern Ganga Basin is a hotspot of concern in relation to both poverty and the impacts of climate change. Even without climate change the challenge of bridging the development deficit in this region is daunting; climate change is likely to compound this challenge. Equally important, the impacts of climate change on poverty in the Eastern Ganga Basin will not be limited to the region alone but will threaten development, undermine poverty alleviation efforts and lower human security across South Asia. In the absence of opportunities for local livelihood diversification, those unable to cope with the loss of their livelihoods are forced to migrate to urban and peri-urban centres. This results in the rapid growth of shanty settlements in already densely populated urban and metropolitan areas, compelling migrants to live in even more vulnerable conditions. The rate of expansion of such settlements currently outpaces the growth in facilities and infrastructure to support and sustain them.

Critical issues facing the development of effective strategies for responding to climate change in the Eastern Ganga Basin relate to both the direct challenges associated with a more dynamic hydrological system as well as economic diversification beyond agricultural livelihoods for particularly vulnerable populations. Where the hydrologic dynamics are concerned, conventional engineering designs may face major limitations in the context of increased variability, higher sediment loads and greater unpredictability of flow and extreme event probabilities. Strategies that mitigate floods and droughts by enhancing drainage and storage within the natural components of the system, particularly wetlands, groundwater and forest systems, may prove more resilient and represent a strategic point of entry for research. Such approaches could also support the expansion of fisheries, aquaculture and the production of diverse ecosystems services that are of particular importance to the rural poor. They could also help to mitigate the impacts of climate change on water quality by providing a degree of natural capacity to filter water as pollutant loads increase. At present, communities respond to floods and droughts by developing protective measures such as raising villages and housing designs that provide points of refuge in the case of floods, or by developing secure water sources to mitigate droughts. Approaches that build off these practices also represent a strategic point of entry for adaptation research.

Where diversification and social flexibility are concerned, prior research in the Eastern Ganga Basin (Moench and Dixit, 2003) indicates that local populations adapt to floods and droughts through migration, economic diversification and the development of communication and remittance systems that support early warning and recovery. As a result, understanding the underlying enabling systems on which non-agricultural livelihoods (and, for that matter, agricultural intensification) and other sources of social flexibility depend, represents another strategic point of entry for supporting both autonomous adaptation to climate change and poverty alleviation.

Economic diversification depends heavily on the availability of energy, transportation, health, communication and financial systems. It also depends on institutional and knowledge systems (such as access to diverse local and global languages) that enable or serve as gateways to economic diversification and wider livelihood opportunities. As a result, for this basin, research on such systems could represent an additional critical point of entry for enabling

autonomous adaptation and for addressing poverty. Tangible courses of action could emerge from conducting research related to the development and design of institutions and infrastructure.

Densely Populated Major River Deltas – A Hotspot

The major river deltas in South Asia including the Ganga-Brahmaputra, Indus, Krishna, Cauvery, and Mahanadi deltas are hotspots where the impacts of climate change on vulnerable populations are likely to be particularly intense for a combination of biophysical and social reasons. These deltaic areas are characterized by:

High levels of physical exposure to extreme storms, flooding from upstream sources and inundation as sea level rises: Deltaic areas have large areas near sea level where river channels meander and large areas are subject to frequent inundation both from upstream sources and the ocean. As a result, they are particularly vulnerable to the impacts of sea level rise, cyclones and flooding. They are also vulnerable to the indirect impacts of actions taken upstream to respond to climate change. The construction of dams or embankments to reduce climate-change induced flooding in upstream areas will, for example, have major consequences for downstream deltaic areas.

Sensitive ecosystems: Deltaic wetland and estuarine ecosystems often have high levels of biodiversity where productivity and ecosystem function depend on a delicate balance between saline, brackish and freshwater sources. They are also highly dependent on sediment load characteristics – which are likely to be disrupted both by climate change *per se* and by upstream interventions to mitigate such impacts. Overall, climate change has a considerable potential to disrupt such systems. Inundation of low-lying lands with saline water during extreme events can, for example, damage the productivity of rice-growing regions for decades.

Large and particularly vulnerable populations in both rural and urban areas: Deltaic regions in South Asia tend, for a variety of reasons, to be among the most densely settled locations in the world. They are also among the most intensively cropped areas. Rural populations residing in delta areas are generally poor, often lack access to basic facilities such as communications systems and storm shelters, and are engaged in climate sensitive livelihoods such as agriculture and fishing. These deltaic regions also contain large urban centres such as Dhaka, Calcutta and Karachi. Poor populations in these centres often settle in low-lying areas that are particularly vulnerable to flooding and storms and where land is inexpensive or has not previously been settled. In Pakistan it is estimated that at least 92% of the urban population lives in these low-lying coastal zones which are at risk (Greenpeace, 2008). Massive industrialization and urbanization in Karachi (the Indus delta) along with land reclamation from the sea to develop it into a mega-city and mega-port have not taken into account flooding risks as a result of anticipated sea level rise (Ali, 2006).

Human induced exposure to hazards and maladapted land uses: Particularly in urban settlements, initially low-lying areas have often subsided further (often below sea level) due to a combination of groundwater extraction from beneath the city, reductions in sediment deposition associated with flood control structures and soil oxidation as former wetland areas dry out. In addition to this, large areas of mangrove have generally been cleared for shrimp farming and other purposes. As a result, when urban flood and storm defences are breached, flooding is much more severe. Similar impacts occur in rural areas where flood drainage is often blocked by roads, railways and other lineaments. Such structures have a

particular impact on drainage in deltaic areas because of the low gradient. Disruption of low flows can also have major impacts. In the low-lying and tsunami impacted districts of Cuddalore and Naggappattinam in coastal Tamil Nadu, for example, recurrent seawater flooding during dry months has been increasing in the last two decades due to upstream irrigation development on a massive scale. Such impacts are likely to be exacerbated by increases in flow variability or upstream demand for water as a consequence of climate change.

Semi-Arid Southwest Asia: Water Scarcity, Drought and Conflict

The semi-arid region of southwest Asia, which includes Afghanistan, the Sindh and Baluchistan provinces of Pakistan and parts of the western Indian states of Rajasthan and Gujarat, has a high vulnerability to climate change. On one hand the area faces severe water scarcity and recurring drought with negative impacts on agriculture, livestock, energy, livelihoods and the environment. It is also a region characterized by intense social conflicts with global implications. The last major drought of 1999-2002, for example, affected more than 100 million people in the region (IWMI, 2005: 1). The impact of that drought was substantially increased by 'chronic conflict' (particularly in Afghanistan and Pakistan). Possibilities for building resilience have also been constrained since any 'surplus reserves' are liable to be looted by local militias. In addition, there are limited opportunities for livelihood diversification. Much rural development in Afghanistan is still led by the controversial provincial reconstruction teams, while foreign aid continues to pour in, largely in the name of humanitarian assistance and the 'war on terror'. Although poppy cultivation has been banned, and prolonged drought is ending in many areas, some two million refugees have begun to return, and the pressure on national and donor development agencies to address questions of food security and access to shelter, healthcare, water, education, and income opportunities are considerable.

Both Afghanistan and Pakistan have low human development indicators, including high infant and maternal mortality rates, low adult literacy rates and limited access to potable water and improved sanitation, particularly in rural areas. In addition, gender disparities are high with women's access to and control over resources and their participation in the public domain (decision-making) being constrained by poverty, ongoing conflicts and the socio-cultural context of Islam (the practice of *purdah* and limited mobility among women).

Livelihoods in this region depend on a combination of agriculture, non-farm activities like weaving carpets, livestock and animal husbandry, fisheries in the coastal parts of Sindh and Baluchistan and migration, both to urban areas like Kabul and Karachi and across national borders to Iran. Although canal-irrigated crop production has played a dominant role in the agricultural economy of southwest Pakistan, the poor here, that is small and marginal farmers like those in Afghanistan depend on rain fed agriculture, drawing water from covered springs with a network of underground tunnels and canals (*kareez*), shallow wells or localized runoff. Better-off farmers have access to tube wells, but with each dry spell, resources to dig wells deeper are diminishing (Bhattarcharyya et al., 2004). Traditional systems of collecting snow (*cha*) in underground storage tanks which used to provide water for families as well as for sale during the summer are not as actively used or promoted in Afghanistan as they used to be, and village level institutions like *shuras* (village councils), water *waqils* (water judges) and *mirabs* (water distributors) are not meeting the expectations of farmers to manage scarce water resources efficiently and equitably. Nor do they provide space for the negotiation of water rights or the participation of women and other marginalized groups such as pastoralists.

While knowledge about adaptation in the region is limited, there is rich and insightful documentation, particularly from Afghanistan (the Afghanistan Rural Evaluation Unit, for example), on people's coping strategies built around social networks embedded in culture and faith. For example, access to informal credit, mostly for consumption purposes, is seen as an entitlement, and most households in Afghanistan both give and receive credit ranging from small loans at flexible interest rates to the giving of survival alms to the poorest and most vulnerable including the physically challenged. Although such informal systems have increasingly come under stress, the introduction of a more formal micro-credit system as part of the State's approach to livelihood and economic growth is viewed with scepticism by many (Klijn and Pain, 2007). Experience from India and Bangladesh also suggests that unless access to micro-credit, which is typically mobilized through (women's) self-help groups, is facilitated by pro-poor, inclusive and gender sensitive organizations, the poorest are unlikely to benefit. In fact, their debt burdens can increase (through multiple loans, limited opportunities to manage risk and invest in productive activities, and inability to repay if money is spent on alcohol or for consumption only), pushing them further into a downward spiral of impoverishment.

Livestock are critical to the rural economy of this region: During periods of drought and scarcity they are invaluable assets for sale or exchange, but increasing pressure on rangelands for pasture, cropping systems for fodder and water resources, in the absence of institutional arrangements, is making it difficult for livestock owners to manage their stock. Unlike India, where farmers allow pastoral nomads access to fallow fields for livestock during the winter months in return for manure (one of the few examples of such symbiotic relationships), ethnic conflicts in Baluchistan and the Afghan war have made many transhumance routes dangerous due to the presence of land mines in that region.

The Deccan Plateau

The Deccan Plateau, also known as the peninsular plateau, represents another area of high vulnerability. This plateau lies south of the Indo-Ganga plain between three mountain ranges – the Western Ghats, the Eastern Ghats and, in the north, the Satpura and Vindhya Ranges. It has an elevation ranging from 100 metres in the north to 1000 metres in the south. The climate of the region varies from sub-tropical in the extreme north to tropical in most of the region and has distinct wet and dry seasons. The monsoon season runs from about June to October. March to June can be very dry and hot with temperatures exceeding 40°C regularly. The region is home to some of India's major river systems, including the Godavari, Krishna and Kaveri. These depend on the rains and tend to dry up in the summer months, resulting in inter and intra-state conflict over water.

Although it is predicted that India will receive more rain in the coming years (Defra, 2005), states such as Andhra Pradesh have typically been receiving less than the national average: "Though the average rainfall over the last 100 years appears to be stable or increasing, rainfall in the crucial month of July has been declining," (Hill, 2002 cited in Reddy *et al*., 2004:54). Erratic rainfall and highly variable distribution add to the uncertainty in a region where agriculture is largely rain fed.

Though agriculture in the region is largely rain fed, it has been overlooked by government policies that focused on Green Revolution led irrigated agriculture with its high chemical inputs and heavy mechanization. Since the advent of structural reforms in India, there has been a considerable shift towards cash crops like the controversial BT cotton (India is the third largest grower of BT cotton in the world) and other food crops like groundnut for

export or agro-processing. Consequently, there has been a decline in the production of traditional food grains like millet, sorghum and barley, which are the mainstay of local diets and cultural systems. Without access to water harvesting and irrigation systems, alternative drought-resistant crops, or social safety nets such as crop insurance, small and marginal farmers have suffered from the increasing vagaries of climate and neo-liberal economic policies (TERI, 2003). Not surprisingly, there have been a spate of farmer suicides in the region, particularly in Andhra Pradesh, and, as a result of growing debt burdens, many farmers, including large farmers, have been forced to migrate.

The Deccan Plateau is the largest eco-region in India and is rich in biodiversity. It contains about 20% of the country's natural habitat of dry deciduous forests and a significant proportion of teak trees. Population pressure and the growing dependence of tribal and pastoral communities on declining forest resources have led to an increase in cases of human-wildlife conflicts (Reddy *et al*., n.d.). Although there are several successful examples of government- and NGO-led community joint forest management and agro-forestry initiatives, policy, institutional and capacity gaps in managing and conserving biodiversity while providing employment opportunities for local communities remain.

The Deccan Development Society has been working with more than 5,000 small and marginal farmers, primarily women, in drought-prone districts of Andhra Pradesh to enhance their food and livelihood security through a range of interventions including natural resources management and the setting up of community grain and seed banks (see: www.ddsindia.com). Today the organization is experimenting with community radio and video, empowering poor women to share their experiences and learning from and with others, both in the region and beyond, breaking social boundaries restricting mobility and access to technology as well as providing a communication platform for strengthening climate and disaster resilience.

The Andhra Pradesh Rural Livelihoods Project which was funded by DFID ran from 1999 to 2007 focusing on pro-poor watershed development as an approach towards developing sustainable rural livelihoods in five drought-prone districts. One of the key lessons of this project was its focus on people rather than on resources as is the case in the approach to most watershed programmes in the country. Beginning with people and their livelihoods necessitates looking at risk, whether due to climate or political instability, and seeing how it is likely to shape outcomes.

In sum, while the Deccan Plateau has a large population of poor farmers that will be heavily affected by climate change if variability and drought increase, as is the case in the arid zone regions, the primary uncertainty here is the degree to which climate change itself is likely to compound existing patterns of vulnerability.

High Himalaya Regions

The high Himalaya receives precipitation in the form of snow. Water is retained in the high slopes in the snow and ice "reservoir" and, as it melts, sustains the base flow of the rivers that originate in the region. Although populations in these regions are small and scattered, snow and ice melt provide a critical source of base flow for the regional rivers. South Asia's major rivers that originate in the Himalaya are the Indus and its tributaries, the Yamuna and the Ganga. The major tributaries of the Ganga that originate in the central Himalaya range of India and Nepal are the Mahakali, the Karnali, the Gandaki and the Kosi. These four rivers account for 75% of the flow of the Ganga River at Farakka (Pun, 2004). In December, the contribution is about 41% of the average flow. This increases to 122% of the average in

June. This regional hydrological system sustains the lives of the millions who live in the basin. Climate change will alter these dynamics and will have major implications for vulnerable populations at a regional level.

The Middle Hills of the Himalaya

Not all rivers in the East Ganga Basin originate in the Himalaya or are snow fed. Many also originate in the middle hills or the Chure Range. Swollen with rainfall, these rivers flood in the monsoon, threatening the millions living in the northern part of the basin.

The middle hills are home to substantial populations whose agricultural livelihoods are potentially highly vulnerable to climate change in ways that are currently poorly understood. The region contains many microclimates and ecological niches. Analysis shows trends of increasing temperatures in the higher elevations and the emergence of pests, diseases like the citrus bug and fungal problems that did not exist in the past. New invasive species of grass and shrubs have also appeared. It seems clear that these changes can be attributed to a changing temperature and humidity regime. In addition to such documented changes, other changes appear likely. Increases in the intensity of precipitation, for example, if they occur, could have major impacts on erosion and landslides while variability could increase both flood and droughts. These impacts threaten the economic base of those who rely on agriculture and horticulture as a source of livelihood.

Across the middle hills, people are gradually shifting away from farm-based to other types of livelihoods. Migration is now a major source of access to jobs with remittances forming a substantial part of the income base for those remaining. This phenomenon has catalyzed substantial changes within farm systems that may reduce their resilience to climate change. Livestock, for example, is kept to earn cash income rather than to produce manure as it had been in the traditional farming system. This may reduce the amount of organic material available in the soil, its water holding capacity and ultimately the resilience of the farming system to drought. In addition, traditional practices of nutrient recycling have been replaced by the application of chemical fertilizers whose supply is dependent on a volatile market. Climate change will add additional stresses that compound existing change processes. Anecdotally, such changes are already being observed. Changes in the rainfall patterns of the monsoon have, for example, affected local farming practices and changes in ecological properties and vegetation types of the middle hills and valleys have been observed. The present knowledge systems are unable to explain such changes or identify solutions to the impacts they have on livelihoods and ecosystems. Overall, the capacity to understand sensitive hill and valley ecosystems in the context of climate change needs to be strengthened.

Cross-Cutting Issues and Strategic Points of Entry for Research

Based on our consultations and interactions in South Asia, we have identified a number of cross-cutting issues which could serve as important entry points for research, practice and capacity building in the region. One issue is **water management**: This includes open basin approaches to flood control, the management of groundwater aquifers to serve as buffers; the implications of glacial melt for regional hydrology; the impact of glacial lakes outburst floods (GLOFs) in the Himalayan region; and management within open basins. Beyond water management there is a need for improved understanding of the impact of climate variability on **health**, particularly the spread of infectious and waterborne diseases (such as typhoid and hepatitis), vector diseases (such as malaria and Japanese encephalitis) plus the incubation of new diseases (such as bird flu and *chikungunya*) will be of major importance as climate change proceeds. In addition, the impacts of climate risks on **migration**, the growth

of small peri-urban towns and unplanned **urbanization** need to be better understood. The economic, social and institutional divide between urban and rural is becoming blurred. This is fundamentally changing the exposure of populations and the livelihoods on which they depend to climate risks. As a result, understanding such changes is of central importance for the development of policies, programmes or projects to support adaptation. Effective **governance** in terms of access to those systems that enable adaptation, including participation in decision-making at different levels, is also critical to adaptation and has particular relevance to the ability of poor and socially excluded populations to adapt.

Most adaptation in South Asia occurs through autonomous processes at the individual, household or community level. These processes are largely undocumented and often occur below the radar of government actors. Direct projects designed to promote adaptation (such as watershed management and drought proofing) focus primarily on community based strategies and have been heavily promoted by governments across the region, often with some support from NGOs and/or local government (e.g. the *panchayats* of India). These projects have provided useful insights about in-situ adaptation. However, limitations of community based methods are becoming evident as the ongoing processes of transformative change (globalization, modern communication, increasing participation in labour market and remittance flows, the feminization of agriculture in many regions and so on) have altered the nature of geographically defined and geographically dependent communities. Accompanying this is the decline of community based resource management institutions: people, activities and products are increasingly mobile and horizontal networks of support are giving way to more vertical linkages, based on relationships of power and patronage. At the same time, formal and informal, market based institutions for delivering water, energy, fuel and fodder are emerging, but they still lack the organizational mechanisms and commitment to engage in questions of equity and governance.

South Asia has a long tradition of participatory, action research on the one hand, and on the other, the region has the scientific and technical capacity for research on climate impacts and for cost benefit analyses of disaster risk reduction and adaptation interventions and alternatives, whether they are energy, biotechnology or communication systems. However, there is little cross-fertilization or shared learning between micro-analysis (typically case studies) and macro public policy processes, among professionals (academics and scientists) or disciplines (engineering, social scientists, and ecologists) and communities of practice. In a social context fraught with conflicts at different scales, the democratization of knowledge is as important as the democratization of decision-making.

In the following sections we present the research themes identified through our consultations, review of literature and analysis. Each thematic issue is followed by a few key questions that provide strategic points of entry for research in the region.

Water Allocation, Management and Governance in Conditions of Relative Scarcity and Abundance

At the heart of the discussions on livelihoods, vulnerability and adaptation to climate variability in both the hotspots and the areas of high vulnerability in South Asia is the question of water – too little, too much, to variable or of poor quality. Management of water under changing climatic conditions presents major challenges for approaches to the design of structures and institutions. Most approaches rely on statistical techniques using historical periods of record to project future conditions. This underlies everything from the design of engineering structures to water allocation agreements between regions. As climate change proceeds, approaches that are more resilient under uncertainty, require less information

and are able to respond flexibly will be essential. Open basin techniques, such as those described in the accompanying box, may represent one such avenue. The social, political and technical viability of such approaches remains, however, to be explored. In addition, major questions exist regarding the types of institutions that could prove effective within the regional context. While there is much to learn from the revival of traditional community water management systems in Rajasthan and Gujarat, Bihar and Nepal as well as more modern approaches to water management, the social and political contexts of Afghanistan and Pakistan require approaches that reflect the long history of regional conflict. Water issues are often points of tension within wider patterns of conflict and, at the same time, serve as a potential common ground for meeting and dialogue. As a result, water management issues need to be addressed within a wider regional dialogue framework that recognizes both points of commonality and tension. Beyond this, specific thematic issue areas within the wider topic of water management where research could make a critical difference to climate adaptation in both applied and policy contexts include:

Open Basin Approaches to Water Management

An "open basin" approach to water management focuses on expanding the natural storage capacity of wetlands and riparian areas to buffer flood flows. When used in conjunction with early warning systems and more limited structural measures to protect high value areas (such as ring dikes around cities and towns) it represents a highly resilient approach to water management in large river basins. This is in contrast to engineering approaches which place much greater emphasis on control structures. Open basin approaches are likely to be better adapted than control based approaches to the increasingly dynamic hydrologic regimes anticipated as a consequence of climate change. As climate change proceeds the historical period of record cannot be used to project future conditions making it impossible to generate the precise information on key hydrologic parameters (flow, flood stage, sediment load, etc.) necessary to design effective control structures. Overall, approaches to water management that do not require precise information on such parameters are required as a central response to climate change. Developing open basin approaches that are effective and also match the social, political and institutional context within basins represent a critical research and capacity challenge.

- Water management strategies that are resilient and able to flexibly moderate large fluctuations in water availability/flows represent a critical point of entry for both flood- and drought-affected areas.
- Production systems, such as inland and deltaic fisheries and aquaculture that could accompany such strategies also represent a strategic point of entry with particular relevance for the livelihoods of poor populations in rural and peri-urban areas.
- Water resilient crop varieties, intercropping, time and space management of crops, demand responsive water management (including drip irrigation, treadle pumps and volumetric metering) is also important but is already a major focus of investment by governments and possibly also by agribusiness.
- The viability of different institutional types for water management under rapidly changing climatic and social contexts including the presence of conflict.

Social and Institutional Mechanisms that Support Migrants

Migration, particularly of young able-bodied men is an important part of livelihood diversification strategies in South Asia. Movement ranges in scale from rural villages to small towns, provincial centres and big cities to long-distance migration across national boundaries. However, there are local differences. For example, the war in Afghanistan led to considerable internal displacement and Pakistan has hosted more than two million Afghani refugees. Nepal's decade-long insurgency has resulted in a large population of internally displaced people. Gender differences in migration are also significant: while women in parts of rural Rajasthan, Gujarat and the hills of Nepal manage land in the absence of their men-folk, particularly during periods of water scarcity, they have little access to resources because that access is linked to land tenure. In Nepal and Bangladesh poverty has compelled households to 'push' women and young girls into exploitative trafficking systems that take them to cities as far away as Kolkata, Delhi and Mumbai. Likewise, in the tribal belt of

western and central India years of drought throughout the 1980s and 90s have forced young, *adivasi* (tribal) women into the sex trade.

It is clear that climate-induced migration is going to increase (Greenpeace, 2008), putting pressure on the ability of already strained and resource-poor local municipalities, peri-urban centres and crowded metropolitan cities to manage basic services (including water, sanitation, solid waste management and shelter). In addition, livelihoods and social security for migrants are precarious since they lack land tenure, have irregular sources of income and cannot easily avail themselves of bank accounts or financial services. Thus, they are dependent on conventional sources of remitting money (such as via the post office or through middlemen) or simply carry it home themselves, putting them at the mercy of border security agencies. Specific thematic issue areas within the wider topic of migration where research could make a critical difference to climate adaptation in both applied and policy contexts include the following:

- There is a need to understand how climate variability has affected migration patterns, both in water-scarce and water-rich areas,
- Research on the extent to which remittances are used for productive investments either in climate proofing infrastructure (hand pumps, tube wells or flat roofs and raised, *pucca*/superior homes in flood prone areas) or setting up new small businesses.
- Although there are examples of emerging initiatives to support migrant labour which address the communication, insurance and social security needs of migrants (e.g. the migration facilitation centre which evolved from DFID's Western India Rain-fed Project and provides migrants with identity cards and information about employment opportunities), there has been little documentation of the learning from such initiatives or of their potential for upscaling or replication.

The Role of Financial Mechanisms for Adaptation and Risk Spreading

Adaptation to climate change often involves basic changes in livelihood systems or assets that require access to capital. Diversification into non-farm activities, migration, the purchase of livestock or the construction of climate resilient housing or other infrastructure: all these require access to capital. Across South Asia many communities and individuals depend on informal sources of capital to undertake such activities and lack of access combined with the high interest rates charged for credit in the informal sector is frequently a major factor limiting the capacity of people to take action. As a result, development of effective mechanisms for extending credit to vulnerable communities could be a major avenue enabling autonomous adaptation. The links between credit and autonomous adaptation have not, however, been explored.

The role of mechanisms for risk management is also important to explore. Given the increasing pressure on traditional risk sharing strategies (borrowing from family, friends, and social networks) and the exploitative nature of moneylenders, particularly during disasters, when the poor are especially vulnerable, access to financial institutions for micro-credit, insurance and financial services has been promoted, particularly in India and Bangladesh, through a variety of institutional mechanisms. These range from women's self help groups and their federations for group savings and micro-credit to banks for the poor (like Grameen and SEWA) to rural/urban cooperative banks and non-banking financial institutions (like Basix and Friends of Women World Banking, India) as well as emerging public and private sector risk transfer and micro-insurance schemes, which are often linked to social incentives (e.g. free education for poor girls). It should be noted that the effectiveness

of many of these interventions as poverty alleviation and livelihood security strategies has been questioned and there is a need to more systematically explore links between micro-finance (credit, insurance and financial services) and climate adaptation.

In the predominantly Islamic context of Pakistan and Afghanistan, and also within Muslim communities in other countries, socially and culturally embedded informal practices of alms giving, particularly to the poor and vulnerable, contrast with recent attempts to promote interest-based lending through formal institutional structures (Klijn and Pain, 2007). The IFAD-funded Dir Area Support Project in the northwest province of Pakistan promoted small micro-enterprise, including technical and managerial skills and credit to rural women within a predominantly conservative social context where women's mobility is restricted and where interest-based lending is not socially acceptable. The project made the lender an active risk-sharing partner in enterprises developed by women.[4] Specific thematic issue areas within the wider topic of credit and insurance where research could make a critical difference to climate adaptation in both applied and policy contexts include the following:

- Given that most micro-credit and insurance schemes rarely reach the 'poorest of the poor' (or the chronic poor), there is a need to better understand how micro-finance can be linked to social support systems that strengthen the adaptive capacity, livelihoods and disaster risk resilience rather than increase the risk and debt burden of the poor.
- There is an equal need to look at the efficacy of financial incentives that facilitate risk sharing and transfer, such as low-cost premiums and flexible repayment rates.

Managing Rangelands and Enhancing Livestock Productivity

Livestock play a critical role in many parts of South Asia as a key asset that buffers variability in income from agriculture and other climate-sensitive livelihood activities. As a result, research on livestock and the rangelands on which they depend represents a key area for supporting the ability to adapt to the increasing climatic variability anticipated as climate change processes proceed. The focus on livestock cannot, however, be effective as part of climate adaptation strategies unless the wider context is well understood.

Given the level of dependence on livestock assets in the drought prone region of southwest Asia and the declining availability and quality of pastures, there is a need to re-think how community based management of common pool resources may work in a context where social relations between sedentary populations (farmers) and pastoral groups are exacerbated by conflict. While there is much to learn from community watershed programmes in Rajasthan and Gujarat, resource allocation for technical solutions to soil and water conservation have not been matched by adequate attention to the property regimes that govern access to water and land. Understanding of how and to what extent soil-water depletion affects pastures in the hills is also limited. This relationship is important because if water conservation plays a significant role in biomass production, the ground will benefit: however, water conservation for this purpose has never been part of livestock development. The potential for cross-cultural learning exists in recent attempts to extend market access for dairy products to livestock owners in the semi-arid region of Kutch in northern Gujarat through small joint ventures between the National Dairy Development Board and women's federations promoted by NGOs like the Kutch Mahila Vikas Sangathan. In this region, which was devastated by the 2001 earthquake, milk has always been a means of exchange, but with access to cooling units, transport systems and veterinary services women are now able

[4] See: www.ruralpovertyportal.org/english/regions/asia/pak/voices/microcredit.htm

to earn important supplementary income to support their families. Specific thematic issue areas within the wider topic of rangelands and livestock where research could make a critical difference in both applied and policy contexts for climate adaptation include:

- The specific role of livestock as an asset and income source that buffers variability in other climate-sensitive livelihood activities (such as agriculture) within different agro-ecosystems across South Asia. This should include the specific role of livestock in the livelihoods of poor farmers in agro-pastoral (cereal/fodder) systems.
- The degree to which the manure produced by livestock or the effects they have on ecosystems through grazing actually contribute to or undermine the resilience of rangelands, agricultural areas and other ecosystems to the specific impacts anticipated as a consequence of climate change.
- The manner in which changing reciprocal relationships between migratory and settled land users (agriculturalists and others) enable or constrain the flexibility and resilience of pastoralist systems that are adapted to variable climate regimes.

Infrastructure and Knowledge Systems: Linking Adaptation-Mitigation

Research into the role of gateway infrastructure and knowledge systems in enabling autonomous adaptation and the links between the energy requirements of such systems and carbon mitigation is essential. Most avenues for economic diversification whether within agriculture or beyond into non-farm systems, require substantial energy input. This is also true for the transportation and communication systems that enable flexible access to labour and product markets, early warning systems and so on. As a result, there appear to be direct linkages between the development of adaptive capacity and the mitigation of greenhouse gas emissions. Access to secure (although not necessarily large) energy sources appears, among other factors of production, to be a key enabling input for climate adaptation. This also appears to be true for other gateway knowledge and institutional and physical infrastructure systems, particularly those enabling mobility, communications and health. Such systems appear to be critical for supporting the development of social networks and the creation of jobs, and the movement of goods, information, services, remittances and people in and out of areas vulnerable to climate stress. Specific thematic issue areas within the wider topic of infrastructure and knowledge systems where research could make a critical difference to climate adaptation in both applied and policy contexts include:

- Understanding how access to key infrastructure systems may enable the alleviation of relative poverty and increases the resilience to climate change of vulnerable populations, particularly women, the poor and socially marginalized groups.
- Understanding the degree to which improvements in low emission energy, communication, transport, and other infrastructure systems can enable the growth of social networks, remittance flows and other institutions in ways that can be demonstrated to enhance adaptive capacity (the ability to shift strategies) and increase social resilience while reducing greenhouse gas emissions.

Key Actors, Partners & Capacity Requirements

The nature of research leadership in South Asia varies tremendously given the diverse nature of states and state formation as well as state-civil society relations. While all countries in the region have ratified the United Nations Framework for the Convention on Climate Change and have become parties to the Convention in the past decade, countries such as India are seen as major leaders in negotiations on the Kyoto Protocol and in adopting clean development mechanism and other emission control/mitigation measures. India and Pakistan

have issued their First National Communication on Climate Change, while Bhutan and Bangladesh have developed their NAPA. India is now working on its Second National Communication and plans to announce its framework on adaptation and the proposed adaptation fund in the summer of 2008. Disaster risk management policies, programmes and institutional mechanisms ranging from national to district to community levels are in place in most countries, although the capacity of different countries to respond is highly skewed and the links between disaster risk reduction, vulnerability, adaptation and climate variability still need to move beyond policy-making and into practice. Given the political contexts and the underlying conflict in Afghanistan and Pakistan, research and practice on climate adaptation is largely driven by the state and a range of donor agencies in those countries as well as by a few well-funded, autonomous research institutes. In India, Bangladesh, Nepal and Sri Lanka there are numerous examples of community led natural resource management and development programmes. Though not designed as climate adaptation measures *per se* they are illustrative of the scale and potential of adaptive mechanisms in drought prone, flood prone, coastal, and mountain or upland areas. Key actors engaged in such programmes tend to include:

- Organizations involved in planning and policy development at the level of national governments such as the Planning Commission in India;
- Sectoral organizations that have substantial capacity for execution of activities at state and local levels (forest and irrigation departments, municipal authorities, etc…)
- Regional and local NGOs and civil society organizations. NGOs have played a major role across much of South Asia in catalyzing innovative approaches to resource management, community development, disaster risk reduction and so on. Such organizations, often also play a key role as the primary locus of interdisciplinary work that cuts across sectors. They also often link with academic and research organizations, thus becoming conduits for the generation and testing of new knowledge.

Actors such as the above are essential to involve in any research programme on adaptation to climate change. At present in most cases they are poorly linked and rarely interact. Some initiatives do exist such as the so called "Abu Dhabi" dialogue on the Ganga Basin that involves governments and the World Bank and localized collaborative research initiatives such as the one ISET-Nepal has been coordinating on climate adaptation in India and Nepal. Linking with and where necessary strengthening such initiatives could support the development of regional networks capable of in depth research, learning and catalyzing numerous location specific adaptation initiatives. In addition to capacity building for research *per se*, catalyzing adaptation in South Asia through a research programme will require substantial capacity building because:

- The link between information needs and the supply of research to meet those needs is weak.
- Limited funding is allocated for research.
- Catalyzing change requires a continuous flow of information, ideas and insights.
- Educational and capacity building institutions are fragmented and interaction among them is inadequate.
- The education system has too much inertia to respond rapidly as ongoing processes of climate change necessitate the timely generation and communication of new knowledge. At present, curricula are conventional and teaching materials insufficient.
- There is little appreciation at policy or other levels regarding the large-scale impacts climate change is likely to have on the region.

The needs for capacity building are dynamic and changing. Research must reflect the dynamic nature of local contexts and the organizations operating within them. As a result, support for capacity building must be dynamic and responsive as well. Local government, communities and NGOs are the main clients for capacity building, but central government and the private sector also need support to be able to respond to constraints that climate change is likely to impose. Community groups and local government actors need to improve their capacity to plan, organize and respond to the emerging challenges in their locality. Local governments play an increasingly important role in enabling both planned and autonomous adaptation at local levels.

South East Asia

Précis

The Southeast Asia region is politically, economically, and culturally diverse, yet faces common challenges in relation to climatic change and variability, poverty and inequity, rapid urbanization, degradation of resources and unsustainable development. Most work on adaptation focuses on national strategies yet change across the region is heavily influenced by the initiative of individuals, households, communities and businesses. Little research has, however, been done to examine adaptation from an actor-oriented perspective or to explore the factors that make people vulnerable to climate change in the first place and that constrain rather than enable their adaptive capacities.

Four high vulnerability areas that demonstrate the complexities facing climate adaptation in the region have been identified. Over 55 million people depend on the ***Mekong River Basin*** ecosystem for food and livelihood security and are vulnerable to the impacts of climate and other changes in river dynamics. ***Coastal deltas*** (such as the Mekong Delta) which contain many cities and key rice growing areas face changes in flows, storms, sea level rise, flooding and salt water inundation, affecting crop production, fisheries, and human health. Poor farmers, fishers and marginalized groups such as women are particularly vulnerable to the combined effects of change and social exclusion. Heavily populated ***urban and peri-urban areas in the western Philippines, eastern Vietnam, Indonesia and southern Thailand,*** are low-lying coastal zones whose settlements lack basic infrastructure and are extremely vulnerable to storms, flooding, and disease. Slums in low-lying/marginal areas, have limited social protection and little capacity to recover from storm and other climate impacts. Small farming and fishing families in ***marginal coastal and upland areas, such as the eastern coast of the Philippines and Vietnam,*** face increases in cyclones, floods and landslides, with a heavy toll on lives, shelter, crops and livelihoods. Families often rely on high interest rate informal credit sources and asset sales to manage losses. The agricultural and fishery systems on which these populations rely will be affected by climate change. Vulnerability is exacerbated by the lack of basic services, early warning systems, disaster management, capital assets, and skills for diversified livelihoods.

Key cross-cutting issues critical to adaptation include: autonomous strategies at individual and household levels; links between disaster risk reduction and climate adaptation; effective and equitable water management practices; livelihood diversification; and differential opportunities and access to resources. The high pace of **urbanization** in SEA has direct implications for adaptation. It facilitates livelihood diversification, but also catalyzes the growth of large slum populations often located in urban floodplains. **Governance**, and the disconnect between sectors and national and local level actors concerning climate change knowledge, information and adaptation planning is a critical issue.

Priority Research Themes:

Migration: Research is needed to: (i) Increase understanding of migration and remittances as adaptation strategies; (ii) Identify opportunities to strengthen underlying support systems such as transport, banking and social networks; (iii) Understand existing social norms, policies and labour market dynamics that mediate migration processes; and (iv) support access of the poorest migrant groups to financial, skills, knowledge and other assets.

Social security mechanisms: Formal and informal social security mechanisms, including credit and insurance, are essential to support adaptation. Research is required to: (i) understand the factors that differentiate access to such mechanisms; (ii) understand the role of informal social security institutions in adaptation; (iii) identify mechanisms, institutions and policies to strengthen accessibility of social security mechanisms to poor and marginal groups, including women.

Small-scale and subsistence fishers and upland farmers: Research is required to understand threats to the livelihood security and strengthen the adaptive capacity of small-scale fishers and farmers. This needs to include production systems; tenure security; access to scientific information on climate and weather; skills and education for livelihood transitions; and participation in adaptation planning and decision-making.

Strengthening resilience to health related impacts: Climate change will increase health risks from diarrhoeal, infectious diseases, heat stress, and food and nutritional insecurity, thus affecting the capacity of individuals and families to adapt. Research is required to identify potential direct and indirect impacts of climate change on human health on different gender and social groups and develop effective social, technological, institutional and policy measures to facilitate planning.

Governance of adaptation across scales: Research on governance of adaptation is required to: (i) identify institutional mechanisms to facilitate effective linkages horizontally between departments and vertically between local, meso and national levels; (ii) explore how intermediate level of governance may facilitate infrastructure, institutions and services that can enhance adaptation; and (iii) understand the constraints, opportunities, conditions and forces that affect the governance of transboundary resource management under climatic variability.

Existing Approaches to Adaptation Research in the Region

The Southeast Asia (SEA) region is widely diverse politically, economically, and culturally, yet faces common challenges of impacts of climatic change and variability, poverty and inequity, and increasing vulnerabilities arising from rapid urbanization, degradation of resources and unsustainable development. Largely tropical and monsoonal, the region consists of countries that are low lying and archipelagic (Indonesia, Philippines, Malaysia) and others that comprise a contiguous landmass sharing common borders and rivers such as the riparian countries of Thailand, Lao PDR, Cambodia, Vietnam, and Myanmar. While agriculture and fishing continue to be the mainstay of national economies and livelihoods, especially for the poor, the region also is experiencing rapid urbanization, industrialization and expanding commercial tourism that are strengthening economic development but stressing fragile natural resource systems and exacerbating social inequities. Climatic changes are expected to severely affect those most dependent on natural resources for their livelihoods, such as poor farming and fishing families, but also vulnerable populations living

in urban and peri-urban areas near coasts and deltas. The region is expected to experience increases in frequency and intensity of tropical cyclones, storm surges, sea level rise, and increased flooding, particularly in Vietnam, Philippines and Indonesia. Increased variability in rainfall patterns across the region, especially in the Mekong Region, is resulting in drought and disastrous floods, with serious implications on people's livelihoods and food security.

To date, attention to climate change research in Southeast Asia has focused on impacts to climate change and mitigation. Research on adaptive strategies and options has been emerging in recent years, and increased attention to develop national adaptation strategies has materialized in part due to UNFCCC commitments and the attention on adaptation at the recent COP 9 meetings in Bali. While all countries in the region have ratified the Convention, only Thailand, Indonesia, Vietnam and the Philippines have submitted their First National Communications, and these present plans and options for mitigating GHG emissions, with relatively less attention to adaptation measures. Cambodia and Lao PDR are the only governments that have submitted NAPAs (RCG, 2007; Government of Lao PDR, 2008) Thailand, Vietnam and Indonesia have national adaptation plans, which similar to the NAPAs, primarily focus on agricultural interventions, water and coastal resource management, infrastructure development, forecasting and surveillance, with some attention to forests and health. However, implementation of these plans has not yet begun. Governments such as the Philippines and Indonesia have recently developed inter-agency committees or task forces to tackle issues of climate change, including adaptations that promote integrated strategies.

Overall, the approach to adaptation has tended to be linear: first, identify expected climate-related impacts, next determine vulnerabilities (primarily biophysical) vis-à-vis these impacts, and these in turn provide a template for planning for adaptation. While significant research has emerged on effective irrigation, water conservation, agricultural technologies and practices, and coastal infrastructure that can assist in adapting to climate change impacts, these studies have focused on technical interventions, rather than on sets of complex responses to factors that contribute to people's overall level of vulnerability. Moreover, this framework is dependent on macro-scale climate models that are inapplicable at local scales, thus, planning of adaptive responses is stalled without confirmation of precise impacts at local levels that will be impossible to predict.

Very little has been done to examine adaptation from an actor-oriented perspective and from an examination of factors that make people vulnerable to climate change impacts in the first place, and which in turn constrain rather than enable their adaptive capacities. Some limited work in the region is underway that explores community-based adaptation responses in cases of floods, drought, and extreme weather events. These small-scale initiatives primarily concentrate on agricultural practices and water management, although some development initiatives increasingly consider strategies of livelihood diversification and poverty alleviation under the adaptation rubric.

While autonomous adaptation practices are universal and pervasive, studies are few and dispersed, and those that exist fail to inform planned adaptation measures at local and national scales. Most studies are also solely survey-based, one-slice-of-time assessments, lacking in time-series data and dimensions of adaptation change over time. These studies have also not fully examined elements that may constrain or enable people's adaptive capacities. Moreover, adaptation has been frequently conflated with short-term "coping strategies" pervasive in disaster risk management and response programmes instead of

employing a view that involves more anticipatory, social and ecological strategies that can enhance people's capacity to respond to uncertainties that climate changes will bring.

Specific Issues Raised in the Consultations

One of the foremost issues raised in the consultation process was the relevance and need for improved and wider understanding of adaptation. Following this was the need for better communications and shared learning within countries and across the region. There was frustration with minimal sharing by researchers and the confinement of data to key agencies. Furthermore, the importance of improving access to information particularly by local groups in usable formats through translation and popularization of scientific conclusions was emphasized. Capacity building across all levels emerged as a major issue across the region, particularly in countries like Lao PDR where it was pointed out that there was limited human resource and capacity to address issues of climate change adaptation.

Issues of governance emerged strongly in the interviewees and consultations, especially the need for more effective and inclusive mechanisms for adaptation planning. In particular, the importance of engaging with local governments was raised, alongside the need to strengthen capacity of other local level institutions, such as religious institutions (e.g. churches in the Philippines) that have strong influence in the community. In Vietnam, and echoed in other interviews, participants felt the challenge was on how to develop a sense of motivation for government action around issues that seem to lie several decades away in a policy context of other chronically urgent problems. Several interviewees across the region raised the importance of economic analyses that demonstrate cost effectiveness of adaptation strategies as being important mechanisms to convince policy makers. Bringing site-specific cases as demonstration models was another approach suggested to scale up adaptation efforts.

Consultations also highlighted the importance of ensuring vulnerability assessments include environmental and social vulnerabilities, and that there is clear differentiation between impacts and vulnerabilties. However, concern was also expressed that most risk-management or vulnerability exercises so far have been donor-driven. There was recognition that these approaches must be promoted by local government authorities but at the moment there were no government resources or technical skills to address the issues, and support is needed to give guidance to local authorities on how they can begin thinking about this.

The importance of bridging the gap between scientific, 'modern' knowledge with local community knowledge was highlighted, particularly in the Philippines and Indonesia. The need to better document, understand and build on local coping strategies was also stressed by many interviewees. There were suggestions relating to strengthening modelling capacity and access of people to use and understand models. One person interviewed urged that modelling be used as a medium instead of an end, not as a prediction tool, but to generate dialogue among stakeholders and policy responses.

The need for an enhanced role for the private sector in climate change adaptation was echoed throughout the region where only few examples were found and there was agreement that more research on this was required. It was pointed out that urbanization and climate change, including heat island and health issues were key issues for the region, but little work had been done on these as yet.

The final Bangkok consultation was designed so as to facilitate more in-depth discussion on the key points of entry for research as have been highlighted in the regional report. Working

groups were formed around the following topics: i) Hotspots: Vulnerable People in Vulnerable Places; ii) Marginal Livelihoods and Production Systems; iii) Health; iv) Social Security Mechanisms; v) Governance; vi) Migration. These have been discussed in more detail in the following section.

Our Analysis

Based on available key informant interviews, roundtable consultations with researchers, reports, documentation, and review of academic journal articles and grey literature on Southeast Asia, we have identified a number of cross-cutting issues critical to consider in adaptation efforts. Our analysis recognizes adaptation as inextricably bound to multifarious economic, environmental and political stresses, social vulnerabilities and differentiated adaptive capacities of people. Understanding these linkages is essential for researchers and policy makers to make sense of how and why people adapt to climate changes the way they do, and which adaptation strategies are most feasible to them.

Areas of High Vulnerability

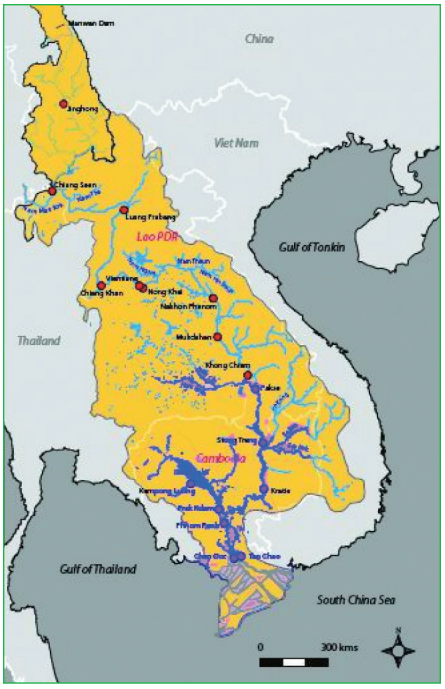
In conducting the study and with aims to understand where and to whom adaptive capacity may be most challenged, the team considered different types of ecozones (coastal, deltaic, upland/mountain) and paid attention to types of localities and populations that may be highly vulnerable to climate change due to climate related impacts and social vulnerabilities. The following are case examples that demonstrate the complexities facing climate adaptation planning and strategies in some of these areas.

The Mekong River Basin

The Mekong River Basin is the largest basin in SEA, spanning a wide range of altitude, latitude, climate and vegetation zones along the 4200 kilometres length of the river. The Lower Mekong Basin (LMB, or downstream of where the river leaves China) and its four lower riparian countries (Lao PDR, Thailand, Vietnam and Cambodia) comprise 77% of the Basin area and account for more than four-fifths of the water that passes through the Basin each year. The great variation in the flow of the Mekong River through seasonal flooding and low water levels drive and constrain the productivity of the agro- and aqua-ecological systems critical to alternating seasons of rice cultivation and fishing in wetlands and floodplains. These are food and livelihood sources to more than 55 million people throughout the basin, and the Mekong Delta is a main rice bowl for the region.

The Delta region, which is the area of highest human density, is especially vulnerable to climate impacts since it is affected by the combined impacts of changes in upstream flows, due to drought and heavy rainfall, coastal storms and sea level rise. Since deltas, unlike most other coastal zones, have low gradients and a tendency toward land subsidence that reduce drainage and encourage saline intrusion, climate impacts will be concentrated in this region. Change in hydrological flow and flooding will affect crop production, fisheries, and human health. Projected sea-level rise for 2030 alone would expose 45% of the Delta's land area to extreme salinisation and crop damage through flooding, with forecasts of a fall in rice production by 9% (UNDP 2007). This would affect not only those living in the delta dependent on rice and fisheries for food and livelihood security, but potentially millions of others within the region and beyond who would face challenges of food shortages and increasing food prices. Degradation of wetland areas, such as the Tonle Sap Lake, in part due to land conversion and variable water levels, is also affecting regulation of flood plains, regulation of waste from increasing urban areas, and fish spawning habitat. Increasing variability in hydrological flow is also compounded by hydropower dam constructions in

China, Lao PDR and Vietnam to meet increasing energy needs in the region. Knowledge gaps exist on how these climatic changes will alter wetland production systems, inland capture fisheries, and coastal floodplain fisheries in increasing saline environments. In addition, due to the common combination of high population densities and poor natural drainage, deltaic areas may become particular centres of disease incubation with increasing climate change. Large warm areas where water ponds coupled with the effluent generated by large populations provide ideal breeding grounds for existing disease vectors such as malaria and the transmission and incubation of new pathogens. Similar challenges face other large deltaic areas in the region such as Irawaddy delta in Myanmar and other mega-deltas of the Red River and Chao Praya vulnerable to storm surges and floods from river drainage impacting basic infrastructure, livelihoods, and food security (Cruz *et al*. 2007).



Longer dry spells and drought in the Mekong Basin also are intensifying competition for water use for irrigation both among and within countries in the region. The severity of drought and flooding in rain fed areas is resulting in crop failures particularly affecting those small, poor farmers with marginal landholdings, who then rely on selling livelihood assets such as land and farm animals and acquire loans from informal sources at high rates, pushing them further to impoverishment. Some family members, many of whom are women, search for alternative employment, particularly as migrant labourers in the Lower Basin where new factories absorb flexible and cheap labour. Partly as a result, the Lower Basin is experiencing a huge and growing segment of poor, landless farmers, small fisher folk, and migratory labourers with limited social protection or health services. For these groups, many of whom live in areas vulnerable to flooding, small declines in income or loss or insecurity of employment opportunities will have adverse consequences for nutrition, health and livelihood security.

Furthermore, the poor, whose livelihoods are highly dependent on the Mekong River, usually do not have a voice in the decisions and policies on water allocation and resource use. The trans-boundary dimension of issues of conflict in water use and management further marginalizes the poor politically and prevents them from meaningfully taking part in major decision making and development planning. In the existing socio-political conditions in the Basin, climate change impacts will most seriously strain the adaptive capacities and resilience of the poor unless serious and focused enabling measures are put in place.

Urban and peri-urban coastal areas of central Vietnam, Indonesia and Philippines

Vietnam, Philippines and Indonesia are countries in the region with the longest coastlines. Climate change impacts expected in coastal areas are increases in frequency and intensity of tropical storms including cyclones, sea-level rise, and coastal erosion resulting in flooding, increasing saltwater intrusion, and changes in marine ecosystems. Coastal erosion has been exacerbated by human activity such as the building of jetties and sea walls, increased industrialization, damming of rivers, sand and coral mining, and the destruction of mangrove forests. Coastal populations will also have to deal with significant health challenges, including the spread of infectious bacterial diseases such as cholera due to warmer sea surface temperatures along coastlines. Flooding, and ensuing poor water quality and sanitation, aggravated by poor drainage systems in cities, will increase incidences of

diarrhoeal diseases and changing vectors of insect-borne infectious diseases such as malaria, schistosomiasis, and dengue fever, the latter especially in urban areas.

Heavily populated urban and peri-urban areas in the western Philippines, eastern Vietnam, Indonesia and southern Thailand and its gulf areas, are low-lying coastal zones whose settlements and basic services infrastructure are extremely vulnerable to climate change impacts. In these zones, urban poor slums are on the rise, and tend to locate themselves in low-lying and marginal areas of big and medium-size cities where they engage in urban petty trade and in irregular informal sector services, with limited social protection. Already lacking in basic water supply and sanitation facilities, they are most vulnerable and least capable to adapt to recover from shelter destruction and health problems in cases of typhoons and storm surges. In some peri-urban areas where livelihoods rely on aquaculture, pond embankments are being destroyed by severe storm surges, and may be vulnerable to flooding and salinization due to sea level rise. Existing governance mechanisms are limited in their ability to effectively plan and manage strategies to mitigate and anticipate impacts arising from climatic changes including attention to settlement patterns, and the infrastructure and institutional support required. While some research on climate-proofing of large-scale infrastructure such as transport systems is taking place, little has been done to consider the challenges of identifying points of refuge in areas of such high population densities, or of needed approaches to strengthen the adaptive capacity of these poor and vulnerable groups particularly through access to services such as health, finance, and education or skill development.

Coastal and Upland areas of eastern Philippines and north-central Vietnam

Poor farmers dependent largely on fragile lands for agriculture inhabit upland areas located near the eastern coastlines of the Philippines and Vietnam where the most vigorous cyclones are formed. Frequently visited by tropical cyclones, these areas have also experienced La Nina-induced heavy rainfall and cyclones producing massive floods and landslides in recent years, which are expected to increase with climate change. These storms have caused unprecedented heavy tolls on lives, shelter, crops and livelihoods, and families often have to rely on informal sources of credit and sale of liquefiable assets to manage losses. In addition, drought and variable rainfall patterns may significantly impact agricultural production in these areas, with further stresses on food and nutritional security. Increasing sea level rise and temperatures will also affect the agriculture and fisheries production systems on which these populations rely. However, research systems has given relatively limited attention to production systems in these marginal lands.

The remoteness of the eastern Philippines also exacerbates inhabitants' vulnerability compounded by their lack of access to basic services. Ethnic groups such as the Vietnamese H'mong, Tay and Philippine Aetas marginalized by mainstream populations also inhabit parts of these upland areas and face higher climate-related risks with weaker social and economic capacities to adapt to such risks. Parts of these areas have become places of refuge for temporary migrants who have fled low-lying coastal areas in view of more frequent climatic impacts severely affecting their former farming livelihoods, or displacement of farming caused by land conversion for urban use. With limited options to diversify livelihoods to increase resilience due to lack of access to skills, training and services, they have moved to even more isolated environments. For all people in the region, improved accessibility of scientific information on climate and weather patterns may enhance their ability to prepare and respond to climate events. Research that strengthens agriculture and fisheries production systems in changing climate contexts and leads to better economic

returns through improved market linkages will strengthen capacity of these populations to adapt.

Cross-Cutting Issues and Strategic Points of Entry for Research

The review and consultations have highlighted a number of key issues of critical relevance to adaptation strategies across the region, which share similarities with the other sub-regions. These include the various forms of **autonomous strategies** at individual and household levels, particularly those that are multi-local and go beyond sedentary or "in-place" productive activities, and of the underlying systems that may assist or constrain adaptive capacity. Given the predominance of extreme climate events in the region and the devastating toll that they take, and their increasing occurrence, the **links between disaster risk reduction and climate adaptation** are logical steps in reducing vulnerability. However, these have been slow to occur in practice. In conditions of changing variability of rainfall and inter- and intra-national competition for water resources, effective and equitable **water management** practices are needed to manage drought and flooding conditions. Attention must be paid to how individuals and families may already be **diversifying their livelihoods** in response to both environmental and economic stresses. At the same time, differential opportunities and access to resources exist, particularly by class, gender and ethnicity, and attention must be paid to how policies and practice may support or constrain such strategies. Similar **differences exist in access to social safety mechanisms,** including **health, finance mechanisms**, which may inhibit adaptive capacity. Extremely limited attention, though, has been paid to social networks and informal institutions on which people rely to facilitate adaptive measures, and how these may be further strengthened and supported. In addition, little consideration has been given to how both mitigation and planned adaptation strategies may **exacerbate poverty, and social and gender inequities.**

A key theme of predominant importance to adaptation efforts that emerged both in the consultations and the review is the very high pace of **urbanization** in most countries in the region (except for Myanmar, Lao PDR and Cambodia). Population of main urban centres is steadily increasing, and the urban-rural divide, in terms of livelihood and economic activities, infrastructure, population distribution and mobility, and residential patterns is fast diminishing. These processes may introduce both new sources of adaptive capacity and new types of vulnerability in the context of climate change. Access to urban-driven non-farm livelihood activities and migration are key mechanisms rural individuals and households use to maintain income and adapt when affected by floods, droughts, and events associated as a consequence of climate change. However, this massive mobility of labour force results in rapid growth of urban populations and the corollary phenomenon of the "urbanization of poverty", and the growing concentrations of poor and vulnerable households in cities and peri-urban areas. These poor often settle in densely populated slums located in urban floodplains, and are further vulnerable to climate impacts through market-mediated scarcities and rising food prices that climate-change shocks and stresses in food producing regions have triggered.

The crucial issue of **governance** emerged strongly in the consultations, and in particular the disjuncture of climate change knowledge, information and adaptation planning between national and local level actors, and sectoral segmentation of knowledge that exists within these levels. Furthermore, increasing urbanization described above is driving fundamental changes in institutions and the role they play in enabling or constraining access to the basic resources on which the ability to adapt to climate change depend. Little attention has been paid to intermediary institutions—such as finance, education and transportation—that can facilitate flow of information, as well as enable or constrain adaptive measures.

In light of these cross-cutting issues and the limitations of existing approaches discussed earlier in the report, we have identified a number of priority research themes that, while critical to ensuring effective research agendas, are currently scarce in current adaptation research. These are: migration; social security mechanisms; livelihood security of small-scale farmers and fishers; strengthening resilience to health related impacts; and governance of adaptation across scales.

Migration

Labour mobility, remittances and out-migration are critical autonomous strategies for adaptation. In Southeast Asia, partly in response to climatic impacts on production systems, individuals and families are diversifying livelihood portfolios through short and long-term migration. Women constitute a large segment of migrants, more so than in other regions of Asia, partly due to fewer cultural constraints emerging labour markets that seek cheap, female labour.

While a substantial amount of research on migration in the region exists, this has not been contextualized within climate change adaptation; hence there is little understanding of how climatic impacts may further amplify or affect movement. Research is needed to understand migration as an adaptive measure and its underlying support systems such as transport, banking for flow of remittances, as well as informal trans-local and transnational social networks that may facilitate access to opportunities. Additional understanding is needed of assets that may enable or constrain migration, particularly of poorest groups, who may lack needed financial capital, skills, knowledge and capacities, since migration is known to be a selective process. The less well-off may move to more ecologically fragile places such as uplands and coastal, low lying border areas and take up risky and gender-specific livelihoods such as factory work under poor conditions, commercial sex work and small-scale logging. Movements to smaller urban and peri-urban centres have implications for city planning, access to services, and social protection.

Often unexplored are the adaptation strategies of left behind elderly and children who may rely on remittances to increase food security and resilience against climate-related changes. Equally noteworthy are migrant workers in captive fisheries, aquaculture and agriculture who are unable to move elsewhere and are also left behind by their employers due to dwindling livelihood opportunities as a result of increasing coastal erosion and water scarcity in irrigation.

Economic push and pull factors and climate change stressors by themselves are not exclusively the drivers of migration. These drivers are mediated (i) by global and national forces that may create or inhibit labour markets that absorb migrants; (ii) by policy regimes and existing transport and banking systems that constrain or enable the migration process and well-being of migrant workers and those they leave behind; (iii) by the relative individual

autonomy of migrants themselves embedded in social and gender norms, as well as in household productive assets and the extent of their supportive social networks. These combined elements can offer more comprehensive explanations to the nature, processes and outcomes of migration as an adaptive strategy in the context of climate change that significantly depart from conventional push-pull explanations.

In sum, research is needed to:

(i) Increase understanding of the current and potential future role of migration and remittances as adaptation strategies in the region;
(ii) Identify opportunities to strengthen underlying support systems such as transport, banking for flow of remittances, as well as informal trans-local and transnational social networks that may facilitate access to opportunities; and
(iii) Improve understanding of the necessary assets that may enable migration, particularly of poorest groups, who may lack needed financial capital, skills, knowledge and capacities, and identify actions and policies that may support them.

Social Security Mechanisms

Formal and informal security mechanisms are crucial for strengthening people's resilience to climate change stressors. Examples of formal mechanisms are credit and crop insurance, state-registered land tenure, rice and crop mortgages with government agencies or NGOs, crop subsidies and state social security systems that include benefits, pensions and health insurance. Informal mechanisms, on the other hand, may be forms of informal loans, group sharing losses, keeping livestock and other assets for 'insurance,' multi-cropping systems to avert single crop failures.

Credit and access to liquefiable assets have been identified as critical strategies for strengthening resilience at times of climate-induced extreme events (see for example Sales 2008, Tran Xuan Bin 2006, Friend 2008, Keil *et al.* 2008). Households and individuals rely on both formal institutions (banks, legal co-operatives), but even more so on informal credit institutions such as money lenders who charge exorbitant interest rates that may exacerbate vulnerability, as well as kin and social networks, who themselves may lack resources if facing similar climatic impacts. Access to social security mechanisms such as credit and insurance is generally more limited to poor and marginal populations who lack official land ownership or collateral required. Women's access may be even more restricted in part due to limited direct ownership over physical assets, and when they are able to access credit, unequal gender relations in their households may weaken their use of loans.

A small number of efforts exist in the region on local micro-credit savings groups, for example in Jakarta, Indonesia and in rain-fed farming areas of Cambodia, though not nearly on the scale as initiatives in South Asia. Some initial consideration has been given to crop insurance in Indonesia and the Philippines, but this has been extremely minimal. These efforts have also tended to focus on approaches dominant in northern countries that are less effective and less accessible to smallholder farmers engaged in multi-crop cultivation such as those predominant in Southeast Asia. Overall, there is limited research on formal and informal access to credit, insurance, or micro-finance institutions, particularly in climate-vulnerable places in the region. Attention must be paid to how access to formal institutions may be enhanced particularly of poor and marginal populations, and of women, who may lack collateral. Formal social security arrangements may be governed by rent-seeking behaviour in many developing regions. Thus formal mechanisms may also be supplemented by informal mechanisms.

In addition, migrant informal workers may lack access to benefits such as health insurance and pensions due to lack of residency or provision of such services. Furthermore they are often burdened with poor working conditions. Research is required to strengthen the access and delivery of social security benefits to these populations, and ensure proper work standards.

In sum, research is required to:

(i) Better understand the factors that differentiate some to have more access to social security benefits and mechanisms than others;
(ii) understand the efficacy and resilience of informal social security institutions such as cooperatives, kin enclaves and credit networks in the face of climate stressors;
(iii) identify mechanisms, institutions and policies to strengthen reach and accessibility of formal social security mechanisms to poor and marginal groups, including women; and
(iv) develop appropriate and effective gender-responsive micro-credit and micro insurance models that are relevant to cultures, practices and socio-political contexts of the SEA region.

Livelihood Security of Small-Scale and Subsistence Fishers and Upland Farmers

Climate-related impacts will have significant effects on agriculture production systems and fisheries on which poor fishing families and upland farmers largely depend. In the Mekong River Basin, excessive flooding and drought will threaten sensitive aquatic habitats and spawning grounds, threatening livelihoods of the 40 million people who subsist on inland capture fishery resources. Future hydropower plants will alter hydrological flows further disrupting fish migration. In coastal areas, it is not yet clear how sea level rise, coral bleaching and higher temperatures will affect marine biodiversity. However, increasing salinization will significantly alter rice-fish and other agricultural production systems. In upland areas of Indonesia, Vietnam and the Philippines where the poorest marginal farmers live and depend on forests and subsistence agriculture, climatic variability is already limiting productivity. Furthermore, national mitigation efforts such as REDD and demarcation of protected forest areas may affect tenure security of poor who may practice subsistence agriculture in these areas, or rely on forest resources to meet livelihood needs.

Research is required to better understand how livelihood security of small-scale fishers and farmers may be threatened, and explore mechanisms that could strengthen their adaptive capacity. This includes research on agriculture and fisheries production systems, particularly in increasing saline environments, alongside mechanisms for tenure security and equitable access to other productive assets and infrastructure. It involves linking scientific information on climate and weather patterns to local levels, and enhancing accessibility of this information by those most affected by such occurrences. It also requires research on potential informal social institutions such as co-operatives that can strengthen linkages with markets through developing economies of scale and enhancing potential returns from small-scale agriculture and fisheries. Current small-scale fishing and farming also need to be examined from the perspective of changing production systems and economic dynamics at meso- and macro-levels.

Research on potential and needs for livelihood transitions, through for example, skills and education, are also critical for strengthening adaptive capacity towards climate change. Small producers are dynamic actors who diversify their livelihoods, engage in multiple portfolios and multi-local livelihoods that are dynamic and adaptive. However, they often lack enabling

and supportive action from governments and NGOs, where policies frame them as *a priori* 'marginal,' or alternatively as 'culprits' of degradation, rather than actors who actively engage in diverse livelihoods and actually engage in ways to adapt to the changing climate.

In sum, research is required to:

(i) better understand how livelihood security of small-scale fishers and farmers may be threatened by climate change combined with other social and environmental stressors;
(ii) explore mechanisms that could strengthen their adaptive capacities including research on agriculture and fisheries production systems, particularly in increasingly saline environments; instruments for tenure security and equitable access to other productive assets and infrastructure; and means to enhance accessibility to scientific information on climate and weather patterns relevant to local levels;
(iii) identify the potential and needs for livelihood transitions such as skills upgrading and education; and
(iv) understand the factors and conditions that work to under-represent and exclude the voices of small producers in national and intermediate-level planning for adaptation and the effects that other mitigation efforts might have on their livelihoods and well-being.

Strengthening Resilience to Health Related Impacts

Health may be considered the "left behind" sector in climate change adaptation research. While the sector is often included in global or even national discussions on adaptation (see for example IPCC 2007, UNDP 2007, Alam et al. 2007), there appears to be limited research in this area. Attention of the public health sector has primarily been in the context of responsive measures for water and sanitation in climate induced disaster situations, and efforts to control diarrhoeal and infectious diseases, such as malaria and dengue. Increases in floods, droughts and storms and changes in temperature will bring increases in health risks to these diseases, particularly among poor, and more exposed populations. This has already been demonstrated in Indonesia where warmer temperatures have led to the mutation of the dengue virus, leading to increase in fatalities in the rainy season. In addition, while not directly associated with climate change, severe outbreaks of both dengue and malaria, including spreading of malaria to highlands of Irian Jaya were associated with ENSO events (UNDP 2007). Furthermore, increases in temperature, particularly in urban areas, may lead to increase in heat-stress illnesses or death, particularly of the elderly poor, and in increases in pollution-related health problems.

However, currently health responses to these challenges are passive, and research is required to strengthen health systems and services to better anticipate and address potential health challenges, and also respond to the uncertainty of climate change, such as unexpected and sudden changes in temperature and precipitation. This may include development of systems for active surveillance of breeding areas, technologies and institutions for climate robust water and sanitation, and development of gendered and accessible health systems that reach poorest populations. In urban areas, planning of water and sanitation systems and drainage is required to strengthen resilience of marginal lands to flooding, and resulting health problems.

A critical but under-discussed area in the health and climate change nexus is that of the implications of limited food production due to drought, increasing salinization, or extreme events for food and nutritional insecurity. Additional research is needed to explore this relationship, and in particular implications for poor populations. In addition, gendered

aspects of health and human security are of concern, particularly in extreme-event situations where women may be vulnerable and exposed to increases in violence.

Overall, poor health in developing countries is a major factor contributing to poverty and vulnerability, and directly affects the capacity of individuals and families to adapt to climate change. The range of severe health impacts that may emerge from climate change will exacerbate these conditions. As a result, it is essential that research and development efforts increase investment and development of capacities to manage these new and dynamic health threats in order for any adaptation efforts to be effective.

In sum, research should aim to:
(i) identify potential direct and indirect impacts of climate change on human health on different gender and social groups;
(ii) identify barriers to successful health-related planned and autonomous adaptation to climate change stressors; and
(iii) develop effective social, technological, institutional and policy measures to overcome such barriers.

Governance of Adaptation Across Scales

Research is required on governance systems at multiple levels that facilitate effective linkages across scales, and which can help address disjunctures horizontally between sectors and stakeholders, and vertically between national level thinking and policies, and local level discussions and actions. At the national level, effective mechanisms to facilitate holistic adaptation planning across ministries and that engage non-state actors need to be identified for adaptation efforts that transcend sectoral boundaries. Stronger involvement of economic or planning ministries to effectively lead co-ordinated planning has been raised as a possible strategy in some countries. Equally important, there is an urgent need for national level perspectives and policy decisions to be informed by local-level discussions of climate change realities and ground-level adaptation strategies. In turn, national level policies need to be flexible enough to be implemented at local levels in a way that responds to local specificities. Local agencies also need to improve capacities and mechanisms for inter-sectoral and multi-stakeholder planning, and for enhanced and meaningful public participation in design and implementation of planned adaptation.

A much less understood, but critical juncture of governance is located between national, centralized and sectoral administrative levels, and the lowest local levels of public management and fields of action (often referred to as city/municipal and grassroots communities). The dynamics, forces and characteristics at work and their potentials at this intermediate level are least explored. However, it is at this intermediate level where area-based integrative management of resources and development and their facilitating institutions, infrastructure and services (such as finance and commercial, government outreach services, education and training, and transportation, etc.), have an optimal extra-local impact. At the intermediate level, markets, business and media, as well as traditional pillar institutions such as education and religion can play an important facilitating role in mobilizing resources for improving people's adaptive capacity.

In the case of the Mekong River Basin, particular attention must also be paid to trans-boundary governance of water resources. In the Basin, climate- and human-induced variability in the water flow of the Mekong has created trans-boundary winners and losers.

There is a need to understand the constraints, opportunities, conditions and forces for developing effective governance mechanisms necessary for equitably allocating water during drought periods and flood management between and among neighbouring countries, cities and municipalities. Likewise, there is a need to research on how trans-boundary governance could have built-in norms, procedures and mechanisms that are responsive to the needs for protection and support of the livelihood stakes of the poor and to strengthen their adaptive capacities. While politically sensitive to discuss issues of water management across national borders, it is also critical to facilitate accountable governance mechanisms to respond to changing flow due to climate variability and hydropower development, and to impacts of alterations of flow regimes on vulnerable populations in the region.

In sum, research on governance of adaptation should:

(i) identify institutional mechanisms that may facilitate more effective linkages horizontally between different departments and vertically between local, meso and national levels;
(ii) explore how intermediate level of governance may facilitate infrastructure, institutions and services that can enhance adaptation; and
(iii) understand the constraints, opportunities, conditions and forces for developing effective governance mechanisms for transboundary management of resources in contexts of climatic variability.

Key Actors, Partners & Capacity Requirements

In order to advance the above agenda of implementing research to enhance adaptation strategies, it will require active engagement of actors from various levels of government, research organizations, private sector, and civil society. Critical is the need for inter- and multi-disciplinary teams to conduct research, as well as networks that link researchers, governments, and civil society as partners in research efforts. A number of regional scientific and interdisciplinary organizations and networks are already engaged in climate change adaptation research in the region, and could continue to play key roles in any adaptation programme. These include, among others, SEA-START, AIT, EEPSEA, SEI, Asia Disaster Preparedness Centre, the Mekong Programme for Water, Environment & Resilience (M-Power), and the Mekong River Commission. International research centres of the CGIAR (such as CIFOR, IWMI, World Fish Centre) and multilateral agencies (UNDP, WHO, ADB) are also important partners.

National level governments are critical partners for engagement in ensuring the results of any research programme will be implemented at scale. This includes economic and planning ministries and sectoral ministries (environment, natural resources, agriculture, fisheries, health, social welfare agencies). As highlighted repeatedly in the consultations, of equal importance are local government bodies that play a significant role in facilitating adaptation planning at local levels. National research institutes and universities, particularly those with interdisciplinary programmes, will need to be central actors in any research initiative. While existing work on climate change adaptation has been concentrated mainly in meteorological, agriculture, forestry, and hydrology departments, it will be important to also engage with social science, health, and economics departments. Government-research institute partnerships (along with civil society) should be encouraged where possible. There are some interesting and recent initiatives in the region focused on climate change adaptation including the Center for Initiatives and Research on Climate Change Adaptation (CIRCA) of the Philippines and the Indonesia Climate Change Adaptation Plan that plans the establishment of a research granting facility. Opportunities also exist to move beyond 'national' actors, and strengthen capacities of research of sub-national universities and 'local' governments to respond to adaptation needs and knowledge priorities.

Private sector organizations with interests in climate change adaptation research have been the un-tapped partners to date. There have been small innovative pilots in the region, such as strengthening access to and delivery of climate-related information through information communication technologies, and corporate social responsibility projects facilitating ecosystem management, these are extremely few and limited. Larger opportunities exist to engage with private sector agencies with direct business interests in adaptation measures such as companies providing infrastructure for water, transport and communications; private small loans and insurance companies; marine and aquatic production companies; as well as chambers of commerce. International and national non-governmental organizations that have primarily been engaged in development and livelihood related initiatives are key partners especially for piloting strategies and interventions.

Effective programmes for climate change adaptation require building research capacity at various levels and among public sector agencies and organizations. Least developed countries in the region, particularly Lao PDR and Cambodia, require basic capacity building for research at all levels of government, and also within national and local universities. Across the region, there is need to educate staff members of government departments in order to influence higher-up officials. Improving offering of and access to higher education courses that focus on planned and autonomous adaptation efforts across sectors and levels can strengthen the capacities of the "next generation of policy makers and researchers" on climate change. Research capacity building should also be encouraged to support local government units to appropriately use climate change information in adaptation planning. Knowledge hubs across sub-national universities, NGOs and other civic and business groups can strengthen learning mechanisms. These can then be supported and reinforced by major research centres or universities in the national capital or through regional collaborative research programmes.

China

Précis

China's climate varies from hot and humid tropical in the south to arid high desert in the north and west. The east has a temperature climate while the north and northeast experience bitter winters. Most of the interior is semi-arid or arid and, as a result, agricultural production is concentrated along the east and southeast coast. Climate change is projected to warm the entire country on average but be being more pronounced in the north. Rainfall is expected to increase in eastern China and decrease in western China. Much of China's research on climate focused on historical conditions, projecting future changes and mitigation. Adaptation to climate change is a new concept in the climate community in China.

Due to the variability in climate and poverty, vulnerability in China differs greatly between regions. For this report four high vulnerable regions were identified: ***Northwest China*****:** Relatively lightly populated but dependent on agriculture. The region is a semi-arid to arid and is prone to periodic drought. While local populations have adopted a range of adaptive measures, water scarcity, lack of infrastructure, and high risks in the face of increasing variability will pose huge constraints to adaptation for the rural population. ***The Tibet-Qinghai plateau*****:** Populated by people whose traditional livelihoods and culture revolve around pastoralism. With climate change, geographical and temporal variability in the quality of pastures and soil moisture is likely to increase, along with livelihood risks. Glacial melt will lead to higher runoff for several decades followed by decreases in stream flow as

the glaciers disappear. ***The Karst Uplands of southwest China*****:** This is the region more densely populated than the two previous regions and receives more rainfall. Yet the geological structure makes water availability an issue. Model projections show increased rainfall with greater variability increasing the risk of drought and flood, soil erosion and landslides. Government has intensified construction of physical infrastructure for this region but the topography and geology challenges conventional engineering approaches. These challenges are expected to worsen with climate change. ***The coastal zone*****:** has a very large population, is the economic engine of China and is home to large numbers of migrants who lack residential registration. There may be large vulnerability to the loss of crucial ecosystem services (such as water purification by wetlands) due to rapid, poorly planned, development. The region will also be vulnerable to sea level rise and storm surge from cyclones.

The key cross-cutting issues for climate adaptation are regional in scope. They include the impact of climate change on natural resource management; links between disaster risk reduction and climate change; how rapid development in conjunction with changing climate will affect ecosystem services; migration and climate vulnerability in cities; how institutional and governance structures can enable autonomous adaptation, greater interagency communication and coordination; and how knowledge systems can be adapted to allow increased interchange between national scientific organizations and local stakeholders.

Priority Research Themes

Natural resource management; Natural resource management is an important area of research in China yet little work has been done on climate adaptation. There are also key knowledge gaps regarding fodder and pasture management, alternative livelihoods and asset diversification.

Local disaster risk reduction and resilience; DRR work in China has not considered climate change. Present efforts to reduce risk to hazards use recent historical climate variability in defining proper construction.

Migration; Understanding how migration influences vulnerability taking into consideration the migrant's unofficial status, lack of institutional support and the importance of the remittances generated. More research on the role of gender, ethnicity, communication, and transportation in influencing vulnerability is also needed.

Institutions and Governance; Government structures, budgets and programmes are "siloed": sectorally administered, vertically-structured, and poorly integrated/coordinated with accountability upwards to the centre. Implementation is often uncoordinated and unresponsive to the local context in which adaptation occurs. Research is needed to develop institutions that are suited to Chinese conditions and can support adaptation.

Knowledge systems; A pervasive challenge across all research themes is the way that knowledge and learning are structured in China's expert-driven society. Adaptation will require local learning as part of adaptive management.

Physical infrastructure: Further research on the significance of factors such as economic policy and transportation / communications infrastructure on migrant labour, remittances, and access to markets in would improve understanding of the climate vulnerability of and alternative livelihood options for the rural population, particularly in Western China and

the Tibet-Qinghai plateau. For the Karst Uplands, innovative engineering research that takes into consideration the unique qualities of the local geology would greatly improve the reliability of local infrastructure.

Coastal ecosystems; There is surprisingly little critical assessment of the trends in wetland degradation or lowland vulnerability to sea level, storm surges and flooding despite there being global strategic interest in the costal zones.

Existing Approaches to Adaptation Research in the Region

Climate research has attracted considerable attention in China, in part because of the strategic importance of food production and the historical exposure of large rural and urban populations to extreme events (droughts, floods, typhoons). There is reasonable consensus on the broad nature of future climate change in different regions of the country under various global emission scenarios, but high uncertainty as to how these trends will be expressed locally. A great deal of research has dealt with impacts on agricultural production, particularly in the highly productive North China Plain and floodplain regions of the south. There are divergent views about the implications of climate change on overall national grain production (partly reflecting different methodological approaches to this assessment), but recent work suggests effects attributable to climate change will vary regionally, with some regions benefiting and others losing. The principal agricultural areas of China are unlikely to be severely affected: they are also reasonably prosperous, dynamic and well served by infrastructure and agricultural inputs. In the northern plains, where water constrains agricultural productivity, the future effects of the South-North water transfer scheme, already committed by the national government, will far outweigh the impacts of climate change on water demand. For these reasons, from the perspective of vulnerability, other regions of the country are of greater interest to our study.

Scientific research capacity in China is strong. Most research attention continues to be devoted to assessing the *effects* of climate change, including issues of data collection (which remains weak in many mountainous and remote areas of the country), modelling and climate forecasting. These are important areas for continuing research effort, particularly when results can be better linked to decision-making through user-oriented information products. There is also growing attention to the impacts of forecast changes on ecosystems and biodiversity, and to assessment of aggregate costs of climate change impacts and adaptation. However, adaptation as a specific domain of research effort in China is a new concept.

For example, so far there has been limited research attention to the process of decision-making and response to anticipated or observed climate variability, especially at the micro level (households, communities, local government). Nor has there yet been much interdisciplinary adaptation research that integrates analytical perspectives across social and natural sciences. While there is a great deal of experimental research on agricultural technologies and techniques, there is limited long-term assessment of farmer behaviour, particularly as economic factors change (relative factor prices, resource availability, accessibility and markets).

Specific Issues Raised in the Consultations

Climate research has attracted considerable attention in China, in part because of the strategic importance of food production and the historical exposure of large rural and urban populations to extreme events (droughts, floods, typhoons). The high interests among both researchers as well as government officers in climate change and its impacts showed at

various consultations whether as a group or as an individual revealed this fact. However, climate change adaptation is a relatively new concepts in China, even to those who are doing climate work. Participants at the first consultation showed appreciation of having such a learning opportunity when some of the basic concepts were introduced by the study team.

Communications, innovation and coordination across agencies and between researchers and government agencies specifically for climate change adaptation, emerged as one of the crucial issues during consultations and individual interviews. However, there seemed little incentive to do so. Capacity building on climate change and adaptation issues at various levels of the government to help understand issues, engage in discussions, and integrate concerns into development planning was also flagged as a priority issue. This was discussed particularly in the context of local level governance institutions in order that they can understand issues, engage in discussions, and integrate concerns into development planning. Interviews and consultations revealed that currently there seemed no mechanisms for integrating climate change adaptation into local decision-making. Interdisciplinary collaboration was seen as particularly important for climate change adaptation research and it was pointed out that little of this was happening at present.

Consultations like the one at Ningxia highlighted the gap between policy changes and implementation at the local level. Participants felt policy changes foster local confusion. Senior governments change their policies too frequently. In consequence, adaptation measures are inconsistent and local decision-makers are not clear on the appropriate direction. Policy objectives and targets are also often unrealistic, creating expectations higher than what local officials can reasonably accomplish. The need to combine the two approaches to planning for climate change adaptations in terms of 'top down' and 'bottom up' was highlighted.

There was general agreement that better access to accurate information will help local people to adapt. Participants particularly from the Ningxia consultation pointed out that there was high local demand for seasonal climate forecasts, but limited capacity on the part of meteorological services to respond. Current forecasting capability is accurate only for a short period, so it can be difficult to anticipate extreme weather events or natural disasters. Risks of natural disasters are perceived as high, but without better information, it is also risky to take loss avoidance measures.

It was felt that although there was evidence of many adaptive practices among local people to climate change in the country's history, there was a need for better documentation. There is a gap between research and application: knowledge is not provided to those who need it, and research lessons are difficult for local officials to interpret and apply. It was pointed out that an effective way to transfer adaptation innovations at the local level is to demonstrate effective practices.

Participants at consultations and during interviews suggested that there was particular value in developing economic tools for assessing adaptation measures. However, the lack of standard methods and criteria for assessing adaptation approaches emerged as a major gap. This was especially true at the level of integrating adaptation strategies into local government planning, where institutional structures are unhelpful in fostering adaptation or innovation.

During some of the personal and individual consultations and communication, a challenging issue seemed to be how to differentiate "development" from "adaptation"? This would have huge implications on how to mobilize and generalize funds for adaptation work in the future.

There was concern that there was little evidence of local government or researchers studying seriously the risks of sea level rise or increased storm surges, while flood risks were well identified. This was specifically pointed out at the Hangzhou consultation, Zhejiang Province. Discussions during the first Beijing consultation also reflected the research gaps in this area even at national level.

Discussion at the final workshop was focused a lot on the uncertainties linked to climate change models. This was followed by deliberations on how to improve the prediction ability of different models. The need to incorporate the impact of human activities into existing models was highlighted. This was in the light of the fact that several participants pointed out that it is also important to quantify the impact of human activities on climate change and the sensitivity of climate change adaptation.

Our Analysis

Areas of High Vulnerability

We identify 4 adaptation areas of high vulnerability for purposes of this report. The four regions of high vulnerability identified for focused study included: the arid and semi-arid northwest (most parts of eastern Xinjiang, northern Qinghai, Gansu, Ningxia, Shaanxi, western Inner Mongolia); the Tibet-Qinghai plateau; the karst uplands of southwest China (parts of Guizhou, Sichuan, Chongqing); and densely populated peri-urban coastal zones. Although there other areas, such as North China with high vulnerability, these are representative areas in which climate impacts on key ecosystems are likely to compel significant changes in livelihood patterns, and where current populations are poor or otherwise vulnerable. These areas are indicated in the accompanying map and discussed in further detail below.

The arid and semi-arid belt of northwest China covers about 37% of the country's area, but includes only 9% of its population. It is an ethnically diverse area, with a high proportion of the population represented by ethnic minorities with indigenous cultures and languages (principally Uyghur, Mongolian, Tibetan, Hui, but also other groups). This area will see larger increases in mean temperature than other parts of the country, particularly in the dry summer months. While mean precipitation may also increase, it is likely to be concentrated in unpredictable, high-intensity events which can be very destructive of the fragile soils in steep terrain that characterize much of this area. This area receives massive subsidies from national poverty alleviation programmes,

many of which are invested in the expansion of irrigated agricultural production (currently 40% of cultivated area). Surface and groundwater extraction already exceed safe limits and climate change will only exacerbate water scarcity. Some areas of rangeland are experiencing severe degradation, and various conservation programmes and incentive schemes have been launched to reduce grazing pressure, leading to pasture enclosure and substitution of costly feed grains. Government policies subsidize local migration and sedentarization, and voluntary migration away from the most impoverished (and vulnerable) areas is also common. While local populations have adopted a range of adaptive measures, water scarcity, lack of infrastructure, and high risks in the face of increasing variability will pose huge constraints to adaptation for the rural population. This area is already the focus of pioneering adaptation research projects, including research on dryland cultivation, crop selection, and soil moisture management techniques. Fundamentally, the future of agriculture in this region is more dependent on water resource policies (including pricing) and the continuation of poverty alleviation subsidies than on local adaptive measures. The significance of factors such as economic policy and transportation / communications infrastructure on migrant labour and remittances seems under-researched.

The Tibet-Qinghai plateau is sparsely populated by people whose traditional livelihoods and culture revolve around pastoralism. There is uncertainty about the effects of climate change on the quality of pastures and other resources in this region, but geographical and temporal variability are likely to increase, along with livelihood risks. Temperature changes will lead to earlier snowmelt and longer snow-free seasons, which will affect late summer soil moisture and require modification of pasture management practices. Cultivated agriculture may be favoured in some parts of this region, subject to moisture limitations, but greater reliance on food grains may increase pressure on biomass for cooking fuel. Glacial melt will translate into higher spring/summer water levels for several decades, followed by decline in stream runoff and upstream flows in the region's many strategically important rivers. Key knowledge gaps revolve around options for fodder and pasture management, alternative livelihoods and asset diversification in a relatively unproductive agro-ecosystem that is isolated from markets and infrastructure. Increased risk of forage vulnerability poses special concerns for a livestock-based economy, where it can take many years to re-build productive herds. Another issue is how to build knowledge systems in a context of traditional pastoral-ecological knowledge that is becoming less reliable.

The Karst Uplands of southwest China are more densely populated than the two hotspots described above, and also receive much more rainfall. However, water supply is often a local issue due to the geological conditions, steep terrain and increasing climate variability. Climate change will mean increased precipitation and higher variability in this region, with attendant risks of drought, flooding, soil erosion and landslides. Agriculture is already fairly diversified in this region, despite poor soils, with production of upland rice and maize varieties combined with vegetables, livestock and various industrial crops (e.g. bamboo). But because of the rugged terrain, communications and transportation infrastructure (including electricity distribution) is unavoidably vulnerable to disruption by extreme weather conditions. The government has invested already in programmes to improve water management under severe hydrogeological constraints, and in disaster prevention and emergency response, but this is an area where further research to strengthen livelihood resilience to frequent local disasters would seem warranted.

The coastal zone is of interest for different reasons: this is a dynamic area of high population density and wealth accumulation, with large numbers of disadvantaged persons who have

either been displaced by development or have recently migrated and lack residential registration. This is also a region of rapid and poorly planned development, where key natural buffer systems are being converted to urban and industrial uses (e.g. wetlands, floodplains, deltas). The concentration of manufacturing and transportation infrastructure in coastal areas at or very near sea level is not only of national, but global strategic importance. Yet there is surprisingly little critical assessment of the trends in wetland degradation or lowland vulnerability to sea level, storm surges and flooding. These areas may be vulnerable precisely because they are assumed not to be (these hotspot issues remain to be explored in more depth in a subsequent consultation).

Cross-cutting Issues and Strategic Points of Entry for Research

Many of the cross-cutting themes of interest that emerge from reviews of the literature in China and the regional consultations are similar to thematic issues in other regions. Of central importance is the distinction between the underlying systems that constrain or enable autonomous adaptation and more directly planned and targeted strategies. Recent development processes in China have focused heavily on building both the underlying physical and social infrastructure that supports mobility, communications and knowledge accumulation. As a result, a key question in the China context may be whether or not this has already created a high level of adaptive capacity within large parts of the society that reduces overall vulnerability to climate change and, as a corollary, whether extending access to the many populations that lack access would reduce their vulnerability?

For this study, we identified four domains of adaptation research that are relevant for China. These are thematic entry points, in the sense that they provide a way to frame and link research across different disciplines and at different scales to provide insight for adaptation strategies that can respond to emerging needs of people who are vulnerable to climate change. These themes were selected based on the climate trends and knowledge gaps identified in consultations, but with a particular focus on the following criteria:

1. The impacts on poor and especially vulnerable people: this criterion was set by DFID and IDRC, and gives the research a clear "developmental" focus by emphasizing that research investments should benefit poor and vulnerable social groups.
2. Geographic contexts of high climate impact: initial investigations suggested four zones of particular interest due to the confluence of relatively high climate impacts and relatively poor or vulnerable people. These geographical contexts of vulnerability led to the selection of sites for consultations and field interviews, and therefore strongly influenced the identification of adaptation issues. These issues should have high relevance in these geographical areas, but will also provide valuable insight for adaptation elsewhere.
3. Research themes not already well covered by existing programmes: China has an extensive national research programme and there are a number of well-funded donor research programmes approaching adaptation issues already. We have tried to identify issues that are not already well covered by existing research investments.
4. Relevant to autonomous and planned adaptation (see conceptual framework in summary report): Most thinking about adaptation in China so far has focused on planned adaptation, which requires good modelling and impact assessment, as well as dealing with the inevitable uncertainties. Many of the areas we recommend for research attention will support planned adaptation, but they are particularly relevant for autonomous adaptation. The actions of many separate households or local governments will be crucial in overall climate adaptation. These actors are not responding only to climate, but to a broad range of social and economic factors. We have tried to select research themes that

will help to broaden the range of choices they face, and to build local capacities for response, in the face of greater climate stress.

These cross-cutting themes are: 1) **Local management of natural resources**; 2) **Local disaster risk reduction and resilience**; 3) **Migration**; and 4) **Practical and flexible organizational strategies for government**. The significance and rational, relevant research issues and knowledge gaps, as well as the linkages between the geographical areas "hotspots" and vulnerable people and the identified major research themes are summarized in Table 6 of the main report. This table is also included at the end of this section. In addition, we have identified the arena of **knowledge systems** as a key cross-cutting issue area of particular relevance in China.

Local Management of Natural Resources

The proximate impacts of climate change are already being felt in areas of China where people depend on local ecosystems for their livelihoods. In Ningxia, for example, longer growing seasons have led to a northward shift of winter wheat cultivation and increased potato production. These changes will have direct implications for how natural resources are managed. The challenges faced by farmers and other resource users will be manifest differently in different locations. In some areas, water scarcity will be the main focus as the frequency of drought events increases, or as higher summer temperatures and increased water demand lead to reduced irrigation water volumes. Land management practices will have to change in areas of steep slopes as the intensity of rainstorms increases. As carbon sequestration acquires commercial value through global capital flows from a post-2012 UNFCCC framework, this will also affect land and resource management strategies in new ways.

Many areas of natural resource management already receive research attention as is the case with the aforementioned agricultural research. An example of a domain that will become more important in many areas of the country, but is already receiving considerable research attention is water resource management. In these cases, future research investments should consider the relevance of climate change in their planning and execution. However, one example of local resource management that does not now receive much research attention, but is likely to grow in importance, is rangeland management for livestock production.

In both the arid northwest and the Tibet-Qinghai plateau, agricultural intensification is problematic as a long-term livelihood strategy. For example, northwest China receives large subsidies from national poverty alleviation programmes, many of which are currently invested in the expansion of irrigated agricultural production (now 40% of cultivated area). Surface and groundwater extraction already exceed safe limits and climate change will only exacerbate water scarcity. There is already a substantial research community engaged in improving the resource use efficiency of irrigated agriculture, but the area suitable for these kinds of systems will be reduced by future water availability. Meanwhile, many areas of rangeland are experiencing severe degradation, and various conservation programmes and incentive schemes have been launched to reduce grazing pressure, with limited success. In order to minimize further degradation and desertification, innovative rangeland management practices will be essential.

Pastoralists are the poorest and most vulnerable social groups in these regions, and have traditionally relied on culturally-embedded ecological knowledge that is no longer reliable. Current management strategies (sedentarization, enclosure, ecological migration) may

exacerbate social conflict and local economic disparity, and yet fail to address the increasing risk exposure of livestock production in a variable climate. At the same time, there may be opportunities for both biodiversity conservation and carbon sequestration in actively-grazed rangelands. These issues will become more serious under more frequent droughts, as irrigated agriculture fails and more area becomes suitable only for pasture land.

Key knowledge gaps revolve around options for fodder and pasture management, alternative livelihoods and asset diversification in a relatively unproductive agro-ecosystem that is isolated from markets and infrastructure. Increased risk of forage vulnerability poses special concerns for a livestock-based economy, where it can take many years to re-build productive herds. Another issue is how to re-build knowledge systems when traditional pastoral-ecological knowledge based on a stable climate becomes less reliable. The research issues in this domain go beyond questions of animal husbandry, health and natural science to include social issues of benefit sharing and household roles, as well as institutional issues of resource tenure and local governance in the face of changing environmental, economic and policy conditions.

Local Disaster Risk Reduction and Resilience

In the karst uplands, and in peri-urban coastal areas, poor people are vulnerable to further impoverishment as a result of increasing frequency of extreme climatic events, such as heavy rainstorms, floods, typhoons and storm surges. Essential infrastructure and new construction are built to current standards for extreme hydrological or storm events, but as climate changes those standards become outdated. Yet there is surprisingly little critical assessment of the trends in wetland degradation or lowland vulnerability to sea level, storm surges and flooding.

Current approaches to disaster management and infrastructure engineering may be less appropriate when climate becomes more variable. The issues may be not simply engineering standards, but the whole approach to engineering (e.g. safe fail designs instead of failsafe). Institutional mechanisms for local risk reduction, disaster preparation and limited self-reliance in some domains may prove to be more resilient than very costly high standard infrastructure that cannot be feasibly protected from extreme events. In low-lying areas this may include planning for floods by designing retention basins and minimizing flow barriers, rather than building dikes. Innovative engineering and infrastructure construction approaches need to be balanced with new approaches to risk assessment and organizational, institutional and social communication methods (awareness-building, warning measures, hazard specific responses, credit and strategic reserve facilities for recovery). Some of these innovations are emerging already, but there is need for research on how they can be better integrated at the local level to address diverse and context-specific conditions.

Migration

Long-standing regulatory controls over residential registration to control the rate of urban growth in the prosperous eastern part of the country have increased the cost to migrants of relocation. However, benefits from participation in China's urban economic boom have exceeded these costs, and there is growing recognition at the policy level of the economic value of the labour force provided by rural-urban migrants in eastern cities. Yet because they lack official registration, and the social welfare protection it brings (health insurance, pension, unemployment benefits and subsidized housing), migrants are particularly vulnerable in urban areas. The government already recognizes the need for ecological migration and subsidizes local and regional relocation (both voluntary and involuntary)

from ecologically fragile zones. Relocation is identified through international experience as a common autonomous adaptation to climate variability and extremes. Migration is a complicated socio-economic decision, simultaneously creating a new form of individual vulnerability and yet offering the prospect of reducing household vulnerability. Gender and ethnicity are factors in determining how migration plays out in both source and destination areas. The process creates social issues at both ends, and can be mediated by many types of information and communication strategies as well as by transportation and communication infrastructure. There are many potential areas of research and of policy intervention in order to improve the social and economic effectiveness of migration and to foster climate adaptation in both rural and urban areas.

Practical and Flexible Organizational Strategies for Government

Climate impacts and adaptation actions are inevitably local in nature, but local adaptation can be enabled by government actions and socio-economic networks at multiple scales. Research could help to identify and describe these enabling actions and the types of government institutions to best address them. Government structures, budgets and programmes are normally administered sectorally, for example, in vertically-articulated "silos" that are not well integrated or coordinated. In these structures in China, accountability is almost entirely upwards to the centre. As a result, even when significant government resources are devoted to ecosystem management and climate adaptation, local implementation is often uncoordinated and unresponsive to contextual priorities. Effective climate adaptation will recognize and support the initiative of local actors. This suggests that policies and programmes be flexible enough to be implemented differently in different places, and that oversight mechanisms encourage accountability and transparency of decision-making both upward and downward.

There is also a need for greater flexibility in responding to emerging and unpredictable local issues without necessarily creating new government organizations. For example, climate vulnerability of poor migrants in peri-urban coastal areas is not only a function of geographic exposure, but also their insecure livelihoods and lack of access to social welfare benefits. In high density urban areas, all of these factors combine to create public health risks as well. To address climate adaptation issues for this group will require innovative and coordinated responses not only between local government agencies with different sectoral responsibilities, but also with national level ministries. Some kind of flexible task force or "*ad hoc*" local coordinating committee will be needed. Similar types of issues will emerge in rural areas as well. The mechanisms for combining budgets and technical resources from different agencies to tackle such emerging adaptation issues need to be better researched.

In the long term, climate change will demand better institutions for adaptive management; i.e. a willingness to take management decisions for complex systems in the face of uncertainty and risk, but to view interventions as learning opportunities, examine outcomes critically and share lessons. Research can help to develop such institutions suited to Chinese conditions.

Knowledge Systems

In all of the above research themes, a pervasive challenge is the way that knowledge and learning are structured in China's expert-driven society. Adaptation will require local learning as part of adaptive management. Technological innovations are likely to require local modification for effective climate adaptation. Ecosystem response to new techniques will inevitably vary depending on dynamic local conditions (including climatic factors, but also pollution and intensification of resource use). Experts will not be able to predict how specific

TABLE 6: **China Summary of Climate Adaptation Research Themes by Regions of High Vulnerability and Climate Impact**

	Arid Northwest China	**Tibet-Qinghai Plateau**	**Karst Plateau**	**Densely populated coastal conurbations**
Vulnerable social groups	Rainfed agriculture farmers Irrigation farmers (if water supply threatened) Pastoralists	Pastoralists	Mixed farmers Small urban settlements	Peri-urban migrants
Nature of climate impacts	Higher temp Greater precipitation variability Reduced surface water supply Some cultivated land may return to pasture	Higher temp Higher proportion of precip as rain Changing pasture management	Higher temp and precip Higher frequency and intensity of storms Landslides, flash floods	Sea level rise Floods Typhoons Storm surge
Research Themes and Issues by region				
Local Natural Resource Management	Water management (already well-funded and studied) Rangeland management	Rangeland management	Soil and water conservation (well studied already)	Limited applicability in urban areas
Local Disaster Risk Reduction and Resilience	Risk of floods may increase with storm intensity and variability		Frequent local disasters lead to infrastructure failure: potential design, planning or organizational reforms might increase resilience	Providing better access to housing for non-registered migrants Infrastructure design for extreme events and sea level rise Disaster risk reduction and multiple hazards in high density areas
Migration	Outmigration from high-risk rainfed areas to irrigated areas; from rural areas to cities; from region to east coast - factors likely to facilitate employment, remittances, resettlement	Historical seasonal migrations of pastoralists may be affected by sedentarization and pasture change	Outmigration to large urban centres	In-migration from rural areas: how to build skills, speed adjustment, improve services and welfare benefits for vulnerable groups
Organizational and governance strategies	Mechanisms to promote cross-sectoral and cross-disciplinary coordination Improved downward accountability of local governments to increase responsiveness to specific local conditions Flexible and *ad hoc* collaboration in program delivery to improve effectiveness and responsiveness to local context Local consultation mechanisms Integration of local and indigenous knowledge in adaptation options			

techniques will perform in diverse and dynamic contexts. Surprise will be the rule, rather than the exception. Under these conditions, new approaches to shared learning and expertise will be needed. These approaches will recognize the value of diversity, rather than uniformity, in local and regional response strategies to foster resilience. They will address plural sources of knowledge and evidence. Most of all, these new approaches will have to build practical local strategies for experimentation, local and scientific assessment, and systematic sharing of learning.

With high uncertainty about ecological changes linked to climate and resource exploitation, together with urgent livelihood needs, there is not enough time for comprehensive research and analysis of long-term options. Yet innovation will be essential. New ways must be found

to support local initiative and creativity in combination with scientific expertise and knowledge of good practice. Relevant issues could include the reform of agricultural extension systems, strengthening regional expertise and capacity in both government and research, the role of private enterprises in responding to innovation incentives, and how best to connect local adaptation opportunities to national and global resource flows (such as market incentives for carbon sequestration).

There is no shortage of innovation and local initiative in China, but local access to scientific knowledge, as well as systems of adaptive management and shared learning are not well-developed even in coastal areas where capacity and resources are plentiful. In poorer and more remote areas research capacity is relatively weak even at the level of provincial academies, never mind the county (local) government. Part of the issue is providing better local access to national scientific knowledge networks, and part of the issue is translating scientific and technical innovations into practical and locally relevant formats that can be easily accessed by practitioners. Reforms of the agricultural extension system could contribute to building these more responsive local knowledge and learning systems. Another way to approach this would be to build participatory research capacity among provincial academies, who can then engage with both national-level interdisciplinary scientific support, and county level implementing agencies, as appropriate to test adaptive management interventions.

Key Actors & Capacity Requirements

National level research organizations (such as CAS, CAAS, CASS, NCC) and are key actors in climate change study but limited numbers of people are working on climate change adaptation. Limited number of NGOs and international research centres (e.g. WWF, ICRAF) are also studying the issues but more from local prospective.

One key government agency for adaptation innovations in China will be the National Development and Reform Commission (National Development Reform Commission) and its provincial / county counterparts. This is an essential policy agency for adaptation responses that require mobilizing resources, ensuring access to knowledge across sectoral "silos" and coordinating across the domains of different sectoral agencies (water, agriculture, health, transportation). They may not be directly involved in research projects, but should be key players in promoting institutional innovations that enable autonomous adaptations.

Other national level government agencies include the Ministry of Science and Technology (MOST), National Natural Science Foundation (NSFC) which are responsible for funding basic and applied S&D research in many areas including climate change adaptation.

County level government agencies are also key actors because of their responsibilities for programme delivery, local service quality, regulatory oversight and problem-solving in relation to poverty reduction and natural resource management. Their high level of local knowledge and practical responsibilities are not matched by engagement in the research system at present. Indeed, most local government agencies have little time for scientific research, which is typically viewed as too impractical and "academic" to address difficult local problems.

Some bilateral and international collaborative institutions also have being playing significant role in promoting the concept and action research on climate change adaptation. DFID is no doubt one of them as well as World Bank.

Synthesis: Consultations, Literature Reviews & Our Analysis

Consultations & Literature

Overall, our review of the literature combined with inputs from the consultations indicate that most work and thinking that is labelled on "adaptation" focuses on: (1) improved modelling and collection of climate and economic data for refining projections of climate change and its likely impacts on populations, ecosystems and the programmes of international donor agencies; (2) national planning activities, that, in most cases, call for strengthening existing areas of activity (such as drought or flood proofing) that can be directly related to climate change; and (3) community-based initiatives, mostly catalyzed by NGOs, that involve local agriculture, disaster risk reduction, ecosystem management and "environment" or "livelihood" related interventions.

In regards to the first point, the consultation exercise highlighted interest from some stakeholders to improve precision of climate information, while others identified the limitations of climate projections at the local level given the uncertainties of climate variability and impacts, modelling tools and existing data. In this context, our own analysis suggests that while there is significant value in understanding climatic impacts and biophysical vulnerabilities and of ensuring access to this information by different stakeholders, the complexities of vulnerability that limit adaptive capacity in the first place and the need to support strategies to respond to uncertainty and surprise are equally important.

Secondly, much existing work focuses on national planned adaptation efforts, particularly on water, agriculture, and infrastructure systems. This has included research to develop climate-resilient technologies and practices within sectors especially irrigation, flood drainage and other infrastructure; water conservation and the development of climate resilient crop varieties. Such critical areas will need to be considered in climate adaptation efforts, and are already receiving substantial research support. However, in many of the consultations it was also pointed out that there has been limited long-term assessment of actual practice of technologies, particularly in dynamic environments as climate, intensification of resource use and economic factors change the conditions for which such technologies were originally designed. Our own analysis also suggests that this is a critical area. The literature reviews and consultations also revealed that limited attention has been paid to marginal production systems (rangelands, fisheries, subsistence agriculture), and predominantly has focused to date on technological interventions, with limited attention to institutions and social networks or underlying systems. Less attention was paid to equally important sectors of transportation, communication, health, and financial mechanisms.

Where community-based initiatives for disaster risk reduction are concerned, the third theme that emerged regularly in the consultative process and literature review, was better documentation and learning of existing efforts "on-the ground", and of the need for stronger linkages between the disaster risk reduction and adaptation research/action communities. Potential limitations of community-based approaches for adaptation in the context of macro transformative changes and dynamic nature of "communities" were, however, also raised. In essence, substantial questions emerged during the review and consultative process regarding the ability of community-based initiatives to address adaptation needs as conditions change.

Other gaps that were stressed during the consultation process include the need for improved understanding and awareness of climate change, potential impacts, and adaptive strategies among different actors – particularly by local governments, local NGOs and vulnerable populations. The importance of the "last mile" of communication to ensure that "local" users can obtain information—about climate and water events, agriculture and water technologies and practices—was raised across the region. The lack of sharing of information across organizations and sectors was also raised. Less discussed was the importance of support to underlying systems that support communication and education, including enhancement of extension programmes.

In both the group and one-on-one consultations, dialogue around research themes tended to concentrate in the three areas described above. However, at the same time, emerging priorities included the social context underlying adaptation with linkages to poverty; economic analyses for assessing adaptation; stronger attention to issues of urbanization, migration, and health; and increased attention to autonomous adaptation strategies. A key priority that strongly emerged across the region was the importance of local governments, and their capacities, in supporting adaptation measures, and the need for any effort to engage actively with this level of governance. Correlated with this point was the challenge of governance across scales, and in particular the disjuncture that exists between national level planning and local level realities and priorities. The need for more flexible policies and mechanisms to streamline learning in both directions was emphasized.

A matrix capturing key issues raised in the consultation process is found in Annex III. As previously mentioned, our analysis attempts to move away from a laundry list of activities, to focus on key priorities across the three sub-regions of China, Southeast Asia, and South Asia. These points emerge from the consultation processes (group, one-on-one meetings, other regional events) and the literature review, but are strongly embedded in our conceptual approach and the strategic and tactical issues described earlier. Of particular consideration is where research may address priority gaps that have received less attention but yet which have the potential to make the largest impact at scale.

As a final point before proceeding to elements emerging from our own analysis, it is important to note a few areas that, somewhat surprisingly, did not emerge as central in the consultations. Forestry issues, including the possibility for linking adaptation and mitigation through either proactive afforestation or avoided deforestation, was only minimally discussed, primarily in Southeast Asia. The potential of the Reducing Emissions through Deforestation and Degradation (REDD) mechanism was a main point of discussion, and concerns were raised about consideration of possible repercussions of REDD on poor and vulnerable groups who may rely on areas demarcated as protected forests, as well as questions of who benefits from payment mechanisms. Similarly, forestry and payment for

ecosystems services issues did not emerge as major points of discussion in any of the consultations or, for that matter, in the EEPSEA conference (somewhat of a surprise since that is specifically and environmental economics meeting). Due to the limited time and resources available for the consultations, the adaptation study team was unable to explore in depth why such issues did not feature in the consultations. As a result, the absence of such issues in our analysis should not be interpreted as indicative of national positions or the relative interest of specific research communities.

Our Analysis

In addition to the issues that emerged in both the consultations and literature review, a number of issues appear important as a result of our own analysis. These issues are derived primarily on the basis of the conceptual framework and our prior research. As discussed below, however, although not directly raised in the initial consultations, discussions often touched on closely related questions or dynamics. In addition, during the second round of consultations, once participants had been exposed to our conceptual framework, these issues were given substantial attention. We believe, as a result, these issues would generate widespread ownership once a research programme was underway. Two research issue areas appear to us of particular importance: (1) social protection systems for vulnerable groups that are not able to adapt as climate conditions change; (2) the links between adaptation and mitigation, particularly in rapidly diversifying economies. In addition, as discussed at the end of this section, continued attention needs to be paid to the conceptual basis for understanding adaptive processes within social systems. The conceptual approach we have used for this analysis is, admittedly, preliminary. While it points toward important relationships and points of entry, other approaches would probably help to identify elements that are not highlighted by the framework we have used. .

Research Issues

First, where social protection systems are concerned, discussions in the consultations and the literature focused primarily on the factors that can assist vulnerable populations in adapting to climate change. Relatively less discussion, except in the final consultation in South East Asia, focused on mechanisms for responding to the needs of populations that, for whatever set of reasons, will not be able to adapt. The conceptual framework we have used as a basis for analysis recognizes that at least in some cases, access to the basic resources, infrastructure and social networks that contribute to adaptive capacity will either be blocked, for example, by the factors that contribute to social exclusion, or for other reasons and thus will prove insufficient for successful autonomous adaptation. As a result, many people within vulnerable groups may face major declines in their livelihoods and wellbeing. As a result, safety nets that can assist such populations are likely to be required. We believe this is likely to be an issue of local, regional and global importance on a combination of equity and other grounds including political and social stability. Despite the absence of much specific discussion of this in the consultations, this belief is validated by the overall interest in questions of poverty and vulnerability that was evidenced by people contacted throughout the review.

Second, where the links between mitigation and adaptation are concerned, many of the discussions in the consultations pointed toward factors such as economic diversification, urbanization (or the blurring of the urban rural divide) and migration as central to adaptation but until exposed to the conceptual framework where use of energy, water and ecosystem

resources is linked to behaviours through the functioning of social and physical infrastructure systems, they did not make any specific link between these adaptive responses and mitigation of greenhouse gas emissions.

A separate analysis ISET has recently undertaken for DFID highlights the growing importance of "peri-urban/peri-rural "*desakota"* zones that are the locus of much economic intensification across much of Asia.[5] We believe such zones are likely to grow as climate change stresses agricultural livelihoods and people diversify into often more energy intensive non-agricultural livelihood systems. Because such zones are new and growing rapidly, the energy and transport infrastructure and use systems on which they depend are often currently being developed rather than deeply embedded parts of the built environment as they are in urban core areas. As a result, particular opportunities may exist for the introduction of "green" transport and energy technologies that assist adaptation but also reduce greenhouse gas emissions. If this proves true, such zones could serve as a nexus linking both adaptation to climate change and opportunities for mitigation of greenhouse gas emissions. As a result, our own analysis suggests this could be a key entry-point for research and experimentation.

The specific opportunities that may be present in rapidly diversifying peri-urban/peri-rural zones represent, our own analysis suggests, what could be a key link between adaptation and mitigation. Many "adaptive" responses to climate change involve energy intensification. ISET is, for example, involved in the Rockefeller Foundation funded programme on Climate Resilience in Asian Cities. Discussions with groups focused on urban climate issues across Asia as part of that programme emphasized the massive demand for air conditioning now emerging as temperatures in urban core areas increase. From their perspective, this demand isn't just from wealthy homeowners. Instead, much of it is emerging as businesses and factories try to maintain processes and the productivity of their workers. Overall, cooling of homes and workplaces is likely to be a central "adaptive" response climate warms. Similar links between adaptation and energy use are likely to emerge in other areas such as transport and the diversification of livelihoods as well. As a result, our analysis suggests that interventions to reduce the energy requirements of cooling, transport and other economic activities represent broad cross-cutting point of entry for supporting both adaptation and mitigation. This analytical perspective is, we believe, validated by the larger interest in questions of mobility and economic diversification evidenced by many people in the course of the consultations. Although the energy implications were not specifically discussed, they are inherent in the adaptive activities identified in both the consultations and the literature.

Conceptual Research Issues

The nested set of relationships between basic resources, social and physical infrastructure systems and the social mobility, networks and markets they enable that forms the core of our conceptual framework for understanding adaptation served as a strong basis for discussions in one-to-one interviews and many of the consultations. In some cases, such as in the China consultations and the meetings we held in Nepal, participants commented that the concepts were directly useful to them as a way of helping structure the diverse array of debates over adaptation to climate change. As our literature review revealed, few conceptual frameworks on this exist. Discussions regarding adaptation are common – but almost none of them refer to any organizing conceptual framework for explaining what "adaptation" is or its driving processes.

[5] This parallel review focuses globally on the changing role of ecosystem services as mixed economy "desakota" regions grow. The term desakota refers to household economic systems that combine urban and rural elements.

The above said, the conceptual framework did not go unchallenged. The South East Asia component of The Adaptation Study Team was uncomfortable with the layered connections being made between resources, social and institutional infrastructure and networks as a framework for understanding the opportunities and constraints people face and the adaptive decisions they make. They were also uncomfortable with the analogies between selective processes operating in natural ecosystems and those driving adaptation. Instead they saw adaptive processes being driven more by social relations. These challenges point to long-standing conceptual differences between branches of anthropology and sociology that are often highlighted in interactions with other disciplines such as economics and systems theory. Such differences won't be resolved here. They are, however, important to recognize. The conceptual framework we have developed and used as a lens to identify points of entry for research highlights certain types of interactions and relationships as important. Other conceptual frameworks would highlight other potential points of entry.

At present, debates over adaptation to climate change are at a very early stage. Alternative conceptual frameworks have not been widely applied to the specific challenge of understanding adaptive processes in social systems facing climate change. While these will emerge over time, at present there is little basis for testing the explanatory basis of any given framework. As a result, our own analysis suggests that continued development of new conceptual frameworks and challenge of existing ones should be a core component of any research programme.

Cross-Cutting Issues & Points of Entry for Research

Cross-cutting issue areas for research are identified in the accompanying table and discussed further in the sections below along with more specific points of entry.

TABLE: **Research Issues**

	Specific cross-cutting issue areas for research
1	The factors enabling and constraining autonomous adaptation
2	The role of migration in adaptation
3	Management of and production in critical but less researched ecosystems: rangelands, inland and estuarine fisheries
4	Health systems
5	Governance of adaptation across scales
6	Knowledge systems for dealing with uncertainty
7	Social protection systems to support climate adaptation
8	Local disaster risk reduction and resilience
9	Water allocation, management and governance in conditions of relative scarcity and abundance
10	The role of financial mechanisms in spreading risks
11	Livelihood security for small farmers and fishing communities

Although most issues related to climate change and poverty have regional or location specific dimensions, many research, capacity and experience gaps exist that are common across the region. Addressing these common gaps is, we believe, essential in order to develop effective responses to climate change and the impacts that will have on poor and vulnerable populations. Key common gaps are discussed in the sub-sections below. How each of these have emerged from the consultations, literature reviews and our own analysis is indicated along with any links they may have to the strategic and tactical considerations identified earlier in the report. Before going into specific entry points for research, however, a few broad points that have emerged from the analysis are important to note.

First, the central role of interdisciplinary approaches needs to be recognized. In both the consultations and our own analysis most topics identified involved multiple disciplines and interactions across scales. At present research and experience exist in the form of community-based case analyses and macro-policy and economic analyses. Far less work is available that links the local with the regional and global. This is particularly true in relation to the informal market, communication, trade and financial systems that our analysis suggests enable and constrain courses of action at the level of households and businesses. It is also true in relation to the presence of potential tipping points within interlinked socio-ecological

systems, particularly those related to water, as climate change proceeds. Floods, droughts and storm impacts on watersheds and also more incremental processes of, for example, water quality or ecosystem change can be moderated where land-use mosaics enable maintenance of critical buffer strips, wetlands and so on. Interdisciplinary research that links critical hydrologic and ecosystem processes with institutional mechanisms for maintaining land-use mosaics will, as a result, be particularly important in responding to climate change. As a result, interdisciplinary research and analysis on the institutional and other systems that link and cut across different scales is important as a generic theme running across virtually all of the more specific research themes identified below.

Second, processes for translation of learning/experience to impact at scale are a key common issue. At present, the processes most groups advocate for translation of projects to scale focus on government policies, the programmes of international donors and, at a much more limited level, the activities of NGO groups. Private sector involvement is often discussed but rarely actualized. Impacts at scale can often be achieved through governmental projects or policy interventions when they relate to activities that can be targeted toward a clearly defined objective. This may often be the case in relation to planned adaptation. Supporting autonomous adaptation process is, however, far more complex. As with development in general, the effectiveness of strategies may only be evident in hindsight. As a result, mechanisms for learning and adjusting strategies as experience is gained will be essential. Research and capacity building related to adaptive management and learning processes represents a key point of entry for this.

Third, beyond learning processes, strategies for engaging with the broad array of relationships that shape the structure of economic activity within large populations – the formal and informal businesses, organizations and networks – will be essential. Here much engagement will depend on the incentives organizations perceive. Simply calling for "stakeholder" engagement is unlikely to draw much response. Models for engagement that focus on the innovation and incubation of technologies, organizational forms, knowledge, etc…*that can be replicated using public or private sector operational business models* are important to explore. The insurance industry is already deeply involved in climate adaptation debates precisely because those debates relate directly to their core area of business. Similar incentives may exist in relation to other institutions and business arenas such as transportation, communications, finance and regional economic development – but most have yet to be explored.

THE FACTORS ENABLING & CONSTRAINING AUTONOMOUS ADAPTATION

Research on the factors enabling and constraining autonomous adaptation processes is a central need. Autonomous adaptation processes – responses to the impacts of climate change by individuals, households, businesses and other entities – are likely to heavily dominate "planned" adaptation. Most research and policy dialogue, however, focuses on planned strategies. Research that identifies the underlying systemic factors enabling and constraining autonomous adaptation processes could as a result identify tangible courses of action that have direct relevance for poverty alleviation. Prior research by ISET and our analysis here suggests that systems of particular importance in climate adaptation are those that: (a) relate to basic resources such as water that will be directly affected by climate change; (b) enable economic diversification and flexibility. The development of water management systems that are adapted to climate variability and both flexible and resilient under changing conditions will be essential. Similarly, the nature and resilience of underlying energy,

communication, financial (banking, credit and insurance), health and transportation systems is central to economic diversification and flexibility. These systems serve as gateways to opportunities for mobility and economic diversification. Access to such systems is often enabled or constrained by the presence of pluralistic institutions that provide multiple avenues for vulnerable groups to access their benefits. Understanding of such systems and institutions along with the roles they play is, as a result, a strategic point of entry for supporting autonomous adaptation. It is also a key point where adaptation, mitigation and development are could be linked through the diffusion of "green" energy and other technologies, where research could lead to tangible interventions that are replicable at scale and that could support engagement at multiple levels. This is particularly true in "peri-urban/peri-rural" areas with emerging and dynamic mixed economies: i.e. the locus of much economic intensification and resource demand across Asia.

Key specific entry points for research on the factors enabling and constraining autonomous adaptation include:

Woman collecting water from well in Gujarat

1. Research on the degree to which economic diversification in household and regional livelihood systems actually mitigates the impact of climate change on populations and vulnerable communities within them: Is diversification central to adaptation? Does diversification within livelihood and economic systems reduce vulnerability and, if so, how? Are new sources of vulnerability (such as increased dependence on global systems for fuel and food) introduced as diversification proceeds?

2. Research to test the link between penetration of (and access to) basic energy, water, transport, finance, health, communication and other infrastructure, diversification within livelihoods and or the ability to shift strategies as conditions change. Is access to such systems a critical factor enabling strategy shifting? Is differential access to such systems on the basis of gender or other social factors a major factor creating vulnerability and limiting adaptive capacity? How can patterns of differential access be addressed?

3. Research to identify opportunities for encouraging the diffusion of low energy technologies to support diversification and mobility in areas undergoing rapid economic development. This is a key area linking adaptation and mitigation. Key focal areas for this could include mechanisms for lifting/ pumping water which are not diesel dependent, e.g. solar panels in Kutch, transportation and cooling systems in peri-urban areas and the smaller rapidly growing towns and cities.

Research on the above is relevant across much of South East Asia, South Asia and Eastern China, particularly along transport corridors where processes of economic intensification may be most intense.

This research area has been identified on the basis of both our own analysis and results from the consultations. The consultations identified factors such as migration, mobility and economic diversification as central to autonomous adaptation. Our analysis and the conceptual framework point toward the underlying role of social and institutional infrastructure in enabling or constraining such adaptive processes.

The Role of Migration

The role of migration, commuting and general increases in population mobility is increasingly recognized as central to climate adaptation and emerged in the literature review, the consultations and as our own analysis based on the conceptual framework. Research increasingly points toward the central role migration plays as a proactive (as well as reactive) component in the strategies individuals and households use to respond to the impacts of climate conditions. Understanding the role of migration and the factors driving it will be central both to identifying tangible courses of action for assisting vulnerable communities and managing the societal and other impacts of climate change at a global level. Key research entry points on this include:

1. Services for supporting migrants and mitigating the negative impacts migration can have on vulnerable groups such as children, women and the aged. Specific support systems of importance for migrants including access to health, education and finance in both source and recipient areas, could be a key entry point for research.

2. Improve understanding of the necessary assets, including social support networks, that enable migration, particularly of poorest groups, who often lack needed financial capital, skills, knowledge and capacities, and identify actions and policies that may support them.

3. Improve understanding of the new vulnerabilities migrants may face, particularly when they shift from rural land-based livelihoods to urban livelihoods. The issue of food security and "feeding the cities" in increasingly interlinked global economic systems may, for example, have particular implications for migrants who are often employed in low-skill jobs with little option for increasing their earning power when prices rise. Other sources of increased vulnerability (e.g. lack of tenure rights which determine access to social security, exposure to urban/gender violence) may also be present.

4. Evaluate the role of remittances in adaptation. Key researchable entry points here could focus on: (a) the conditions that encourage remittance flows to be invested in supporting adaptation in migrant source areas; (b) the degree to which remittances could serve as sources of social protection; and (c) the removal of institutional constraints in remittance flows. Research also needs to explore the reasons that remittances don't necessarily 'flow' – they are often irregular, often physically carried on their person when migrants return home and are subjected to scrupulous border security.

5. Improve understanding of the informal institutions for finance, water supply, health and other services that migrants draw on to meet many of their basic needs. This would also apply to the issue of remittances noted above.

6. Migration policy in the context of climate change: many countries place restrictions on migrants that are increasingly reinforced by the assertion, often violent, of neo-nationalist identities and security concerns, particularly in South Asia. If migration becomes a central strategy for adaptation, then new policy frameworks may be required.

Specific locations for research on this would include major source areas, such as the highly vulnerable Eastern Ganga Basin, Mekong River Basin, the middle hills of Nepal and the Deccan plateau. Both international and in-country destination areas for migrants, including urban areas and the rapidly diversifying peri-urban/peri-rural zones already identified above could also be a focal location for such research.

Critical yet Less Researched Ecosystems

Increased production in critical ecosystems (arid zones, wetlands and uplands) could play a central role in climate adaptation. Research on the impacts of climate change for major agricultural production systems is already a major theme for many national governments and other entities. Other production systems are, as emphasized in the regional reports on China and Southeast Asia, often central to the livelihoods of the poor and are also particularly vulnerable to the impacts of climate change. Freshwater fisheries and wetlands in major river basins, coastal and estuarine ocean and brackish water systems and upland rangelands are likely to be particularly affected by climate change and play particular roles in the livelihoods of poor and vulnerable populations. In addition, in some cases (such as where increased flows in river basins contribute to the growth of wetlands), innovative approaches to climate-adapted management could increase the productivity and resilience of such systems. In the Ganga and other major river basins, for example, devoting increased area to wetlands and village ponds could enhance freshwater fisheries, increase groundwater recharge and buffer floods. Similarly, in coastal areas new approaches to aquiculture that address the ecological problems associated with shrimp and fish farming could utilize the increased brackish water areas anticipated as a consequence of sea level rise and storm surges. Specific points of entry for research on this include:

1. Livestock in arid, semi-arid and upland ecosystems. As noted in the China and South Asia regional reports, livestock are a critical factor in the ability of populations to live within areas where climatic variability is high. The role of livestock as a key asset for poor and vulnerable populations is also well known. Research on strengthening livestock production systems and enhancing returns through improved market linkages of derived products may enhance populations respond to the impacts climate change.

2. Wetland fisheries and related production systems. In major river basins and their estuaries such as the Ganga and Mekong, increasing climatic variability may increase flood risks. Approaches to water management capable of responding to this may require strategies that expand riparian and wetland areas capable of serving as flood and storm buffers. This could have major ecosystem benefits but will be socially difficult to achieve given high population densities unless the economic and livelihood productivity of such areas can be increased. Inland fisheries and wetland agriculture represents a potentially key avenue for achieving this and would build off the existing livelihood strategies of many groups in such regions. Similarly, in deltaic areas increasing salinity as a consequence of sea level rise and storms will increase the importance of brackish water fisheries and agriculture. As a result, this represents a potentially strategic entry point for research. Key elements in a research programme on this are noted in the regional sections.

Specific locations for research on livestock issues includes: (1) the arid zones in Pakistan, India and China including the Deccan plateau; (2) the Tibet-Qinghai plateau; and (3) the middle hills of Nepal and other high mountain regions. Specific locations for research on wetland and estuarine fisheries and related production systems would include: (1) the central Ganga and Mekong basins; (2) deltaic areas in the Mekong, Indus, Ganga-Brahmaputra and other major river systems.

This key research entry point has been identified on the basis of both our own analysis and results from the consultations. The conceptual framework highlights access to ecosystem services (water and food) as central to adaptation. This also emerged regularly in the consultations. Because substantial existing research focuses on the impacts of climate change on major agricultural systems and the systems above appear central to climate adaptation in key areas but have received far less attention, we view them as strategic entry points.

Health Systems

The potential implications of climate change for human health emerged in many of the consultations. Discussions focused heavily on the potential for spread of infectious diseases such as malaria and dengue, and waterborne bacterial and other vectors. In addition, however, health stress in some environments, such as urban areas, may be caused by temperature increases alone. The likely impacts of climate change on human health are poorly understood as are the potential avenues for addressing them. Concerns about the indirect impacts of climate change on food and nutritional security were also raised. Poor health is a major factor contributing to vulnerability, and directly affects the capacity of individuals and families to adapt to climate change. Research is needed to better understand these new health threats, and potential avenues for addressing them, in order for any adaptation efforts to be effective. Key entry points on this, however, include research to:

1. More clearly identify potential direct and indirect impacts of climate change on human health across different gender and social groups. This would include both the spread of pathogens and direct impacts through changes in temperature in key locations such as urban core areas.

2. Identify barriers to successful health-related planned and autonomous adaptation to climate change stressors. This could include the specific issue of health services for migrants.

3. Develop and test social, technological, institutional and policy measures to overcome such barriers. In addition to issues such as health services for migrants, the potential connection between health and cooling may represent an important point of entry to explore that would link the health dimension of adaptation with GHG emissions issues.

Health issues were noted in many of the consultations. In most cases, however, the discussion was very general. As a result, the points of entry identified above are based more on our own analysis than specific inputs received in the consultations.

Rapidly urbanizing areas and mixed-economy peri-urban/peri-rural zones appear to be a strategic location for research on health issues. These have large mobile migrant populations that may be particularly susceptible to the impacts of climate change on health. They also combine the high waste loads, concentrated populations and poor sanitary conditions that are conducive to major disease outbreaks.

Local Governance

Currently, there are disjunctures between local level realities and national level policies. Mechanisms are required that can ensure national policies are informed by, and flexible enough to be implemented in ways that respond to local level needs and priorities. Local agencies require improved capacities and instruments for inter-sectoral and multi-stakeholder planning to strengthen local institutions and adaptation planning. Particularly in urban areas the nature of local governance systems will have a large impact on settlement patterns and the types of infrastructure and institutional support systems that affect vulnerability for poor and marginal populations. Patterns of settlement in urban flood plains, the presence or absence of effective disaster risk reduction strategies, the availability of health facilities and the control of potential disease vectors – all these ultimately reflect

the nature of local institutions and governance systems. Specific points of entry for research on local governance and the links with climate adaptation could include:

1. Identify institutional mechanisms that facilitate more effective linkages horizontally between different agencies, and vertically between local, meso, and national levels to enable flexible policies and practice that enable adaptation at the local level.

2. The role of local government entities in urban areas and rapidly growing peri-urban areas in activities that are directly related to climate adaptation including: (a) flood control; (b) disaster risk reduction; (d) water supply; and (d) drought relief. There are numerous specific existing programmes in many countries on these topics that could serve as a basis for targeted research. Flexible, adaptive management strategies would be a particularly important entry point on this.

3. The role of local governments in supporting or constraining migration and services to migrants. This links to the migration issue area.

4. The role of local governments in supporting economic diversification either directly or through the provision of basic social and physical infrastructure systems. This links to the research area on the factors enabling and constraining adaptation.

5. Typically, most local governments have been involved in disaster management, particularly post-disasters. There is a need to build capacity and engage in paradigm shifts that link short-term disaster responses or DRR to climate risks.

This issue area cuts across most regions. It may, however, be possible to develop strong synergies by focusing on cities where the Asian Cities Climate Change Resilience Network (financed by the Rockefeller Foundation) will be working. The network is currently going through a process of city selection in India, Vietnam, Thailand and Indonesia.

The role of local governments emerged as strategic point of entry for research in many of the consultations. This role is also implicit in our conceptual framework as part of the key social infrastructure layer. It is of direct tangible importance to climate adaptation debates because, although many processes are global, most impacts will be local.

Knowledge Systems for Dealing with Uncertainty: Water, Economics & Policy

Knowledge systems for institutional and infrastructure design in key fields such as water resource management that do not require specific or probabilistic information on future climate conditions, that is, that have greater capability for dealing with uncertainty, are essential. Major investments are currently being made in research and other activities to improve the precision of climate information. Given inherent uncertainties in modelling process and limitations in the basic data on which they are based (a particular constraint in developing country conditions), this is unlikely to provide reliable probabilistic information regarding basic hydrologic parameters. As a result, the viability of conventional strategies for designing water resource infrastructure, insurance systems and institutions for water management (flood zoning) that requires such probabilistic information will be severely challenged. Given the massive existing investments now going into improved climate

modelling and data along with the inherent uncertainties regarding the additional information this will produce, improving the resolution of local climate projections does not represent a critical gap limiting adaptation. Instead, the development of knowledge systems for institutional and infrastructure design that do not require probabilistic information on future conditions is seen as a critical gap.

Specific points for research and action on this topic focus:

1. On avenues for introducing a better understanding of uncertain climate conditions into the basic principles of water resource analysis and engineering design. How robust are projections of future probabilities? Can approaches to water management be designed that do not require knowledge of such probabilities?

2. On economic analyses of the costs and benefits of disaster risk reduction or, for that matter, any investment in adaptation. Current "best practice" for economic analysis of risk reduction focuses on probabilistic techniques. While logical, this will be an inadequate avenue for justifying or evaluating investment possibilities if the probability of extreme events or other climatic conditions remains difficult to predict. As a result, research to identify techniques for evaluating the economic viability of investments under uncertainty is a key strategic entry point.

3. Strategies to improve decision-making under uncertainty. Virtually all decisions related to investment or policy changes in relation to climate change will be made under conditions of high uncertainty regarding location specific impacts. We believe that improvements in modelling are unlikely to resolve this. As a result, improved strategies for decision-making that reflect inherent uncertainties are essential.

Specific locations where this research would be particularly relevant include the Ganga, Mekong and other major river basins and deltas – but the issue is widespread across virtually all regions studied. These entry points respond to key strategic and tactical considerations – in specific the need to identify tangible avenues for climate adaptation that can be justified on an economic basis. Both themes were present in a number of the consultations and are also implicit in the conceptual framework.

Social Protection Systems to Support Climate Adaptation

The ability to adapt to climate change will be heavily affected by social differentiation; i.e. the wide array of gender, ethnic, economic and other factors that enable or constrain courses of action within all social systems. The development of social support systems capable of addressing the needs of those who face major constraints in adapting to climate change will be a major factor determining future patterns of poverty. We believe the factors that determine access to the systems supporting autonomous adaptation will be among the most important elements in social protection. Key points of entry for research and experimentation on this include:

- Basic research to improve understanding of the factors that differentiate some to have better access to social security benefits and mechanisms than others, including the efficacy and resilience of informal social security institutions such as cooperatives, kin enclaves and credit networks in the face of climate stressors;

- Identify mechanisms, institutions and policies to strengthen reach and accessibility of formal social security mechanisms to poor and marginal groups, including women. As part of this focused research on differential access to social and other services for migrants and for groups such as women, minorities, children and economically disadvantaged groups. Key services will include water, power, sanitation, health, education and finance (banking, credit and insurance).

- Mechanisms that enable both internal and international mobility for climate-affected populations including the ability to change locations of residence;

- Standard working conditions for mobile and vulnerable portions of the populations;

- Research on the development of appropriate and effective micro-credit and micro insurance models that are relevant to cultures, practices and socio-political contexts of the SEA and South Asia region. It is important to recognize that credit as a mechanism enabling access to the resources required for strategy shifting may be as or more important than insurance with respect to climate adaptation.

Experimentation and research on systems that can provide such services in rapidly changing and dynamic environments represents a critical point of entry for addressing the nexus between adaptation and poverty.

Key Actors & Stakeholders to Engage With

The range of key actors it will be important for the programme to engage with varies from sub-region to sub-region within Asia and often depends on the specific context or issue being addressed. In a generic sense, however, there are many commonalities across them. These broad groups of organizational types that will be important to work with are listed in the table below.

TABLE: **Research Issues**

Key stakeholders for the research programme to engage with
1 Research and policy networks
2 Policy making agencies operating across and within sectors at a national level
3 Local and regional governments
4 Private sector organizations, particularly those involved in the innovation and incubation of new technologies, services and institutions
5 Scientific and educational research institutions particularly those with interdisciplinary programmes
6 National and international NGOs
7 Civil Society and community-based organizations

The above mix of actors reflects the capacities we believe will be required to catalyze adaptation at scale. Research and policy networks that include policy-making agencies operating across and within sectors and interdisciplinary scientific and educational organizations are essential for cross-regional learning and to link knowledge generation with major decision-making processes. Local and regional governments are, however, likely to be the governmental entities most directly familiar with and involved in adaptation activities at a local level. Since much adaptation will occur autonomously, involvement of the private sector is central to achieving impacts at scale. Finally, NGOs along with other civil society and community based organizations combine the flexibility required for testing of innovative approaches with the explicit focus on vulnerable populations that is required to ensure vulnerable groups are not excluded or further marginalized as climate impacts increase. The specific capacities and roles each of these groups could bring to a programme of research on adaptation to climate change are discussed further below.

Research & Policy Networks

Due to the wide array of issues involved actors that need to be influenced, partnerships that involve diverse combinations of NGO, academic, private sector and government actors are

likely to be of particular importance in supporting adaptation. Where such networks don't currently exist, encouraging their formation will have greater impact than attempting to work on a one-to-one basis with individual organizations however strong they may be. Open governance of these networks is essential – networks that conform to national interests or demand consistency regarding the messages they communicate on "best practice" or the issues and approaches they treat as legitimate will not have the intellectual dynamism required to generate the wide array of insights required to catalyze effective strategies for climate adaptation. Networks have unique regional and cross-sectoral engagement capacities, are often able to identify multiple points of entry or leverage, and are often capable of engaging in and replicating the results from learning strategies. Strengthening networks and the institutions that actively engage with them is likely to have higher and more replicable returns than focusing on individual key organizations.

Economic Planning & Sector Specific Agencies in National Governments

National governments are the key players particularly in climate change negotiations in all the countries of the region. Within national governments there are often innovative actors at multiple levels that can contribute significantly. However capacities of national governments to play a significant role in climate change adaptation differ across the region. In addition to national government entities that are designated as nodal points for activities related to climate change, two types of agencies are of particular importance:

Economic Planning Agencies: Consultations and interviews in all the sub-regions revealed that economic planning agencies could play an important role in climate change adaptation. In India, for example, the Planning Commission can become a key player in adaptation responses and in coordinating across different sectoral agencies. Stronger involvement of economic or planning ministries to lead coordinated planning has been raised as a possible strategy in some South East Asian countries. In China National Development Reform Commission (which already has coordinating authority and a climate mandate) plays a significant role.

Sector Specific Agencies: Because much adaptation is likely to occur through autonomous processes that are constrained or enabled by communication, transport, financial, energy and water resource and ecosystem condition, the sectoral government and non-government organizations that have specific engagement with those systems will be of particular importance as counterparts.

Scientific & educational research institutions, particularly those with interdisciplinary programmes

The scientific research community in most countries across the region (barring the strife ridden countries like Afghanistan) is strong but has primarily focused on effects of climate change and modelling and climate forecasting. There are academic/research institutions at both the national as well as local level and both are play important roles. There are also regional level research networks such as START, APN and EEPSEA in South East Asia that support regional level research.

Organizations such as these will be among the most important for implementing any research programme. Educational and scientific institutions will be particularly important that are: (1) well connected with current policy environment; and (2) that produce the graduates who ultimately populate local government, national sector or policy organizations, and private business entities. Such organizations train future generations of sector-specific and integrating (planning & economic development) experts – i.e. the individuals who will ultimately "actualize" systems at the local level.

Local Governments

Local governments play a significant role in climate change adaptation across the region. In all areas, the factors that constrain and enable both autonomous and planned adaptation will be heavily influenced by location specific conditions. As a result, local government counterparts will be particularly important counterparts. County level government agencies in China for example are seen as key actors responsible for programme delivery, regulation of law and policy and resolving issues relating to poverty reduction and natural resource management. Regional consultations in South East Asia also identified local governments as important players and urged the capacity building for this sector. Local governments are also important in South Asia. Building capacity of *Panchayats* (lowest level of governance) in India will make them important actors in working on adaptation strategies. Overall, local governments are among the most important "key actors" who can utilize the results of research and demonstration activities. Local governments have the greatest capacity to implement planned strategies at scale but in a manner that still reflects regional to local conditions.

Private Sector

Migration is emerging as a key strategic entry point in all the regions and subsequently issues such as transportation and communications infrastructure, particularly relating to migrant labour, will become significant. It is in this context that the role of the private sector will become meaningful. The role of the private sector in promoting innovative pilots to strengthen the access and delivery of climate-related information through communication strategies needs to be further explored.

The underlying systems that enable or constrain courses of action and the choices people make that drive both autonomous and planned adaptation will rely heavily on activities that fall within the private sector. Involvement of the private sector is, as a result, essential. Such involvement will flow most naturally from R&D processes that lead to courses of action that reflect the core business interests and models on which private sector activity is based. Direct business interests are the core reasons why the insurance and energy industries are heavily involved in work on climate change while it has proved difficult to "involve" other private sector actors. Identifying points of entry that respond to the inherent logic driving private sector actors represents the core avenue for encouraging their involvement. From this perspective perhaps the most important private sector organizations to engage with are those involved in the innovation and incubation of new technologies, services and institutions: Business incubators have specific experience in taking small innovative initiatives and driving them to scale using appropriate operational models. They also have specific skills in the innovation and incubation of organizations so that their products can

be marketed at scale. Most commonly these are private sector models – but non-profit and public sector models exist as well. The incubation function has, we believe, been a significant element in the rapid growth of many Asian economies, particularly but not only limited to the high tech sector.

National & International NGOs

Bilateral and multilateral agencies support many national and international NGOs in the region. Their work has focused on development and livelihood related initiatives particularly linked to disaster risk reduction. Such organizations may play a particularly critical role in the innovation and incubation of technologies, strategies and pilot initiatives to support climate adaptation that can then be replicated at scale through private sector business models or public sector interventions. They may also play a particularly critical role in the development of climate related social protection initiatives that would otherwise fall below the radar screen of national governments and do not generate the profits required to catalyze private sector investment

Civil Society & Community-based Institutions

The region is rich with examples of community-led natural resource management and development programmes. Although not designed as climate change adaptation initiatives, they are indicative of adaptive mechanisms that could potentially be undertaken in drought, flood prone, coastal and mountain or upland areas. Social institutions such as cooperatives can also play a significant role in strengthening links with markets for better returns in small-scale enterprises.

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ACRONYMS

ACCCA	Advancing Capacity to Support Climate Change Adaptation
ADAM	Adaptation and Mitigation Strategies: supporting European climate policy
ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
AIACC	Assessments of Impacts and Adaptations to Climate Change
AIT	Asian Institute of Technology
APN	Asia-Pacific Network for Global Change Research
APRLP	Andhra Pradesh Rural Livelihoods Project
AREU	Afghanistan Research & Evaluation Unit
ASEAN	Association of South East Asian Nations
CAAS	Chinese Academy of Agricultural Sciences
CAS	Chinese Academy of Sciences
CATIE	Tropical Agriculture Center for Research and Higher Education
CBO	Community Based Organizations
CC	Climate Change
CC-A	Climate Change Adaptation
CCAP	Centre for Chinese Agricultural Policy
CDM	Clean Development Mechanism
CECI	Canadian Centre for International Studies and Cooperation
CETDEM	Centre for Environment Technology and Development Malaysia
CGIAR	Consultative Group for International Agriculture Research
CIDA	Canadian International Development Agency
CIFOR	Center for International Forestry Research (CIFOR)
CIRCA	Center for Initiatives and Research on Climate Change Adaptation
CMA	China Meteorological Administration
COP	Conference of Parties
CPWF	Challenge Program on Water and Food
CRES	Centre for Resource and Environmental Studies
CRR	Climate risk reduction
CSI	Community Social Initiatives
CSR	Corporate Social Responsibility
DANIDA	Danish International Development Agency
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DENR	Department of Environment and Natural Resources
DFID	Department for International Development (UK))
DRM/DRR	Disaster Risk Mitigation/ Disaster Risk Reduction
EGB	Eastern Ganga Basin
EEA	European Environment Agency
EEPSEA	Economy and Environment in Southeast Asia
EITI	Extraction industry transparency initiative, Lao PDR
ENSO	El Nino/La Nina Southern Oscillation
EU	European Union
GB	Ganga Basin
GCM	Global Circulation Models
GDI	Gender Development Index
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEM	Gender Empowerment Measure
GHG	Greenhouse Gas
GLOF	Glacial Lake Outburst Floods
GM	Genetically modified
GO	Government Organization
GP	Ganga Plains
GTZ	German Technical Cooperation
HDI	Human Development Index
HDR	Human Development Report
IACCC	Inter-Agency Committee on Climate Change
IAP	Institute of Atmospheric Physics
ICCAP	Indonesia's Climate Change Adaptation Plan
ICEM	International Center for Environmental Management
ICIMOD	International Centre for Integrated Mountain Development
ICRAF	International Centre for Research on Agro Forestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development

IFRC	International Federation of Red Cross
IGSNRR	Institute of Geographic Sciences and Natural Resources Research
IIED	International Institute for Environment and Development
IISD	International Institute for Sustainable Development
ILRI	International Livestock Research Institute
IMHEN	Institute of Meteorology and Hydrology for the Environment, Vietnam
IPB	Bogor Agricultural University
IPCC	Inter-governmental Panel on Climate Change
IPCC WGII	Inter-governmental Panel on Climate Change Working Group II
IRI	International Research Institute for Climate Prediction
ISET	Institute for Social and Environmental Transition
IUCN	World Conservation Union (formerly International Union for the Conservation of Nature)
IUCN: IEC	International Union for the Conservation of Nature—Interim Executive Committee
IWMI	International Water Management Institute
J&K	Jammu and Kashmir
LDC	Least Developed Countries
LEAD	Leadership for Environment and Development
LECZ	Low Elevation Coastal Zone
LMB	Lower Mekong Basin
MAF	Million Acre Feet
MARD	Ministry of Agriculture & Rural Development, Vietnam
MDG	Millennium Development Goals
MGD	Million Gallons Per Day
MICCG	Malaysian Climate Change Group
MoE	Ministry of Environment
MoNRE	Ministry of Natural Resources and Environment, Vietnam
MoST	Ministry of Science and Technology
M-POWER	Mekong Program for Water, Environment & Resilience
MRC	Mekong River Commission, Lao PDR
NAFRI	National Forest Research Institute, Laos
NAPA	National Adaptation Programmes of Action
NC	National Communication
NCAP	Netherlands Climate Assistance Programme
NDRC	National Development Reform Commission
NGO	Non-Government Organization
NREGP	National Rural Employment Guarantee Programme
NRM	Natural Resource Management
NISTPASS	National Institute for Science and Technology Policy and Strategy Studies
NSFC	National Natural Science Foundation in China
ONEP	Office of Natural Environmental Protection
PACT	PACT Cambodia (not an acronym)
PAR	Philippine Area of Responsibility
PDR	People's Democratic Republic
PEACE	Pt. Pelangi Energi Abadi Citra Enviro
PRRM	Philippine Rural Reconstruction Movement
PTFCC	Presidential Task Force on Climate Change
RCG	Royal Cambodian Government
REDD	Reducing Emissions from Deforestation and Degradation
SDC	Swiss Agency for Development and Cooperation
SEA	South East Asia
SEA-START	South East Asia- SysTem for Analysis, Research and Training
SEI	Stockholm Environment Institute
SEWA	Self Employed Women's Association
SHG	Self Help Group
SLR	Sea level rise
START	SysTem for Analysis, Research and Training
TDRI	Thailand Development Research Institute
TEI	Thailand Environment Institute
TERI	The Energy and Resources Institute
TroFFCA	Tropical Forests and Climate Change Adaptation
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework for the Convention on Climate Change
UPLB	University of the Philippines Los Banos
USER	Unit for Social and Environmental Research
VARG	Vulnerability and Adaptation Resource Group
VO	Voluntary Organization
WB	World Bank
WHO	World Health Organization
WWF China	World Wide Fund for Nature, China

ANNEX I:

The Conceptual Framework

The conceptual frame we bring to the analysis of research gaps focuses on vulnerable people in vulnerable places. We define human vulnerability to climate change as a function of exposure susceptibility (lives, livelihoods, relationships and assets that are either directly or indirectly susceptible to major impacts from climate change) and the capacity to shift strategies in ways that reduce such exposure. The capacity to shift strategies is, in turn, seen as a function of: (1) access to underlying infrastructure, knowledge, communication, economic and other systems; (2) relationships within those systems; and (3) assets, particularly convertible assets. This is closely related to the IPCC definition. This definition relates vulnerability to the degree systems are *susceptible to* and *unable to cope with* the adverse impacts of climate change. According to their definition: "Vulnerability is a function of the character, magnitude, and rate of climate change and the variation to which a system is exposed, its *sensitivity*, and its adaptive capacity" (IPCC, 2007 emphasis added). The definition of the Hyogo Framework encapsulates a wider definition of vulnerability as a "set of conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of a community to the impact of hazards"[6]. Such a wider definition is needed to emphasize how poverty, gender, ethnicity and other factors that contribute to social exclusion contribute to social vulnerability. These factors, and related power differentials, affect how individuals or collective groups may access systems, opportunities and social networks that may reduce their vulnerability. Individual factors of attitude and behaviour (see Ahmed and Mustafa, 2007), and health status also contribute to vulnerability. It is important to recognize that these social relations are dynamic and negotiable/negotiated.

Beyond the definition of vulnerability, our analysis starts with a clear distinction: Adaptation is not "coping." In well-adapted systems people and the environment are "doing well" despite (or because of) changing conditions. People can't, however, "do well" unless they are able to shift strategies as conditions change or unless existing systems are resilient and able to respond flexibly. As a result, at its core *adaptation* is about the capacity to shift strategies and to develop systems that are resilient and sufficiently flexible to respond to change.

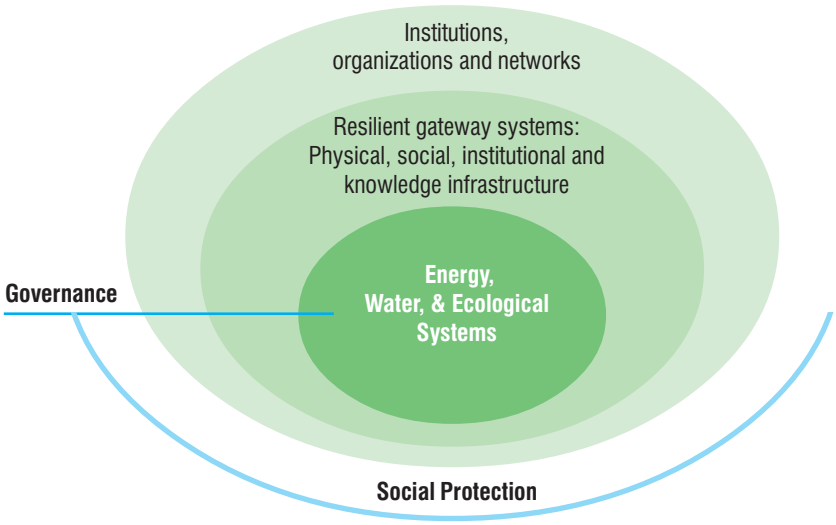
Adaptation is both "planned" and "autonomous". "Autonomous" adaptive responses are actions that individuals, households, and organization undertake on their own in response to the opportunities and constraints they face with climatic change and other sources of livelihood shocks and stresses. This is based on the systems that enable people to take advantage of opportunities available in the new environment or constrain their ability to shift strategies as conditions evolve. Resilient and flexible systems that enable communication, health, and access to energy and water, transport and mobility represent the core "railway tracks" that enable strategy shifting. They also underpin the development of social networks and the generation and transfer of new knowledge. These systems combine social/institutional and physical infrastructure. Socially for example, access to global languages serves as a gateway to global labour markets and global information systems while local language dependence is an envelope that constrains. The physical counterpart to global language systems, flexible communications infrastructure such as cell (mobile) systems, is an equally important gateway. Similar combinations of social, institutional and physical infrastructure are equally central determinants in relation to health, energy, water, transport and mobility. "Planned adaptation" includes planned responses that may be implemented as programmes and

[6] The Hyogo Framework 2005-2015, adopted by the UN at the World Conference on Disasters in 2005

projects by governments or communities to respond to, or in anticipation of, expected climate impacts. At a societal level, directed shifting of strategies through planned actions is enabled by the factors that: (1) allow proactive identification of and response to emerging constraints and opportunities; (2) enable flexible responses to surprise; and (3) help to create underlying infrastructure support systems for individuals, households and communities that support flexibility but are themselves resilient.

As conceptualized above, planned adaptation and autonomous adaptation are directly linked through social and physical infrastructure systems. While created and governed at societal (national and international) levels, such systems enable or constrain the shifting of strategies by individuals, households and organizations. They thus serve as the bridge between action at national or global levels and the inherently local level realities where responses to climate change will ultimately occur. The *resilience* and *governance* of such systems are central to adaptation. *Resilience*, whether the systems themselves have the inherent flexibility necessary to respond to changing conditions, determines whether or not such systems enable or constrain the ability to shift strategies and therefore, adaptive capacity. *Governance* is equally important. Governance considerations determine access for local populations, particularly vulnerable groups such as women and the poor, to the flexibility and opportunities to shift strategies that such systems can enable. As illustrated in the diagram below, governance issues cut across all levels. Governance is also about developing accountable, transparent and participatory institutions where women, poor, socially marginalized, can have 'voice'.

One final element is central to our conceptual framework. That is the need for social protection. As conceptualized above, adaptation is a process that is enabled by core social/institutional and physical infrastructure systems. As global development experience amply documents, however, even when substantial attention is paid to their governance, the poor, women and other vulnerable groups are often unable to access or benefit from such systems. Although society as a whole may adapt (that is respond to opportunities in ways that enable them to "do well"), residual vulnerability will remain high. Social protection systems represent, as a result, an essential "safety net" if poverty is to be reduced as adaptation occurs. The overall conceptual framework that results is diagrammed below.



It is important to recognize that the conceptual framework diagrammed above is nested rather than hierarchical. While the existence of specific natural resources such as water or energy could be seen as a "foundation" for other "higher level" systems, the reality is more complex. In an increasingly interlinked world, the availability of such resources in any given location depends heavily on a combination of physical and social infrastructure systems and the networks they enable. Virtual flows of water in the form of traded grain, for example, depend on both transport and communication infrastructure and the existence of market-based networks. Overall, as a result, the conceptual framework emphasizes interactions between equally important layers in nested systems as central to adaptation. No single layer could serve as a foundation; all are equally important elements contributing to adaptive capacity.

Foundations in Systems Theory

In many ways, concepts of adaptation (whether in society or ecosystems) have their basis in early work on ecosystems and subsequent analysis by leading thinkers such as C.S. Holling and Lance Gundersen of the parallels within interlinked socio-ecological systems (Gunderson and

Holling, 2002). Our conceptual framework owes a debt and draws heavily in ways that are often not explicitly cited here on their work and that of the many contributors to the Resilience Alliance. Returning to this initial foundation in the ecological sciences serves as a useful starting point for understanding the adaptive change processes we are concerned with in human systems facing climate change.

In ecosystems, the process of natural selection is the conceptual starting point for understanding adaptation. The process of natural selection operates at the level of individuals and describes the interaction between individuals, populations and their environment. When subject to selective pressures, (whether due to competition for resources with other individuals/species or from external factors such as the presence of a toxin), some individuals are better equipped to survive and reproduce. Natural selection thus provides a pressure that "weeds out" individuals lacking specific characteristics and encourages reproduction of those having the stronger characteristics. Natural selection can also function at a population level, weeding out species that are unable to compete or deal with disruption in their environment and favouring other species that have characteristics enabling them to cope with or take advantage of disruption and competitive pressures. The process of weeding out "undesirable" and encouraging "desirable" characteristics (i.e. characteristics that respectively either reduce or enhance the competitive advantage of an individual or species within a changing environment) is the core driver of adaptation.

Agency and structure are the main differences between natural ecosystems and human systems facing adaptive pressures. Humans at all levels strategize and can respond proactively as well as reactively to changes that are either observed or projected to occur in the environment. Within the social frameworks we have created, we move toward the opportunities we perceive and we move away from or seek to address the constraints we face. Constraints and opportunities, or at least our perceptions of them, are thus core drivers. It is important to emphasize here that, unlike purely natural ecosystems, the constraints and opportunities shaping adaptation in human systems depend heavily on perceptions, social relations and the networks of institutional relationships that "frame" our worlds. At the same time, at a very basic level, in human systems just as in natural systems, selection primarily reflects the ability to capture, use and direct basic resources. Poverty reflects lack of access to exchange processes or local productive capabilities and a resulting inability to capture or generate "wealth."

The above ecologically derived understanding of adaptation represents a conceptual starting point for our work. Before relating this to our framework for analysis of adaptation to climate change in Asia, one further link with ecosystems thinking serves as an important element underpinning our conceptual approach. Ecosystems are generally conceptualized as complex webs in which "generalist" species are able to compete effectively within multiple niches while "specialist" species have evolved in ways that give them particularly strong comparative advantages within specific, often very narrowly defined niches. Diversified ecosystems offer a greater number of potential niches but the ability to occupy these niches depends on the specific capacities of individual species. Furthermore, in disrupted ecosystems generalists have a comparative advantage when the specific conditions defining a niche change beyond the range a specialist species can effectively compete within.

Applications in Social Systems

When applied to questions of social adaptation to climate change, the conceptual starting points outlined above form the basis for the relatively simple framework that we have developed as a lens to organize our own understanding and identify critical knowledge and research gaps.

At the core of our framework is the notion of constraints and opportunities within social and economic systems. Individuals, households and organizations (whether at the level of communities or global organizations) exist within complex social and economic systems that, in a manner parallel to ecosystems, have varying levels of diversity and accompanying livelihood niches. Within these systems, entities respond to the opportunities and constraints they perceive as they seek to maintain or improve their livelihood status. Livelihood status is, as in ecological systems, at its core essentially about

the ability to capture or store sufficient resources necessary to flourish, or in economic terms, stay out of absolute or relative poverty. It depends on the ability to access sufficient resources to maintain livelihoods either directly (as in subsistence farming systems) or through exchange mechanisms. In such contexts, adaptive capacity is the ability to shift strategies as conditions change; that is, it represents the movement of individuals, households and organizations toward opportunities (new niches) as they emerge and away from old niches as they become constrained.

Unlike ecological systems, we conceptualize movement away from constraints and toward opportunities as a function of proactive decision-making within contexts that are bounded by resources and the social and physical infrastructure people can access, through both informal and formal mechanisms. Before exploring the nature of systems and resources themselves it is important to emphasize again that *access* to them is a fundamental factor influencing the decision-making space individual perceive and can act within. Access to resources or physical and social infrastructure systems is, in most contexts, heavily conditioned by gender, age, economic status and other social factors. As a result, the opportunities and constraints individuals perceive and act on within a given social context are heavily influenced by social position and by the governance factors that either enable or constrain the options they face. This relates adaptive capacity directly back to our definition of vulnerability and the array of factors contributing to social and political exclusion.

Now to return to the question of systems: whether at the level of individuals or governments, proactive decision-making is a major driver of change in response to the opportunities and constraints people perceive. The array of decisions that individuals can make depends, however, on the availability of basic energy, water and other resources and on the nature of the social and physical infrastructure they have access to. Social infrastructure systems (i.e. institutions, languages, social networks, health, finance, education, communication and knowledge systems) all shape the options and constraints individuals perceive and act on. At the same time, however, the decision-making space available is also a function of physical systems. The physical infrastructure enabling or constraining mobility (transport systems), communications, access to natural resources and exposure to hazards all shape both the reality and perception of opportunities and constraints. The combination of physical and social infrastructure existing in a given context along with basic resource availability creates an envelope that can be seen as bounding potential decisions on shifting strategies. In practical terms, such infrastructure and resources limit the number of socioeconomic niches potentially available and are a major factor constraining or enabling access to these niches. As a result, within our conceptual framework, the nature of social and physical infrastructure systems has a major influence on the array of adaptive responses that are physically or socially "available" as climatic conditions change.

The flexibility and resilience of underlying systems that support livelihoods is also central to adaptive capacity. When systems supporting mobility and communication or social and institutional networks are disrupted, then the ability to adapt by shifting strategies will also be disrupted. The nature of physical and social infrastructure also bounds the number of livelihood niches available within social and economic systems. Where economic systems are narrowly defined and key social and physical infrastructure systems for transportation and communication are limited then the number of niches will tend to be narrow. If these social and economic niches depend heavily on climate conditions—the case in many agricultural systems—then vulnerability to climate change is also likely to be high. Social and physical infrastructure that enables diversification within social and economic systems—that is, increases the ability of materials, goods, information, people and jobs to flow between areas—creates a greater number of niches individuals and organizations can theoretically occupy. When populations have the capacities required to take advantage of numerous niches, diversification within livelihood systems by individuals, households and organizations, at a conceptual level, should reduce dependency on narrow climate vulnerable niches. There thus should be a dynamic in which economic diversification at a macro level combined with social capacity at a local level and key forms of social and

physical linking infrastructure will influence the array of opportunities for diversification within livelihoods.

When governments and other entities discuss planned adaptation to climate change they are, in essence, seeking to proactively influence or change social and physical infrastructure at a large scale in ways that reduce anticipated impacts. Autonomous adaptation, on the other hand, generally involves the use and (typically at a smaller scale) modification of social and physical infrastructure systems by individuals, households and organizations in ways that enable them to shift strategies to take advantage of emerging opportunities or move away from constraints.

Tangible Implications

This conceptual framework has very tangible implications in relation to questions of adaptation to climate change and the basic resources needed for survival and the maintenance of economic activities. We discuss this here by moving outward through the nested layers in the conceptual diagram.

First, on a practical level, virtually all "adaptive" activities depend on access to resources such as energy, water and other services from productive ecosystems either directly or (as discussed further below) through the equally important social and institutional networks that enable relationships in society. Agricultural intensification, the development of non-farm activities, and so on all depend on the presence of reliable energy supplies. They also require access to water at a minimum for domestic uses and above that for many productive activities. You can not adapt if you do not have access to sufficient water to survive or the energy required for transport, communications and so on. Finally, adaptation also depends either immediately or in a more distant manner on ecosystem services. Adaptation requires food. The condition of productive agricultural, fishery and other ecosystems that can be accessed either directly at a local level or globally through trade in ecosystems services is, as a result, fundamental to adaptation. As a result, in a very practical manner, the ability to adapt to climate change is directly related to systems for *energy* (and thus to approaches for mitigating GHG emissions), *water*, and *ecosystems* management.

Second, the strengthening of basic social and physical "gateway" infrastructure systems is conceptually a key entry point for enabling adaptation. Access to diverse niches and resources for adaptation within complex socioeconomic systems depends on what might be called "gateway" infrastructure[7]. What do we mean by this? Prior research conducted by ISET indicates that the ability to "do well" in flood and drought contexts depends heavily on the ability of information, goods and services to flow into and out of affected areas (Moench and Dixit, 2004). This is determined by the presence or absence of the transport, communication, financial and knowledge systems already identified above. Such systems are, in essence, the gateways that either enable or limit access to resources beyond the local. Having access to transport, communication and financial systems, for example, can enable food and other resources to flow into drought affected areas in exchange for goods or services. Having access to a health system enables access to productive activities of all sorts – health services are critical gateways. Similarly, access to a global language as part of the local knowledge system is a central factor "enabling" access to work and information environments beyond those accessible through local language systems. It is not, however, just access to information and work. Many forms of organization (from businesses to social networks and markets, and from environmental movements to governments) depend heavily on these systems as critical factors enabling organization and reorganization. In sum, underlying "gateway" infrastructure systems can, in effect, be seen as the rails on which adaptation the shifting of strategies within an

[7] The term "gateway" is not intended to serve as a tightly defined conceptual element. Instead, it is intended to draw attention to the differential access implicit in the nature of systems. A fully developed banking system can be a gateway to everything from savings and credit to insurance, a global language is a "gateway" to global knowledge, a multi-function communication system is a "gateway" to a huge diversity of resources and networks, a resilient transport system is a gateway to global goods. This contrasts with the much more narrow access to resources and networks that more limited systems, such as those based on local languages or single purpose communication facilities, provide.

ever-evolving institutional environment can run. As a result, on a practical level one of the most tangible entry points for strengthening adaptive capacity (and linking adaptation with development) may lie in strengthening of such systems.

Third, the nature of institutions, organizations and networks represents a key factor enabling or constraining adaptation. This is where practical points of entry may address the specific impacts of climate change may be most evident. Whether the proximate issue relates to disaster risk reduction, land use planning, migration network support, water allocation, trade regulation or the development of adaptive agricultural management strategies, numerous practical points of entry for supporting CC-A exist on this "outermost layer." Conceptually, however, these systems are co-dependent on the functioning of the perhaps less-evident layers in the framework.

Fourth, questions of access, and thus of governance, cross cut all of the above systems. Access to energy, water and key ecosystem services on one side and institutions and alternative forms of organization on the other side are enabled or constrained by access to "gateway" infrastructure systems. The reverse is also true, without access to affordable energy, the proximity of a highway does not contribute to mobility. Similarly, if access to markets is denied for social reasons, the presence of a highway or an energy system may provide little help in adaptation. Governance, the mediation of access to all such systems is, as a result, a central cross-cutting feature underlying adaptive capacity.

Fifth, a final factor beyond governance that is central within our conceptual framework is the importance of social protection. Systems that enable proactive and autonomous forms of adaptation may be necessary conditions for society to evolve effective responses to climate change—but they are unlikely to be sufficient, particularly for vulnerable groups. Women, children, the poor and socially marginalized groups have always faced differential levels of access to and ability to utilize basic social and physical systems. These are root causes of poverty and will constrain the ability of vulnerable groups to shift strategies as climate conditions change. Social protection, the creation of safety nets, is thus essential if poverty is to be addressed as part of or in conjunction with efforts to adapt to climate change.

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ANNEX II:

Appraisal of Approach and Process

This project was carried out through regional consultations in each of the three sub-regions, in-depth one-to-one interviews with key individuals and extensive literature reviews.

The project started at an opportune time when there has been an increased focus on climate change particularly in India and China. The recent visits of the United Kingdom Prime Minister, Rt. Hon. Gordon Brown MP to India and China have focused on the issues of climate change in both the countries. The India-UK Annual Summit that was held in Delhi on January 21, 2008, highlighted the need to find effective and practical solutions to address issues of climate change and its implications. These included mitigation and adaptation strategies that would also address the economic and social development of developing countries. During his China visit also Mr. Brown has promised to help China tackle climate change. The Conference of Parties in Bali raised the profile of climate change issues in South East Asia.

These events have raised expectations amongst the national governments as also the climate change community. As a result of this growing interest in climate change, there have been several different kinds of meetings organized on climate change issues in various countries of the Asia region and some times, consultations carried out under this project, were confused with other similar processes taking place. Also, as a result of the high profile of issues related to climate change, the demand for national level consultations through this process could not be met.

One of the weaknesses of this scoping process has been that there has been simply not enough time for exploring or communicating new ideas between groups of actors. Many of the issues raised by the conceptual framework and the sets of prior research on which it is based have not been a central focus of organizations engaged in "planned" adaptation activities. As a result, catalyzing dialogue and building ownership first requires building a shared understanding of the issues involved. In brief consultations, such as the ones held so far under this exercise, people generally tell you what they are currently doing and not what new and innovative things that could be done. The objectives of the consultation thus seem incompatible with attempting to build ownership and link high-level policy to issues of poverty and vulnerable people. Effective strategies for building ownership will require a longer dialogue process that engages groups beyond those currently active in climate adaptation debates. These might include, for example, the major private sector organizations that have experience incubating organizations and technologies. They might also include organizations focused on specific sectors – such as the international, national and state level water management organizations active in many regions.

If we analyse individual components of the process, the objective of regional consultations has been to help assess existing challenges, knowledge and activities on climate change adaptation – considering both planned and autonomous adaptation — and to identify key gaps where additional research could contribute substantively to addressing the overall adaptation challenge. Of special consideration has been to see how research and advocacy can also lead to changes of policy and practice on a larger scale. The consultations have been a good approach and have been successful in meeting the objectives set out. They have provided a good platform to introduce the project and get feedback. Consultations also proved useful to help identify some key people for further one-to-one interviews. Presentations made at these events have contributed resource material for the regional reviews.

The challenge has been to get the right mix of people for each one of these consultations. Emerging gaps in adaptation related work very often reflected the participant profile at these consultations. Participants have been people who: (a) are doing research on climate change

adaptation; (b) are doing direct action with communities that are beleaguered by disasters or the graduated effects of climate change (floods, drought, rise in sea levels, etc) since they may be in a good position to share first hand knowledge about how people actually adapt to climate change; and (c) government people who are responding through planned measures for adaptation to climate change.

Key to the consultations has been the local institutions that helped organize them. These ranged from academic institutions such as universities to non-government organizations. These institutions were selected on the basis of their ability to organize such events and their role in adaptation related work in the region.

Regional consultations have followed the concept of partnerships. As mentioned earlier, most of the consultations have been organized and hosted by partner organizations. There has also been considerable other donor interest in the project and there have been contributions from some in terms of supporting travel of partners in select consultations. SDC and GTZ for example, participated and SDC also supported one if its partners in the Kathmandu consultation held on April 22, 2008. LEAD and IUCN were both partners for the Islamabad consultation that was held on April 03, 2008.

Consultations combined with one-to-one interviews in each country where the consultation were held, was a useful approach to follow. One-day consultations were adequate for an over view of issues and relevant people of the region. one-to-one interviews are equally important for a more in-depth view from individuals. These interviews reflected the knowledge and experience of individuals and also led to the identification of other key individuals and initiatives as suggested by people interviewed. A format with a list of key questions was prepared and used for the one-to-one interviews. There has also been an extensive literature review for each sub-region and this has helped in the drafting of the regional reviews. An analysis of this literature has also been carried out.

A presentation of the draft report was made to the Reference Group (April 09-10) in London. The report was revised based on feedback from the Reference Group meeting as also the final round of consultations.

The primary objectives of the last round of regional consultations were to convene a group of regional experts on climate-related change in order to (i) obtain a critical review of draft report; (ii) gain additional information to enhance the report; and (iii) identify other relevant issues yet unaddressed by the draft report. Each consultation was structured according what was considered a relevant approach for each region. The South Asia consultation had select donor presentations showcasing their own work related to climate change adaptation followed by small group discussions on the selected hotspots, areas of interest and strategic points of entries. The South East Asia consultation, besides having presentations from some key institutions, spent considerable time in small group discussions focused on main research areas discussed in the report. The China consultation had a very impressive list of participants despite many senior officials still at the earthquake site and others attending the Conference of Parties in Bonn. The consultation was designed to have key presentations from select senior professionals; feedback from the peer reviewers and finally, a plenary session for feedback on the draft report itself. There was a special effort to ensure that each consultation had adequate representation from as many countries representatives as possible. Regional reports were also reviewed by individual regional experts, some of whom presented their feedback at these consultations. Finally, the regional reports as well as the main report were revised based on feedback from the Reference Group as well as the regional consultations.

ANNEX III:

Activity Schedule (November 2007-June 2008)

ISET Inception Meeting
Kathmandu, Nepal, Nov 20-21, 2007

SE Asia Regional Consultation
Vietnam (Hanoi) November 28, 2007

Climate Change Conference of Parties (ISET Participation)
Indonesia (Bali) December 03-14, 2007

SE Asia Regional Consultation
Philippines (Manila) January 07, 2008

China Regional Consultation
China (Beijing) January 10, 2008

South Asia Regional Consultation
Sri Lanka (Colombo) January 25, 2008

South Asia Regional Consultation
Nepal (Kathmandu) January 28, 2008

EEPSEA Regional Meeting (ISET Participation)
Indonesia (Bali) February 13-15, 2008

China Regional Consultation
China (Ningxia) March 09, 2008

ISET Writing Workshop
Bangkok (Thailand) March 13-15, 2008

South Asia Regional Consultation
Pakistan (Islamabad) April 03, 2008

Reference Group Meeting (ISET Participation)
United Kingdom (London) April 9-10, 2008

Role of *Panchayati Raj* Institutions in Climate Change Adaptation
MSSRF (ISET Participation)
India (Chennai) April 19-20, 2008

South Asia Regional Consultation (Final)
Nepal (Kathmandu) April 22, 2008

China Regional Consultation
China, Hangzhou (Zheijiang) May 05, 2008

South East Asia Regional Consultation (Final)
Thailand (Bangkok) May 23-24, 2008

China Regional Consultation (Final)
China (Beijing) May 29, 2008

ISET Final Writing Workshop
Nepal (Kathmandu) June 08-14, 2008

ANNEX IV:

Matrix of Key Issues Raised in Consultations

Gaps identified in consultations	Details	Discussion
Awareness and Understanding	■ **Awareness and Understanding of Climate Change Issues, Impacts and Adaptation Strategies among:** • Vulnerable Populations • Local NGOs • Local governments ■ **Better Understanding of Issues Relating to:** • Climate modeling and interpretation Indonesia, China, Philippines, Sri Lanka, India, Bangladesh, Nepal, Pakistan	Importance of strengthening local government capacities is raised in entry points, as well as improving accessibility of information and knowledge systems.
Access to and Sharing of Information; Lack of cross-sectoral initiatives	■ **Information Sharing and Integration across Sectors:** • Inter and intra-government • Research agencies and others (local authorities, farmers, disaster management authorities) Vietnam, Indonesia, Philippines, Malaysia, Sri Lanka, Bangladesh, Nepal, Pakistan	The lack of integration across sectors due to bureaucratic functioning and budgetary allocations within ministries was raised. The need for potentially larger roles of economic/ planning agencies to lead co-coordinated adaptation strategies across sectors emerged in several countries across the region.
Research	■ **Research Relating to:** • Implications of climate change on food and water security • Impacts of sea level rise on the marine environment, fisheries and coastal livelihoods • The social context underlying adaptation with linkages to poverty • The role of migration and the factors driving it ■ **Standard Methods and Criteria for Assessing Adaptation Approaches** ■ **Combine Traditional Systems and 'Modern' Scientific Research for Implementation** ***Thailand, Sri Lanka, China, Philippines, India, Bangladesh, Nepal, Pakistan***	Research on enhancing livelihood security of vulnerable people in marginal production systems is raised as an entry point with a focus on fisheries in SE and S Asia. Strategic entry points from China suggest that research issues will need to include social issues of benefit sharing and household roles. Entry points from SE Asia also suggest better understanding of enabling and constraining factors particularly in the context of migration, credit, health systems. Migration being a key point for the South Asia and SE Asia regions, an understanding of these factors will also be of importance here.

Documentation	■ **Document Adaptation Strategies by Local Communities** *Philippines, Indonesia, China, Sri Lanka, India, Bangladesh, Nepal*	Although not a specific entry point, this came up very often in consultations and would be a tool for better understanding of issues at the community level and integrating local level issues into policy at national levels. However, mechanisms to effectively translate learning across scales are also a key issue.
Capacity Building	■ **Strengthen capacity across sectors:** • Government (at all levels) • Local level NGOs and other institutions (e.g. religious institutions such as the Church that have strong influence in the community) • Community institutions *China, Philippines, Indonesia, Lao PDR, India, Malaysia, Sri Lanka, Nepal, Bangladesh*	Building capacity at all levels will be imperative for effective programmes at various levels.
Integrated Approach	■ **Integrated and Multi-sectoral Approach** *China, Sri Lanka, Philippines, Indonesia, Lao PDR, India, Nepal, Bangladesh, Pakistan*	This approach has been recommended for in all the regions.
Engagement With Private Sector	■ **Mechanisms for Private Sector Engagement (e.g. infrastructure, communication, micro-finance)** *Vietnam, China, Cambodia, Philippines, Indonesia, Sri Lanka, India, Nepal, Bangladesh*	Not much has been done in various countries across the regions, except for a few examples. There is a need for further exploration of how best to engage with the private sector for various strategic entry points.
Governance	■ **Engage with and Strengthen Local Government Units (LGUs)** ■ **Participatory Planning Approach that builds on Local Knowledge, Indigenous Practices and takes into account gender/equity concerns** ■ **Linking of Local Level Initiatives to National Level Policy Planning** *Indonesia, Philippines, China, Philippines, Bangladesh, Vietnam, India, Lao PDR, Nepal, Bangladesh*	Strategic entry points for all the regions stress need for engaging with local governing bodies and addressing issues of cross scale governance.
Vulnerability Assessments	■ **Need for Vulnerability Assessments; Mapping Poverty, Livelihoods and Infrastructure Availability** *Vietnam, Lao, Indonesia, Sri Lanka, India, Nepal, Bangladesh, Philippines, Pakistan*	While important tools for understanding vulnerability, these assessments tend to neglect the dynamic nature of vulnerability.

Economic Analysis	■ **Economic Tools for Assessing Adaptation (eg. Cost-benefit analysis)** *Indonesia, China, Philippines, Nepal, Bangladesh*	Limitations of conventional cost-benefit analyses in contexts of uncertainty have been raised. Perhaps more critical is contributing to understanding economic investments of both public and private sectors in adaptation.
Urbanization	■ **Heat Islands Effect** *Thailand, Philippines, Indonesia*	Urban issues have emerged in the context of migration both in the SE Asia and China.
Health	■ **Health Issues** *Indonesia, Thailand, India, Nepal, Bangladesh*	Health has been a relatively neglected sector on CC-A. Despite the fact that it did not come up often in consultations, it is an important strategic entry point and has been highlighted in the SE Asia region.
Financial Support	■ **Need for Targeted Funding for Research Studies and Pilots/Demonstration** ■ **Need to explore mechanisms for micro-finance and micro-insurance** *Bangladesh, Nepal, Indonesia, India, Philippines, Pakistan*	The issue of credit, micro-finance and credit has come up as an important one in all the regions particularly in the context of migration and also as a coping strategy.
Gaps identified in consultations	**Details**	Discussions
Awareness and Understanding	**Awareness and Understanding of Climate Change Issues, impacts and adaptation strategies among:** Vulnerable Populations Local NGOs Local governments Better Understanding of Issues Relating to: Climate modeling and interpretation *Indonesia, China, Philippines, Sri Lanka, India, Bangladesh, Nepal*	Importance of strengthening local government capacities is raised in entry points, as well as improving accessibility of information and knowledge systems
Access to and Sharing of Information; Lack of cross-sectoral initiatives	**Information Sharing and Integration across Sectors:** Inter and intra-government Research agencies and others (local authorities, farmers, disaster management authorities) *Vietnam, Indonesia, Philippines, Malaysia, Sri Lanka, Bangladesh, Nepal*	The lack of integration across sectors due to bureaucratic functioning and budgetary allocations within ministries was raised. The need for potentially larger roles of economic/planning agencies to lead co-ordinated adaptation strategies across sectors emerged in several countries across the region.

Research	**Research Relating to:** Implications of climate change on food and water security Impacts of sea level rise on the marine environment, fisheries and coastal livelihoods The social context underlying adaptation with linkages to poverty Standard Methods and Criteria for Assessing Adaptation Approaches Combine Traditional Systems and 'Modern' Scientific Research for Implementation *Thailand, Sri Lanka, China, Philippines, India, Bangladesh, Nepal*	Research on enhancing livelihood security of vulnerable people in marginal production systems is raised as an entry point with a focus on fisheries in SE and S Asia. Strategic entry points from China suggest that research issues will need to include social issues of benefit sharing and household roles Entry points from SE Asia also suggest better understanding of enabling and constraining factors particularly in the context of migration, credit, health systems. Migration being a key point for the South Asia region, an understanding of these factors will also be of importance here.
Documentation	**Document Adaptation Strategies by Local Communities** *Philippines, Indonesia, China, Sri Lanka, India, Bangladesh, Nepal*	Although not a specific entry point, this came up very often in consultations and would be a tool for better understanding of issues at the community level and integrating local level issues into policy at national levels. However, mechanisms to effectively translate learning across scales are also a key issue.
Capacity Building	**Strengthen capacity across sectors:** Government (at all levels) Local level NGOs and other institutions (e.g. religious institutions such as the Church that have strong influence in the community) Community institutions *China, Philippines, Indonesia, Lao PDR, India, Malaysia, Sri Lanka, Nepal, Bangladesh*	Building the capacity at all levels will be imperative for effective programmes at various levels.
Integrated approach	**Integrated and Multi-sectoral Approach** China, Sri Lanka, Philippines, Indonesia, Lao PDR, India, Nepal, Bangladesh	This an approach recommended for strategic entry points for all the regions.
Engagement with Private Sector	**Mechanisms for Private Sector Engagement (e.g. micro-finance, insurance, credit)** *Vietnam, China, Cambodia, Philippines, Indonesia, Sri Lanka, India, Nepal, Bangladesh*	Not much has been done in various countries across the regions, except for a few examples. There is a need for further exploration of how best to engage with the private sector for various strategic entry points.

Governance	**Engage with and Strengthen Local Government Units (LGUs)** Participatory Planning Approach that builds on Local Knowledge, Indigenous Practices Linking of Local Level Initiatives to National Level Policy Planning *Indonesia, Philippines, China, Philippines, Bangladesh, Vietnam, India, Lao PDR, Nepal, Bangladesh*	Strategic entry points for all the regions stress need for engaging with local governing bodies and addressing issues of cross scale governance.
Vulnerability Assessments	**Need for Vulnerability Assessments; Mapping Poverty and Infrastructure Availability** *Vietnam, Lao, Indonesia, Sri Lanka, India, Nepal, Bangladesh*	While important tools for understanding vulnerability, assessments tend to neglect dynamic nature of vulnerability.
Economic Analysis	**Economic Tools for Assessing Adaptation (eg. Cost-benefit analysis)** *Indonesia, China, Philippines, Nepal, Bangladesh*	Limitations of conventional cost-benefit analyses in contexts of uncertainty have been raised. Perhaps more critical is contributing to understanding economic investments of both public and private sectors in adaptation
Urbanization	**Heat Islands Effect** *Thailand, Philippines, Indonesia*	Urban issues have emerged in the context of migration both in the SE Asia and China.
Health	**Health Issues** *Indonesia, Thailand, India, Nepal, Bangladesh*	Health has been a relatively neglected sector on CC-A. Despite the fact that it did not come up often in consultations, it is an important strategic entry point and has been highlighted in the SE Asia region.
Financial support	**Need for Targeted Funding for Research Studies and Pilots/Demonstration** *Bangladesh, Nepal, Indonesia, India*	

ANNEX V:

Literature Review

As potential outcomes of climate change are investigated, questions arise as to what steps can be taken to reduce the outcomes (mitigation) and how to change behaviours and societal institutions to thrive in a world of increased variability and uncertainty. We are already committed to climate change, but quantifying the full range of possibilities of change cannot be known. Thus, the adaptation question becomes a series of questions: How do we adapt across the scales of individual through institution? What are the factors that enable and constrain adaptation, especially when each individual is vulnerable in different manners? How much can adaptation be planned by formal institutions? How can formal institutions support individuals' autonomous adaptation, which will dominate, and provide safety nets when some autonomous adaptations prove maladaptive? Much of the literature on climate change and adaptation centres around one or more of these questions.

Our literature review focused on articles collected as part of this project that explicitly focused on adaptation to climate change or were selected by team leaders as of particular relevance.

The Global Literature

As potential outcomes of climate change are investigated, questions arise as to what steps can be taken to reduce its effects (mitigation) and how to change behaviours and societal institutions to thrive in a world of increased variability and uncertainty (adaptation). Early work on climate change was primarily focused on mitigation and attribution of the problem. Yet, despite the risks and visible environmental degradation to date, altering of the economy's reliance on fossil fuels and cheap natural resources is not presently occurring. Most importantly, due to inertia in the climate system even if we were to stop emitting fossil carbon today we would still be committed to a further 0.5 ºC of warming and are thus already committed to climate change. Due to these issues the need for adaptation has become a major area of interest.

But what is the best strategy for adaptation? Early climate adaptation work was focused on technical means such as damn construction to address water control and dyke building to address issues of sea level change. The general push for engineered solutions has been much of the impetus behind calls for improved climate models which would allow improved projections of climate impacts on more a localized level and thus improve planning (Ali, 2000; Chinvanno and Snidvongs, 2005). Yet due to the non-linear nature of climate and the influence of other local conditions, such as orography, such improved models still posses a good deal of uncertainty. Due to the high degree of uncertainty in climate projections there has been more interest in addressing the issue of adaptation, particularly on the community to household scales, by improving the adaptive capacity of people and society in general. With this understanding, the adaptation question becomes a series of questions: How do we adapt across scales from the individual to the regional, from national to international? What are the factors that enable and constrain adaptation, especially when each individual is vulnerable in different ways? How much can adaptation be planned by formal institutions? How can formal institutions support individuals' autonomous adaptation, which should and likely will dominate? And will these formal institutions provide safety nets when some autonomous adaptations prove maladaptive?

Early Work

Much of the early work on the societal impacts from climate change dealt with the physical effect climate change would have and on methods of how to attribute given impacts to anthropogenic changes. In this regard early work was primarily concerned with mitigation. This can be seen in the IPCC Working Group II Second Assessment Report (SAR) in 1995 which was vested, like the

first assessment with the goal of "review[ing] the state of knowledge concerning the impacts of climate change on physical and ecological systems, human health and socioeconomic sectors" (IPCC, 1995: 1). But with the SAR the group was also given the task of researching available information on "potential adaptation … strategies" (IPCC, 1995: 1). Though the assessment did not spend a great deal of time on adaptation, what recommendations it did give were concentrated on technical solutions for managed systems such as agriculture and water. At this point in time there was no discussion of the human system outside of the direct physical impacts and challenges that climate change might have. Within the discussion of impacts, the concept of vulnerability was introduced without definition but it was implied to mean the degree of risk of being affected by the physical changes alone.

Publication of the SAR raised the profile of climate adaptation and produced greater interest from the social science community. Thus with the publication of the IPCC Third Assessment Report (TAR) in 2001 the role for adaptation had been expanded and had incorporated more aspects of the social sciences. The expanded role for the social sciences brought more attention to the interlinkages that exist between people and their environment through the issues of poverty, equity and sustainable development. Though the non-linear nature of adaptation is mentioned as well as recognition of the impacts of other stressors such as environmental and resource degradation, the recommendations made for adaptation remained linear in nature. For example the creation of wide scale reserves and parks with transport corridors, as suggested by the IPCC (2001: 11), can have multiple impacts on its own on the ability of people and the ecosystem to adapt. Such impacts are not necessarily positive such as seen with the creation of protected lands Sub-Saharan Africa and elsewhere (New Vision, 2007) and as such need further consideration as how to best be implemented.

It was with the IPCC Fourth Assessment Report (AR4) (Parry, O.F. Canziani et al., 2007) that adaptation changed from a "necessary strategy" (IPCC, 2001: 8) to "essential" because "the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades" (Parry, O.F. Canziani et al., 2007: 20). Yet the overall tenor to the IPCC adaptation strategy continues to strive to understand the level of impact that climate change will have on individual places or systems and in finding proportional, often technical, solutions. Though many such efforts at systems hardening are likely to be beneficial, human and natural systems are not linear and thus as changes move through interlinked, feedback prone systems the outcomes will unlikely be proportionate.

Planned versus autonomous adaptation

The adaptation literature can be broken down into two sets, planned and autonomous. These two sets are also indicative of considered spatial scale with planned adaptation being associated more on the national to global scale and autonomous adaptation being associated more with the community to household scale. By far the bulk of the climate adaptation work has been focused on planned adaptation strategies, this is likely due to the foundations of climate science work being at the global scale and based in the physical sciences. Such a focus is revealed in the IPCC's AR4 (Adger, S. Agrawala et al., 2007) when they mention that adaptation entails "infrastructure design, coastal zone management" as well as other planned activities (719). Such planned, large-scale adaptive strategies have an important role to play, but due to the pervasiveness of climate impacts and the variability in how they will be realized at the local level, adaptation is expected to be largely an autonomous process.

Planned Adaptation

The NAPAs

Though the National Adaptation Programmes of Action (NAPA) are not designed to be planned adaptation strategies, their structure tends to promote that approach.

The National Adaptation Programmes of Action provide a process for Least Developed Countries (LDCs) to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change and which are integrated in the country's development strategies. The actions will also include human and institutional capacity building. The NAPA is structured to be participatory in that it promotes community components of

communication and grassroots participation. This is in contrast to scenario-based model studies to asses modes of action.

Despite the call for grassroots participation, the national and developmental focus of, and the institutional responsibility for the reports tends to favour national institutional priorities. As such larger scale, planned adaptation strategies tend to be favoured. These strategies though, which tend to focus on infrastructural development, may well provide the essential foundation upon which an expanded adaptive capacity for communities and households can be constructed.

Top priorities for most of the NAPA nations are cantered on water (availability, control and quality) and agriculture. Most priorities set were for construction and improvement of dams and reservoirs, irrigation and distribution of and education in the use of drought tolerant food crops, and methods. Additionally most nations participating in the NAPA process consider establishing early warning systems as vital.

Agriculture

In the literature there are two levels of discussion with regard to agriculture. One, which is more locally focused, is the desire for the establishment of an adaptation strategy that addresses food and food security (Sathaye, Shukla et al., 2006). The other is largely focused around technical solutions, particularly introduction of new crop types that should better handle expected future conditions (Chinvanno and Snidvongs, 2005; Royal Government of Cambodia, 2006; Chinvanno, Boulidam et al., 2008). There is some concern expressed in the gray literature about how well such new crop varieties will be accepted in the communities, how marketable they will be for the farmers within the social context of the markets they serve.

Water management

Projections of climate change suggest that many areas of the world will experience increased variability and intensity in precipitation. Planned adaptation to this possibility includes dam and reservoir construction and maintenance, drought tolerant crops and farming techniques and efforts at groundwater recharge as storage (Gupta and Deshpande, 2004).

Autonomous Adaptation

There is some primarily case study based literature that investigates autonomous adaptation which views autonomous adaptation in two ways. One is as stated in Abramovitz (2002) as "essentially an unconscious process of system-wide coping" (10). This definition is also the implied use of the term by the IPCC in the TAR (2001). The other is that offered by Few et al. (2006) who see autonomous adaptation as being an end result of efforts to reduce vulnerability and increase resilience. Yet even "autonomous" individual adaptation is constrained by institutional processes (Adger et al., 2005). The literature therefore offers some discussion of the role of formal institutions in supporting autonomous adaptation through the creation and support of community-based resource management programmes. At the same time, other autonomous adaptation literature (Moench and Stapleton, 2007; Adger et al., 2005; Tacoli, 2007) recognizes that individuals will make decisions based on access to markets, information, transportation networks and the perceived benefits within such systems. The need for institutional support (from local to international) is recognized within the context of discussions of autonomous adaptation. Here institutions play an essential role acting to support individuals and communities where attempts at autonomous adaptation fail. Such a role promotes innovative adaptive approaches. Little work has been done to understand the role that meso scale institutions, such as provincial and county governments, will play yet their role may well be vital (Krishna, 2003; Christoplos, 2008).

Disaster risk reduction

In attempting to understand issues of local autonomous adaptation there is a good deal of potential synergy between the climate adaptation community and the disaster risk reduction (DRR) community. Traditionally the DRR community was largely focused on "top-down" technical solutions where local communities either had no interaction with researchers or were informed by researchers to change behaviour to adjust to risk. As put by Tansel (2005) 'the prevention and reduction of risks requires understanding, development, and application of engineering solutions' (2005:91, cited in Mercer, Kelman et

al., 2008). Yet solutions given under the authority of a community outsider with no consultation and thus no understanding of the drivers of present behaviours tend to have limited impact on vulnerability. This was noted by Mercer et al:

> Singas villagers were told by a local disaster official to move settlements away from riverbanks to higher ground. Faced with an authoritative figure, villagers agreed. However, as evidenced by a subsequent visit to their village seven months later, they had no intention of moving. There were multiple reasons for this, which included: the river was their livelihood for fishing, agriculture, water supply and clay for cooking pots; they were close to amenities (the main area provincial buildings and medical facilities were the other side of the river above the flood plain); and they had resided there for years, coping with previous floods. These are all factors that the disaster official in his 'top-down' approach had not taken into account. (2008:180).

The realization of the limited success of "top-down" adaptation attempts in the DRR community has led to some recent work on understanding the drivers of risk to natural hazards which has applicable value for the climate adaptation community. Research on vulnerability, social capital and adaptive capacity, keys to autonomous adaptation, can be found in the DRR literature. Understanding how these concepts interlink and the scales at which they operate is still in its nascent stage.

Some researchers from the natural hazards and disasters fields are attempting to bring knowledge from their areas to the attention of policy-makers. Thomalla et al. (2006: 40) present a simplified comparison of the disasters research community and the climate adaptations community, which is effective in arguing for greater collaboration between the two groups (Table 1).

A potential large hurdle to incorporation of these lessons form the DRR community is the language of the climate community which is little understood within the DRR, development and humanitarian communities. There is a

Climate change adaptation	Disaster risk reduction
APPROACH	
• risk management • strong scientific basis • environmenttal science perspective • highly interdisciplinary • vulnerability perspective • long-term perspective • global scale • top-down	• risk management • engineering and natural science basis • traditional focus on event and exposure and on technological solutions • shift from response and recovery to awareness and preparedness • short term but increasingly longer term • local scale • community-based
ORGANISATIONS AND INSTITUTIONS	
• United Nations Framework Convention on Climate Change (UNFCCC) • Intergovernmental Panel on Climate Change (IPCC) • Academic research • National environment and energy authorities	• United Nations (UN) • ProVention Consortium (world Bank) • International Federation of Red Cross and Red Cresent Societies (IFRC) • International, national and local civil society organisations • National civil defence authorities
INTERNATIONAL CONFERENCE	
• Conference of the Parties (COP)	• World Conference on Disaster Reduction

ASSESSMENT

- IPCC Assessment Reports
- IFRC Vulnerability and Capacity Assessment (VCA)
- IFRC World Disasters Report
- International disasters databases:
  - EM-DAT
  -NatCatSERVICE (Munich Re)
  -Sigma (Swiss Re)

STRATEGIES

- National communications to the UNFCCC
- National Adaptation Plans of Action (NAPA) for least Developed Countries
- UN International Decade for Natural Disaster Reduction (IDNDR)
- Yokohama Strategy and Plan of Action for a Safer World
- UN International Strategy for Disaster Reduction (ISDR)
- Hyogo Framework for Action 2005–15

FUNDING

- Special Climate Change Fund
- Least Developed Countries Fund
- Kyoto Protocol Adaptation Fund
- National civil defence/emergency response
- International humanitarian funding (for instance, UN Office for the coordination of Humanitarian Affairs (OCHA)
- Multilateral banks
- Bilateral aid

realization that climate negotiators will be very unlikely to listen to arguments from outside the climate change framework of mechanisms and concepts with which they deal (Christoplos, 2008).

A surprising result of the literature search is that issues surrounding migration, and livelihood diversifications (arguably areas in which autonomous adaptation dominates) are not well connected to the climate change literature. This might be due to the limited

attention that these means of adaptation get in the literature even today where, despite an increased interest in the subject of adaptation, mitigation remains the primary focus of the climate community (Sathaye, Shukla et al., 2006).

Migration

Historically the primary means of autonomous adaptation to a sudden change in circumstances is migration. In the DRR literature movement away from a disaster affected area is a primary, though usually short-term, adaptive strategy (Few, Osbahr et al., 2006; Tacoli, 2007). Such a strategy is used in the most developed nations where early warning systems, such as those for hurricanes, operate. Tacoli (2007) informs us that most long-term migration is an adaptation to "inequalities in the spatial distribution of opportunities, be they economic, social, cultural, political or environmental" (Tacoli, 2007: 1) thus migration will likely be a logical autonomous adaptive strategy to climate change. Though there is some discussion of the impact of migrants on urban infrastructure and institutions (Tacoli, 2007) there would appear to be a gap in terms of how the movement of people from the countryside might affect the balance of goods and services exchange between coupled urban-rural systems.

Livelihood

Relative to the number of articles that mention migration as an adaptation strategy, there are more articles that mentioned livelihood within the context of climate change. However most of the ones that deal with aspects of livelihood diversification were associated with the DRR literature (Abramovitz, Banuri et al., 2002; Few, Osbahr et al., 2006; Osbahr, Viner et al., 2006). Though the climate change literature did mention livelihood as a concern, none discussed issues of diversification and usually referred to the maintenance of livelihoods as a goal without any specific recommendations. In general the issues of migration and livelihoods were associated with the concepts of individual and

community level vulnerability and resilience. Despite the common usage of the terms, "vulnerability" and "resilience", the literature is mixed on what these terms mean with regard to climate change. Though most of the literature does not define these terms, taking them as self evident, the literature that does define them leads to some different definitions.

Vulnerability

The majority of the adaptation literature that discusses vulnerability leaves the term undefined. The implied meaning in most work is the level of direct risk from a single identified climate impact. Abramovitz et al. (2002) define vulnerability in the DRR context as being dependent on six criteria: exposure to risk, weakness (personal, communal or structural), lack of protection, disadvantage (lack of resource), lack of resilience and powerlessness. Ebi et al. (2006) define vulnerability within the context of climate impacts on health as the degree to which one might be exposed to vector or water borne disease. Few et al. (2006) imply that vulnerability is a measure of how well existing local capacity is utilized in preparation for climate related risks, the degree to which the generally national level science communities and the local communities interact and communicate, and whether risk aversion recommendations took climate change into account. For Clark et al. (2000: 2) vulnerability is "the risk of adverse outcomes to receptors or exposure units (human groups, ecosystems, and communities) in the face of relevant changes in climate, other environmental variables, and social conditions" (Cited in McLaughlin and Dietz, 2008).

For Adger (1999) vulnerability to climate change takes on a social dimension that is "largely underemphasized in assessments of the impacts of climate change" (249). In this work vulnerability is composed of individual and group level aspects that can be disaggregated yet are highly interlinked through political economy and institutions. Adger's model incorporates multiple levels of interaction and feedback within the social structure of society and shows that aspects of institutional response, such as rent seeking, can be maladaptive. Delving further into institutional response to adaptive demands Berkhout et al. (2006) use nine case studies to argue that adaptation to climate change shows many of the same aspects of organizational learning. The authors suggest that some of the institutional inertia experienced by Adger may be due to roadblocks to organizational learning that the ambiguity of the issue and the unclear benefits of adapting produce.

Resilience

An important aspect of adapting to climate change is the resilience of a system to change. But as with adaptation and vulnerability the literature does not always clearly define the term. Abramovitz et al (2002), when considering disasters, calls resilience the ability of a person, group or community to "avoid, withstand or offset and recover" from a given risk (17). For the IPCC: resilience is defined as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning" (Parry, O.F. Canziani et al., 2007: 37). Though Adger (1999) does not define resilience, it is implied to incorporate social aspects such the degree and quality of networks.

Key to the concepts of vulnerability and adaptive capacity is an understanding of poverty and the poor. Common to a lot of the global scale investigations is the consideration of "the poor" as a universal subset all sharing the needs in terms of vulnerability and adaptive capacity to climate change. Yet poverty and vulnerability are not necessarily synonymous (Ahmed and Mustafa, 2007). Such was the case with vulnerability to earthquake hazard in Pakistan in 2005. Wealthier families in the rural areas shy away from using the traditional wood, straw and mud roofing favouring concrete. This increased their risk to earthquake hazard (Mustafa, 2008).

Systems approach

The literature grapples with the issue of uncertainty in climate change and how to recommend adaptation strategies. Traditional scientific and policy-making demand precise, probabilistic outcomes. A few literature sources (Barnett, 2001) argue for no-regrets adaptation policies that enhance social and ecological resilience. There is recognition that a healthy social system and ecosystem are better able to weather a variety of shocks and gradual changes than one that has been stressed to the margins of collapse (Snidvongs, Chinvanno et al., 2006). Again, however, this no-regrets adaptation literature is in the minority amongst theoretical researchers.

Much of the effort to study adaptation policy using models necessarily take a reductionist approach because they must be reduced to a small subset of parameters, which may or may not be relevant (Adger, 1999). Given the difficulty of studying systems, much of the literature focuses on only one or two facets of a given adaptation response. Exploration of linkages between various facets within a systems framework is, in general, not occurring. Yet a better understanding of them would be warranted since these systems are filled with nonlinearities and uncertainties, tend to generate the most surprises (Bohensky, Reyers et al., 2006) and are presently under increasing stress due to human impacts (Vitousek, Mooney et al., 1997).

> … there is minimal evidence of systematic vulnerability analysis in which the physical, economic and social data are comprehensively integrated together. Furthermore, where vulnerability assessment takes place, it is normally seen as a specific process in measuring what is certainly more tangible and static than all the complexities of people within communities which are undergoing dynamic change.
>
> (Davis, 1994: 11, cited in Ahmed and Mustafa, 2007: 91)

The Regional Literature

South Asia

South Asia, inclusive of the Tibetan Plateau, is an important climatic region of the world. The role that the Tibetan Plateau plays in diverting airflows inland to produce the Asian Monsoons has influence on climatic patterns around the globe. The monsoons that it produces have made South Asia one of the most productive areas of the world watering crops that over 2 billion people rely upon. But this very reliance is also the region's vulnerability in the face of climate change.

Bangladesh is most likely to face the severe adverse effects of climate change. (Schaerer et al., 2003) and the primary effect of climate change are experienced will be in the form of increased inundation, reduced low river water flows, increased salt water intrusion and a higher intensity of cyclones. Driven by poverty, the population remains vulnerable to the erratic climatic events as the country's agro-ecological zones. According to Chaudhary (2003) output of the regional climate model show that river banks areas would face warming by 1.4 and 1.8°C by 2020 and 2050 respectively relative to 1990. Various models used for analyzing changes in monsoon rainfall and it's implications of runoff along the major rivers passing over the country. It is estimated that that a 2°C warming with a 10% increase in precipitation would increase runoff in the Ganga, Brahmaputra and Meghna rivers by 19%, 13% and 11%, respectively (Ahmed, 2004) "Climate scenario exercises for Bangladesh suggest that a 4°C temperature increase could reduce rice production by 30% and wheat production by 50%. In Pakistan, climate models simulate agricultural yield losses of 6–9% for wheat with a 1°C increase in temperature." (UNDP, 2007) While the global model provide the scenario for the future, the importance of downscaling and the value of social and ecological systems needs to be recognized. Sathaye et al. (2006) suggest that "[i]mproved understanding of the exposure, sensitivity, adaptability and vulnerability of physical, ecological and social systems to climate change at regional and local level" (324) are critical

The reliance on ecosystem services is significant for many countries in South Asia. Bangladesh has one of the highest population densities in the world with over 1000 people per square kilometre. It is also one of the most disaster-prone countries in the world – between 30 to 70% of the country is normally flooded each year and due to a unique topography, storm surges from tropical cyclones are funnelled inland (Agrawala, Ota et al., 2003). Bangladesh is also one of the most vulnerable nations in the world to sea level rise associated with climate change (Ali, 2000).

The regional literature tends to view vulnerability through the lens of impacts of climate change on infrastructure, e.g. flood embankments (Garg, Shukla et al., 2007). This focus is possibly an artefact of the national level interest in physical infrastructure development. However, the concept of social vulnerability and the important role it plays in climate adaptation is increasingly being addressed in the literature. Social vulnerability – the complex intersection of poverty, gender, caste and social space –

determines the ability and capacity of households and communities to cope with or recover from climate risks and disasters (Ahmed and Mustafa, 2007). Ahmad (2000) suggest that crop production will be vulnerable under climate change, scenarios, and as a result, the food security of the Bangladesh will be threatened due to floods, droughts, salinity intrusion, low-flow of surface water systems. The untimely floods offer excess water to the root zones, increased in temperature increases evapo-transpiration, which will hinder the crop production. Model studies have been used to show that such changes will affect *Boro* rice and during droughts, as soil evapo-transpiration increases *Aman* cultivation would suffer (Karim, 1998).

In their article, Roy and Venema (2002) look at the key role women play in household income for the rural poor in India, and how that role has changed as a result of technological and institutional changes over the past 60 years. The authors suggest that a key to climate adaptation in India may be found through social change that allows women to own and self-manage their land, use farm machinery (such as the plough or tractors), and be able to exercise greater civil rights, thus improving their resilience. In addition, access to knowledge, skills and resources (credit) for livelihood diversification for women in climate vulnerable regions where male out-migration is high, such as Nepal and Bangladesh, is also important.

Despite decades of contravention by the state, caste remains an important indicator of vulnerability in India and to an extent, Nepal. Bosher et al. (2007) measured the vulnerability of the population of coastal Andhra Pradesh to the impacts from cyclones and found that one of the key factors underlying vulnerability was caste. There was some evidence of improved resilience of the poor and backward castes through informal social networks, primarily via women working with CBOs and NGOs.

Climate change researches in Nepal have focused on the impact the processes will have on snow processes and potential mitigation of Glacial Lake Outburst Floods (GLOF). Increasing temperatures and retreating glaciers is likely increase the threat of GLOF and decrease reliability of summer stream flows.

Drought is a recurring disaster for large parts of south and western Afghanistan, Pakistan and parts of western, central and southern India creating poverty traps for many rural poor households unable to build assets, diversify livelihood opportunities or access social security or risk spreading mechanisms. In areas of severe conflict, such as parts of Afghanistan, farmers did not build surplus reserves during the drought of 1998-2003 because of the risk of them being raided by the militia (Pain and Lautze, 2002).

Planned vs. Autonomous Adaptation

As in the global literature the implied adaptation role for institutions in South Asia is to promote large scale adaptation projects. A major issue for India is water availability. India's population is expected to peak in the year 2050 at 1.65 billion people. The larger population coupled with expected changes in water usage with development lead to a need to almost triple water availability (Gupta and Deshpande, 2004). Though global circulation climate models do not provide the resolution to project rainfall for India (Ravindranath, Shukla et al., 2006) increasing temperatures will likely further increase water demand. In Gupta and Deshpande (2004) one adaptation strategy they offer is an effort to redirect surface flows into aquifers in areas of the country where the geology is favourable. If, as some climate projections suggest, there is increased intensity but decreased duration of rainfall, the need to quickly store surface runoff would require a large scale engineering effort.

Such planned, large-scale efforts are also the focus of climate change adaptation work in Nepal and Bangladesh. In Nepal, the primary focus of adaptation work has been on the risk of GLOF with some consideration on the impact of water flow variability on hydropower production (Agrawala, 2003). The studies on GLOF are already in various stages which are looked at within the context of development projects. Most of this work has concentrated on mapping of lakes with a focus on engineering of structures to lower the water level and prevent sudden breach of lakes. It is perhaps surprising; with Nepal already seeing large impacts from climate change, that adaptation has not yet gain little policy importance. There is no specific policy

on climate change, even policy work in the hydropower industry fails to recognize climate change impacts.

Activities on climate adaptation in Bangladesh are almost entirely concentrated on engineered physical systems solutions such as the construction of dykes and levees and of emergency shelters, with some attention to engineered ecosystem solutions such as mangrove protection, seacoast tree planting and alternative cropping (Ali, 2000). Studies by ISET and its team have identified some of the key factors that would enable adaptation to climate induced variability generally in South Asia.

Though vulnerability is addressed within the implied context of adaptive capacity, there has been no direct attention to autonomous adaptation in South Asia. Since by definition autonomous adaptation will occur without outside assistance, perhaps this lack of research makes some sense as practitioners have first addressed the most obvious and simplest strategies. But autonomous adaptation is perceived to be more than coping and key to shaping the direction that such adaptation will help understand the cross scale and boundary interlinkages between social, institutional, ecological, and physical systems.

Southeast Asia

The region, despite making advances in economic growth and education, continues to be hampered by poverty and development challenges, environmental degradation, and social and gender inequities (UNDP, 2007; World Bank, 2007) that exacerbate vulnerability. All nations in the region are vulnerable to climate change, although distinct social, institutional, physical and ecological systems lead to differing vulnerabilities within each country.

Vulnerability

Both rural and urban populations of coastal areas of Southeast Asia are extremely vulnerable to climate impacts, including increase in frequency and intensity of storms, increased flooding, seawater intrusion, and coastal erosion. The Philippines and Indonesia have some of the longest coastlines in the world where many of the local populations rely on fisheries for their livelihood (Capili et al., 2005; Las, 2007). Although the extent of sea level rise is unknown, in Vietnam, projections of a 1 m sea level rise would flood 5,000 sq km of the Red River Delta and 15,000 to 20,000 sq km of the Mekong River (Cruz et al., 2007), leading to extreme salinization and crop damage. These would affect not only those living in the delta dependant on rice and fisheries for food and livelihood security, but potentially millions of others within the region and beyond facing challenges of food shortages and increasing food prices. Furthermore, in Vietnam, recent institutional change also has increased the vulnerability of populations as areas of organizational responsibility are in flux (Adger, 1999). Coastal and upland populations of the Philippines and Vietnam already have long histories of dealing with extreme weather events and the resulting destruction, with between six to eight cyclonic systems passing through this these countries each year (PAGASA, 2001; Amadore, 2005; Cruz et al., 2007), that lead to loss of livelihoods, land and property and infrastructure. Poor in urban and peri-urban coastal areas are often located in urban slums that may be situated in flood plains, and that may also be areas of waste disposal, which on flooding lead to loss of property, dislocation and spread of disease (Adger, 2003). In more rural areas, vulnerability is often exacerbated by lack of access to basic services, early warning systems, disaster management, and capital assets.

The uplands of SEA are home to ethnic minorities, some of the most poor within the region, who rely on subsistence agriculture and access to surrounding resources to meet livelihood needs. Drought and variable rainfall patterns are already significantly impacting agricultural production in these areas (Alam et al., 2007), with direct implications for food and nutritional security. Key cereal crops such as wheat (Fisher et al., 2007), rice and soy will decline. Increases in droughts and warm temperatures are also leading to increases in forest fires, particularly in Indonesia and the Philippines, limiting access to forest resources by the poor, and contributing to smog and pollution domestically and across boundaries (Cruz et al., 2007).

Cambodia, Lao PDR, and Myanmar, the least developed countries in the region, hampered by low income, high mortality rates, economies highly dependent on agriculture (UNDP, 2007), and limited technical capacity are highly

vulnerable to climate change. Floods already have accounted for 70% of rice production loss between 1998 and 2002, and drought 20% of this loss (Royal Government of Cambodia, 2006).

Planned vs. Autonomous Adaptation

Planned Adaptation

Within the region, Cambodia and the Lao PDR are the only countries to have completed National Adaptation Programmes of Action (NAPAs). In Cambodia, the NAPA focuses on adaptive management systems of agriculture, water and coastal resources, forests, land use, health, forecasting and surveillance together with research and capacity building measures to support these programmes, although with varying emphasis. While it discusses what is and the need for improved understanding of the social and institutional context to climate adaptation, its high priority recommendations focus on improving physical infrastructure (Royal Government of Cambodia, 2006). The recently completed Lao PDR NAPA prioritizes agricultural interventions, water management strategies and infrastructure development (such as bridges); although it does consider promotion of secondary professions in order to improve farmers' livelihoods. However, there has been no study of the socio-economic impact that climate change will have on the Lao PDR (Government of Lao PDR, 2008).

At the national level, Thailand and Vietnam have developed adaptation plans that concentrate on agriculture and water interventions, including the development of resilient crop varieties, cultivation practices, irrigation measures and coastal zone management (Quang, 2007). Planned adaptation strategies in Indonesia include the development of prediction and early warning systems, forest and agricultural development plans, that focus on rural irrigation and cropping management (Las, 2007), although a broader adaptation plan is in development.

Autonomous Adaptation

Despite the greater spotlight on larger scale more centrally planned adaptation strategies, some trends in local adaptive strategies have been documented. Since the late 1980s Vietnam has been undergoing institutional restructuring that has devolved some of the central government's powers, largely in the economic sector. The change has promoted some institutional maladaptation through rent seeking but has also revived some local governance capacity (Adger, 1999; Shaw, 2006). Other more locally based studies have documented inter- and intra-household strategies to mitigate impacts from coastal erosion, windstorm and floods (Tran et al., 2006) and drought (Nguyen, 2007).

There are a few studies on inter/intra household and individual autonomous adaptive measures documenting strategies in response to extreme climate events including drought, floods, and intense storms. In response to drought, these document efforts of re-allocating financial resources and reduction in consumption of food, medicine and basic necessities; seasonal migration to seek alternative employment; storage of food stocks; adjustment of cropping patterns and diversification of crops; water harvesting; sale of assets; and obtaining loans from informal sources at high interest rates (Keil, 2005; Lasco et al., 2006; Pandey et al., 2006; Nguyen, 2007). Faced with challenges of flooding, tropical cyclones, coastal erosion and sea level rise, individuals and families have reinforced housing structures, constructed protective structures such as dikes and breakwaters, and moved to safer areas. Studies also document strategies that are similar to those in response to drought conditions, such as credit through informal mechanisms, sale of assets, and diversification of livelihoods, in part through migration (Sales, 2008; Jarungrattanapong and Manasboonphempool, 2007; Marfai, 2007; ADPC, 2003; Royal Government of Cambodia, 2006; Tran et al., 2006). Studies, however, are few in number, very recent, and small local cases that are buried for the most part in grey literature.

An interesting case study worth highlighting, although autonomous adaptation was not the focus, documents the greater autonomous adaptive capacity of the people of Savannakhet Province, Lao PDR versus those of a similar region in Thailand (Chinvanno et al., 2006). Although common assumptions are that lower levels of development constrain adaptive capacity, in this case due to poor economic development and limited agricultural technologies, the people of Savannakhet Province have a more diversified source of alternative sustenance versus those in Ubonratchathani Province, Thailand, decreasing their relative climate vulnerability.

China

China is the world third largest country by land area. The climate is variable from hot and humid tropical conditions in the south of China to arid high desert conditions in the north and west. The east of China has a temperature climate while the north and northeast can experience bitter cold winters. Most of the interior of China is semi-arid or arid with the bulk of agricultural production occurring along the east and southeast coast. Climate change is expected to warm the whole of the country on average with warming being more pronounced in the north. Eastern China is expected to see increased rainfall. Rain intensity is projected to increase as the number of rain days either remains the same or decreases. For western China the annual amount of precipitation is projected to decrease with an increase in winter precipitation of +4% not making up for a decrease in summer precipitation of -13%. Though these projections have a high degree of uncertainty, they point to potential vulnerability to flooding in the east and drought in the west of China (Christensen, B. Hewitson et al., 2007).

China has 1.3 billion people or nearly 20% of the world's population but has only 7% of the world's arable land. The nation has experienced tremendous growth and development in the last twenty years (~9% annually) (Cohen, 2005). This economic growth has brought more then 400 million people out of abject poverty in the country, here defined as US$ 1 per day or less (Chen and Ravallion, 2004). Yet despite these improvements the country's large rural population, approximately 800 million people, is still largely poor. Subsistence farming is still the major source of livelihood in the rural areas. An estimated 100 million people from rural areas are internal migrants to China's cities where they find labour jobs, in factories and the construction industry (Cohen, 2005). The migrants often live in cramped conditions in company dormitories and have restricted access to the city in which they live (Hessler, 2005).

Vulnerability

Due to the variability in climate and poverty, vulnerability in China will be realized differently in different regions and contexts (Wang, Mendelsohn et al., 2007). There is direct climate vulnerability for subsistence farmers in the east and southeast of the country who would be vulnerable to increased flooding and crop damage from the projected increased intensity of rainfall while those in the west would experience drought stress if the climate model projections prove true (Yue, Erda et al., 2007).

A major concern is the impact of warming on agricultural production. Lin et al. (2005) developed a climate model to investigate projections of climate change and the impacts that might have on China's three major crops: rice, maze and wheat. They projected that the average temperature increase in China by the end of this century could be between 3º and 4º C and show that, without taking into consideration the impact of the CO_2 fertilization effect, such an increase in temperature could reduce yields by neatly 37%. With the addition of the CO_2 fertilization effect ameliorates the loss rates (and even improves yield for certain crops under certain conditions) but the complexity of feedbacks involved in the CO_2 fertilization effect increases the level of uncertainty in these projections (Lobell and Field, 2008; Tao, Hayashi et al., 2008).

Some studies also raised the issue of the vulnerability of ecosystem due to climate change (e.g. Wu, et al., 2007). This will have implications to future bio-diversity conservation. While others concerned that due to climate change, some traditional planting seasons have to be shifted to fix the increasing warmer and longer growing seasons (Yang et al., 2007).

Yet the social context of vulnerability in China is perhaps more pressing. Many of the working age adults from rural areas have migrated to cities for employment leaving the elderly and the very young in the countryside. Although migration has been regarded as one of the fastest growing sub-sector in terms of off-farm employment of rural labour force and it contributed significantly to poverty alleviation in rural China (deBrauw et al., 2002). Of those that have not migrated, they usually represent the poorest of the rural population (Du, Park et al., 2005). Migrants themselves are housed in crowded conditions that promote ill health and are removed from their social networks (Liu and Guo, 2006). The heat wave in result of increased temperature may cause high death rate in the high populated areas (Takahashi, K., Y. Honda, and S. Emori, 2007).

Planned vs. Autonomous Adaptation

Planned

The bulk of present adaptation to climate risk in China is through physical defences and disaster compensation (Yue, Erda et al., 2007). Most work on adaptation to future change takes a centralized, planned frame. The national government communication on climate change addresses the subject of adaptation with a list of planned government policy directives (National Development and Reform Commission People's Republic of China, 2007). Among the many items listed are adaptation strategies that look to improve water system infrastructure for agriculture, maintaining and promoting engineering quality, upgrading of aging systems. These plans promote centralized cropping decisions to crop climate appropriate crops and breed stress resistant varieties. The government will pass laws to prevent degradation of grassland areas under threat of desertification. In addition money will be spent in Bio-technology and generally improved technologies for plant and animal breeding.

What unclear in this communication is how well these central government decisions will be received in the provinces and counties and the means for enforcing adaptation regulations as they come online.

Autonomous

Perhaps the most important climate related issue and one with the most history of conflict within China is that of water. Thus it is perhaps not surprising that the most work on autonomous adaptation has happened surround water issues, particularly efforts focused on farmers. There are presently many efforts in China to address the water issue (Erda, Wei et al., 2005; Yin, 2006; National Development and Reform Commission People's Republic of China, 2007; Wang, Mendelsohn et al., 2007; Yue, Erda et al., 2007). Most deal with issues of acquiring, accessing, moving of, and efficient use of water. These are planned centralized control mechanisms, like the South to North effort to move water from the precipitation rich and flood prone southeast to the semi-arid and arid north. Policies issued to address water scarcity have also led to cross sectoral and regional conflict in China as some sectors and regions win out and others lose out in the redistribution of the water resource (Yin, 2006). Due to the history of conflict over the water resource in China there have been some efforts to engage local farmers in knowledge transfer farming practices honed for their local climate. The government has started two agricultural demonstration projects, on water saving agriculture, one in the main production area and the other in the arid western region (National Development and Reform Commission People's Republic of China, 2007). Still efforts around autonomous adaptation to climate change in China still remain largely unexplored in the literature and perhaps under utilized by government in planning.

Summary of Key Gaps in the Global and Regional Literature

While this is at best partial, key gaps that appeared in the global and regional literature reviews include:

1. Extremely little work has been done on autonomous adaptation processes and the social, technical, institutional, economic, policy or other factors enabling or constraining them.
2. There is little work done on issues of migration and livelihood diversification within the context of climate change adaptation.
3. Little work has been done on the role of meso scale institutions in adapting to climate change and how those institutions interact across scales to enact policy.
4. More work is needed in bridging the gap between the climate adaptation and the DRR communities. An increased focus on meso scale issues, which is outside the areas of focus of both communities, may help to break institutional resistance that prevents deeper interaction.
5. A deeper understanding of ecological, sociological and psychological thresholds for change would improve our understanding of adaptive capacity and would leverage adaptation efforts.
6. There is limited awareness of the impact of social networks on behaviour in both the community and institutional, the role of innovators within those networks (agents of change), and how information is accepted (or rejected) and applied.

ANNEX VI:

Glossary

This glossary has been compiled from a number of different sources. The majority of the definitions are those used by the Intergovernmental Panel on Climate Change (IPCC) in its publication "Climate Change 2007: Impacts, Adaptation and Vulnerability". As the purpose is to show definitions that best represent how the Adaptation Study Team interprets these words and concepts, other sources have also been used to find the best fit. An important alternative source has been the glossary of terms used by the United Nations Framework Convention on Climate Change (UNFCC)[8].

The source is noted in parentheses at the end of the definition. Changes to IPCC or UNFCCC definitions by the Adaptation Study Team are shown in square brackets. Partial deletions of definitions from outside sources have not been noted.

Adaptation: "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

> **Anticipatory adaptation** – Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
> **Autonomous adaptation** – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.
> **Planned adaptation** – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state." (IPCC)

As used in this report we differentiate between adaptation and coping. Adaptation is not "coping." In well-adapted systems people are "doing well" despite changing conditions. They are doing well either because they shift strategies in ways that respond to emerging changes or because the underlying systems on which their livelihoods are based are sufficiently resilient and flexible to absorb the impact of changes. As a result, at its core adaptation is about the capacity to shift strategies and develop systems that are resilient yet sufficiently flexible that they enable vulnerable people to respond to change.

> **Planned Adaptation:** Planned adaptation includes programmes and projects that governments, NGOs, and international donors implement as a result of specific climate impact and vulnerability assessments. Planned adaptation responses generally respond to predicted ecosystem and hydrological impacts and human vulnerability, focusing on sectoral interventions, such as those related to water management, flood control etc. (Adaptation Study Team)

Autonomous Adaptation: Autonomous adaptation includes actions that individuals, communities, businesses and other organizations undertake on their own in response to the opportunities and constraints they face as climate changes. Autonomous actions are individual or collective unplanned responses. These may involve changes in practices and technologies, diversification of livelihood systems, access to financial resources (e.g. micro-insurance, micro-credit), migration,

[8] http://unfccc.int/essential_background/glossary/items/3666.php

reconfiguring labour allocation or resource rights, and collective action to access services, resources or markets. Social capital and access to skills and knowledge can be particularly important to enable these responses. (Adaptation Study Team)

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

In this report adaptive capacity is defined in relation to the ability to shift strategies as conditions change in ways that maintain human health, well-being, and economic status. Adaptive capacity enables populations to thrive rather than cope with the consequences of changing conditions. (Adaptation Study Team)

Adaptation Fund: The Adaptation Fund was established to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol. The Fund is to be financed with a share of proceeds from clean development mechanism (CDM) project activities and receive funds from other sources. (UNFCCC)

Afforestation: Planting of new forests on lands that historically have not contained forests. (UNFCCC)

Agency: Refers to the capacity of individual humans to act independently and to make their own free choices. In the context of adaptation, exercising agency is the ability of humans to proactively take decisions and shift strategies. (Adaptation Study Team)

***Aman* rice cultivation:** *Aman* rice cultivation is practiced in Bangladesh and parts of India. *Aman* rice is grown widely during the monsoon season, which is July to December. It is also known as *T. Aman* rice cultivation.

Anthropogenic: Resulting from or produced by human beings. (IPCC)

Aquaculture: The managed cultivation of aquatic plants or animals such as salmon or shellfish held in captivity for the purpose of harvesting. (IPCC)

Aquifer: A stratum of permeable rock that bears water. An unconfined aquifer is recharged directly by local rainfall, rivers and lakes, and the rate of recharge will be influenced by the permeability of the overlying rocks and soils. (IPCC)

Arid region: A land region of low rainfall, where 'low' is widely accepted to be <250 mm precipitation per year. (IPCC)

Atmosphere: The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen and oxygen, together with trace gases including carbon dioxide and ozone. (IPCC)

Baseline/reference: The baseline (or reference) is the state against which change is measured. It might be a 'current baseline', in which case it represents observable, present-day conditions. It might also be a 'future baseline', which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines. (IPCC)

Basin: The drainage area of a stream, river or lake. (IPCC)

Biodiversity: The total diversity of all organisms and ecosystems at various spatial scales (from genes to entire biomes). (IPCC)

Biofuel: A fuel produced from organic matter or combustible oils produced by plants. Examples of biofuel include alcohol, black liquor from the paper-manufacturing process, wood, and soybean oil. (IPCC)

Biomass: The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass. The quantity of biomass is expressed as a dry weight or as the energy, carbon or nitrogen content. (IPCC)

Biome: Major and distinct regional element of the biosphere, typically consisting of several ecosystems (e.g., forests, rivers, ponds, swamps) within a region of similar climate. Biomes are characterized by typical communities of plants and animals. (IPCC)

Biosphere: The part of the Earth system comprising all ecosystems and living organisms

in the atmosphere, on land (terrestrial biosphere), or in the oceans (marine biosphere), including derived dead organic matter, such as litter, soil organic matter, and oceanic detritus. (IPCC)

Biota: All living organisms of an area; the flora and fauna considered as a unit. (IPCC)

***Boro* rice:** Generally *boro* rice has been grown in swampy areas or areas affected by water logging. At present, high yielding, irrigated dry season *boro* rice is preferred by farmers in northern India where growing rice is not possible during the monsoon season or in areas affected by floods. With better irrigation inputs and modern high-yielding and shorter-duration *boro* rice varieties, farmers have been abandoning the risky low-yielding deepwater rice in favour of *boro* rice.

Breakwater: A hard engineering structure built in the sea which, by breaking waves, protects a harbour, anchorage, beach or shore area. A breakwater can be attached to the coast or lie offshore. (IPCC)

Bishyari: *Bishyari* are flash floods that occur when there is an outburst from a lake formed upstream of a landslide. A landslide, commonly triggered by a cloudburst, obstructs a river damming it temporarily and creating a reservoir upstream. When the dam breaks a sudden flood is created. This event, which cannot be predicted precisely, is called a *bishyari*. The resulting floods gouge out river beds and banks, thereby substantially increasing the sediment load of a river. They also bring devastation to lives and property downstream.

Capacity: Capacities are the characteristics of communities and people which can be used to respond, cope and adapt to climate change and natural disasters. (Adaptation Study Team)

Capacity building: In the context of climate change, the process of developing the technical skills and institutional capability in developing countries and economies in transition to enable them to address effectively the causes and results of climate change. (UNFCCC)

Note: In this report we use capacity building in a much broader sense to include the needs of all populations, not just those in developing countries, to address the causes and results of climate and other change processes. Capacities are also not limited to technical skills and institutions but also include a wide array of social networks and other relationships that contribute to social capital. (Adaptation Study Team)

Carbon cycle: The term used to describe the flow of carbon (in various forms, e.g., carbon dioxide) through the atmosphere, ocean, terrestrial biosphere and lithosphere. (IPCC)

Carbon dioxide (CO2): A naturally occurring gas fixed by photosynthesis into organic matter. A by-product of fossil fuel combustion and biomass burning, it is also emitted from land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured, thus having a Global Warming Potential of 1. (IPCC)

Carbon market: A popular but misleading term for a trading system through which countries may buy or sell units of greenhouse-gas emissions in an effort to meet their national limits on emissions, either under the Kyoto Protocol or under other agreements, such as that among member states of the European Union. The term comes from the fact that carbon dioxide is the predominant greenhouse gas and other gases are measured in units called "carbon-dioxide equivalents." (UNFCCC)

Carbon reservoir: A component of the climate system, other than the atmosphere, that has the capacity to store, accumulate or release a substance of concern (e.g., carbon or a greenhouse gas). Oceans, soils, and forests are examples of carbon reservoirs. (IPCC)

Carbon sequestration: The process of removing carbon from the atmosphere and depositing it in a reservoir. (UNFCCC)

Carbon sink: Any process, activity, or mechanism that removes a greenhouse gas, an aerosol, or a precursor of a greenhouse gas or aerosol from the atmosphere. (IPCC)

Catchment: An area that collects and drains rainwater. (IPCC)

CC-A: Climate change - adaptation

Chikungunya: The Chikungunya virus (CHIKV) is an arbovirus of the genus Alphavirus that is

transmitted to humans by virus-carrying Aedes mosquitoes. (Wikipedia)

Clean Development Mechanism (CDM): A mechanism under the Kyoto Protocol through which developed countries may finance greenhouse-gas emission reduction or removal projects in developing countries, and receive credits for doing so which they may apply towards meeting mandatory limits on their own emissions. (UNFCCC)

Climate: Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO). (IPCC)

Climate change: Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage [of the IPCC] differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines 'climate change' as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. See also climate variability. (IPCC) [Adaptation Study Team uses the UNFCCC definition]

Climate change commitment: Due to the thermal inertia of the ocean and slow processes in the biosphere, the cryosphere and land surfaces, the climate would continue to change even if the atmospheric composition was held fixed at today's values. Past change in atmospheric composition leads to a 'committed' climate change which continues for as long as a radiative imbalance persists and until all components of the climate system have adjusted to a new state. The further change in temperature after the composition of the atmosphere is held constant is referred to as the committed warming or warming commitment. Climate change commitment includes other future changes, for example in the hydrological cycle, in extreme weather events, and in sea-level rise. (IPCC)

Climate model: A numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes, and accounting for all or some of its known properties. The climate system can be represented by models of varying complexity (i.e., for any one component or combination of components a hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical, or biological processes are explicitly represented, or the level at which empirical parameterizations are involved. Coupled atmosphere/ ocean/sea-ice General Circulation Models (AOGCMs) provide a comprehensive representation of the climate system. More complex models include active chemistry and biology. Climate models are applied, as a research tool, to study and simulate the climate, but also for operational purposes, including monthly, seasonal, and interannual climate predictions. (IPCC)

Climate prediction: A climate prediction or climate forecast is the result of an attempt to produce an estimate of the actual evolution of the climate in the future, e.g., at seasonal, interannual or long-term time scales. See also climate projection and climate (change) scenario. (IPCC)

Climate projection: The calculated response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based on simulations by climate models. Climate projections are distinguished from climate predictions, in that the former critically depend on the emissions/ concentration/radiative forcing scenario used, and therefore on highly uncertain assumptions of future socio-economic and technological development. (IPCC)

Climate (change) scenario: A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships and assumptions of

radiative forcing, typically constructed for explicit use as input to climate change impact models. A 'climate change scenario' is the difference between a climate scenario and the current climate. (IPCC)

Climate threshold: The point at which external forcing of the climate system, such as the increasing atmospheric concentration of greenhouse gases, triggers a significant climatic or environmental event which is considered unalterable, or recoverable only on very long time-scales, such as widespread bleaching of corals or a collapse of oceanic circulation systems. (IPCC)

Climate variability: Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also climate change. (IPCC)

Coastal squeeze: The squeeze of coastal ecosystems (e.g., salt marshes, mangroves and mud and sand flats) between rising sea levels and naturally or artificially fixed shorelines, including hard engineering defences. (IPCC)

Communicable disease: An infectious disease caused by transmission of an infective biological agent (virus, bacterium, protozoan, or multicellular macro parasite). (IPCC)

Conference of the Parties (COP): The supreme body of the Convention[9]. It currently meets once a year to review the Convention's progress. The word "conference" is not used here in the sense of "meeting" but rather of "association," which explains the seemingly redundant expression "fourth session of the Conference of the Parties." (IPCC)

Cope: To survive under the impacts of climate change. Coping is fundamentally different from thriving. (Adaptation Study Team)

Coral: The term 'coral' has several meanings, but is usually the common name for the Order *Scleractinia*, all members of which have hard limestone skeletons, and which are divided into reef-building and non-reef-building, or cold- and warm-water corals. (IPCC)

Coral bleaching: The paling in colour which results if a *coral* loses its symbiotic, energy-providing, organisms. (IPCC)

Coral reefs: Rock-like limestone (calcium carbonate) structures built by *corals* along ocean coasts (fringing reefs) or on top of shallow, submerged banks or shelves (barrier reefs, atolls), most conspicuous in tropical and sub-tropical oceans. (IPCC)

Cryosphere: The component of the climate system consisting of all snow and ice (including permafrost) on and beneath the surface of the Earth and ocean. (IPCC)

Dalits: In the Indian caste system *dalits* are the so called 'untouchables', or outcasts. The term is not the name of any traditional caste. *Dalit* is the term used in modern India and Western countries for the so called untouchable people of India. With respect to the legal terminology in India, the National Commission for Scheduled Castes has held that the term "Scheduled Castes" to be the proper constitutional usage for the castes identified as *dalits*. A *dalit*, is hence a person who belongs to one of the castes identified as Scheduled Caste. *Dalit* has a similar meaning in Nepali.

Deforestation: Conversion of forest to non-forest. (UNFCCC)

Dengue fever: An infectious viral disease spread by mosquitoes, often called breakbone fever because it is characterised by severe pain in the joints and back. Subsequent infections of the virus may lead to dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS), which may be fatal. (IPCC)

Desakota: The mixed-economy region between "rural" and "urban," captured by the Bahasa Indonesia term "desakota" (meaning village-town). The term was initially defined by McGee (1991). The desakota phenomenon encompasses more than the term "peri-urban." It refers to closely interlinked rural/urban livelihoods,

[9] "Convention" refers to the United Nations Framework Convention on Climate Change.

communication, transport and economic systems. Desakota systems occupy, and radiate out from a spectrum of conditions that have purely urban and purely rural as the two extreme ends. The term was initially defined by McGee (1991). (Adaptation Study Team)

Desert: A region of very low rainfall, where 'very low' is widely accepted to be <100 mm per year. (IPCC)

Desertification
Land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. (IPCC)

Disaster Risk Reduction (DRR): The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development. (Wikipedia)

Discount rate: The degree to which consumption now is preferred to consumption one year hence, with prices held constant, but average incomes rising in line with GDP per capita. (IPCC)

Downscaling: A method that derives local- to regional-scale (10 to 100 km) information from larger-scale models or data analyses. (IPCC)

Drought: The phenomenon that exists when precipitation is significantly below normal recorded levels, causing serious hydrological imbalances that often adversely affect land resources and production systems. (IPCC)

Dyke/Dike: A human-made wall or embankment along a shore to prevent flooding of low-lying land. (IPCC)

Ecological community: A community of plants and animals characterised by a typical assemblage of species and their abundances. See also ecosystem. (IPCC)

Ecological corridor: A thin strip of vegetation used by wildlife, potentially allowing movement of biotic factors between two areas. (IPCC)

Ecological migration: (see human migration)

Ecosystem: The interactive system formed from all living organisms and their abiotic (physical and chemical) environment within a given area. Ecosystems cover a hierarchy of spatial scales and can comprise the entire globe, biomes at the continental scale or small, well-circumscribed systems such as a small pond. (IPCC)

Ecosystem services: Ecological processes or functions having monetary or non-monetary value to individuals or society at large. There are (i) supporting services such as productivity or biodiversity maintenance, (ii) provisioning services such as food, fibre, or fish, (iii) regulating services such as climate regulation or carbon sequestration, and (iv) cultural services such as tourism or spiritual and aesthetic appreciation. (IPCC)

Ecotourism: Nature-based tourism which involves education and interpretation of the natural environment, is managed to be ecologically sustainable and also benefits the local community. (Adaptation Study Team)

Ecozone: An ecozone or biogeographic realm is the largest scale biogeographic division of the earth's surface based on the historic and evolutionary distribution patterns of plants and animals. Ecozones represent large areas of the earth's surface where plants and animals developed in relative isolation over long periods of time, and are separated from one another by geologic features, such as oceans, broad deserts, or high mountain ranges, that formed barriers to plant and animal migration. Simply they are a definition of the plants and animals in a region further divided by the land form region. (Wikipedia)

El Niño-Southern Oscillation (ENSO): El Niño, in its original sense, is a warm-water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation the inter-tropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño-Southern Oscillation. During an El Niño event, the prevailing trade winds weaken and the equatorial countercurrent strengthens, causing

warm surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru current. This event has great impact on the wind, sea surface temperature, and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world. The opposite of an El Niño event is called La Niña. (IPCC)

Endemic: Restricted or peculiar to a locality or region. With regard to human health, endemic can refer to a disease or agent present or usually prevalent in a population or geographical area at all times. (IPCC)

Ensemble: A group of parallel model simulations used for climate projections. Variation of the results across the ensemble members gives an estimate of uncertainty. Ensembles made with the same model but different initial conditions only characterise the uncertainty associated with internal climate variability, whereas multi-model ensembles including simulations by several models also include the impact of model differences. (IPCC)

Epidemic
Occurring suddenly in incidence rates clearly in excess of normal expectancy, applied especially to infectious diseases but may also refer to any disease, injury, or other health-related event occurring in such outbreaks. (IPCC)

Erosion: The process of removal and transport of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, winds and underground water. (IPCC)

Eutrophication: The process by which a body of water (often shallow) becomes (either naturally or by pollution) rich in dissolved nutrients, with a seasonal deficiency in dissolved oxygen. (IPCC)

Evapotranspiration: The combined process of water evaporation from the Earth's surface and transpiration from vegetation. (IPCC)

Externalities: Occur when a change in the production or consumption of one individual or firm affects indirectly the well-being of another individual or firm. Externalities can be positive or negative. The impacts of pollution on ecosystems, water courses or air quality represent classic cases of negative externality. (IPCC)

Extinction: The global disappearance of an entire species. (IPCC)

Extirpation: The disappearance of a species from part of its range; local extinction. (IPCC)

Extreme weather event: An event that is rare within its statistical reference distribution at a particular place. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called 'extreme weather may vary from place to place. Extreme weather events may typically include floods and droughts. (IPCC)

Fail Safe: A fail safe mechanism which, if (or when) it fails, fails in a way that will cause no harm or at least a minimum of harm to other systems. (Wikipedia)

Feedback: An interaction mechanism between processes is called a feedback. When the result of an initial process triggers changes in a second process and that in turn influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it. (IPCC)

Food security: A situation that exists when people have secure access to sufficient amounts of safe and nutritious food for normal growth, development and an active and healthy life. Food insecurity may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. (IPCC)

Forecast: See climate prediction and climate projection.

Forest limit/line: The upper elevational or latitudinal limit beyond which natural tree regeneration cannot develop into a closed forest stand. It is typically at a lower elevation or more distant from the poles than the tree line. (IPCC)

Gateways (gateway systems and infrastructure): The term "gateway" is not intended to serve as a tightly defined conceptual element. Instead, it is intended to draw attention to the differential access implicit in the nature of systems. A fully developed banking system can be a gateway to everything from savings and

credit to insurance, a global language is a "gateway" to global knowledge while a local language system can be a gateway to local knowledge, a multi-function communication system is a "gateway" to a huge diversity of resources and networks, a resilient transport system is a gateway to global goods. This contrasts with the much more narrow access to resources and networks that more limited systems, such as those based on local languages or single purpose communication facilities, provide. (Adaptation Study Team)

General Circulation Model (GCM): See climate model.

Generalist: A species that can tolerate a wide range of environmental conditions. (IPCC)

Glacier: A mass of land ice flowing downhill (by internal deformation and sliding at the base) and constrained by the surrounding topography (e.g., the sides of a valley or surrounding peaks). A glacier is maintained by accumulation of snow at high altitudes, balanced by melting at low altitudes or discharge into the sea. (IPCC)

Globalization: The growing integration and interdependence of countries worldwide through the increasing volume and variety of crossborder [transnational] transactions in goods and services, free international capital flows, and the more rapid and widespread diffusion of technology, information and culture. (IPCC)

Greenhouse effect: The process in which the absorption of infrared radiation by the atmosphere warms the Earth. In common parlance, the term 'greenhouse effect' may be used to refer either to the natural greenhouse effect, due to naturally occurring greenhouse gases, or to the enhanced (anthropogenic) greenhouse effect, which results from gases emitted as a result of human activities. (IPCC)

Greenhouse gases (GHGs): The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N20). Less prevalent —but very powerful — greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6). (UNFCCC)

Gross Domestic Product: Gross Domestic Product (GDP) is the monetary value of all goods and services produced within a nation. (IPCC)

Gross National Product: Gross National Product (GNP) is the monetary value of all goods and services produced in a nation's economy, including income generated abroad by domestic residents, but without income generated by foreigners. (IPCC)

Groundwater recharge: The process by which external water is added to the zone of saturation of an aquifer, either directly into a formation or indirectly by way of another formation. (IPCC)

Habitat: The locality or natural home in which a particular plant, animal, or group of closely associated organisms lives. (IPCC)

Heat island: An urban area characterised by ambient temperatures higher than those of the surrounding non-urban area. The cause is a higher absorption of solar energy by materials of the urban fabric such as asphalt. (IPCC)

Hot spots: For this report, hotspots are areas where: (1) multiple considerations make large-scale impacts from climate change highly likely; (2) multiple factors contribute to vulnerability and appear likely to limit the ability of local populations to adapt to the specific impacts anticipated as a consequence of climate change; and (3) vulnerable populations are large.

Human migration: Human migration denotes any movement by humans from one locality to another, sometimes over long distances or in large groups. (Wikipedia),

In the China section of this report, ecological migration relates to a specific policy context. The China report states that: "The government already recognizes the need for ecological migration and subsidizes local and regional relocation (both voluntary and involuntary) from ecologically fragile zones."

According to other sources, Ecological migration is a policy adopted in 2001 by the Chinese government to relocate a large number of herders, in particular Mongolian herders of the Inner Mongolia Autonomous Region, from their traditional grazing lands to agricultural and

urban areas as part of the government's initiative to restore and recover the seriously degraded grassland ecosystem in the Autonomous Region. (Wikipedia)

Hydrological systems: The systems involved in movement, distribution, and quality of water throughout the Earth, including both the hydrologic cycle and water resources. (IPCC)

(climate change) Impact assessment: The practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of climate change on natural and human systems. (IPCC)

(climate change) Impacts: The effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts: (IPCC)

Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation.

Residual impacts: the impacts of climate change that would occur after adaptation. See also aggregate impacts, market impacts, and non-market impacts.

Infectious disease: Any disease caused by microbial agents that can be transmitted from one person to another or from animals to people. This may occur by direct physical contact, by handling of an object that has picked up infective organisms, through a disease carrier, via contaminated water, or by the spread of infected droplets coughed or exhaled into the air. (IPCC)

Infrastructure: The basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of an organisation, city or nation. (IPCC)

In this report, we use a substantially expanded definition of infrastructure that includes the array of social institutions for delivering services or functions within society. The "infrastructure" of markets includes, for example, the organizations involved and the structural relationships between buyers and sellers. (Adaptation Study Team)

Intergovernmental Panel on Climate Change (IPCC): Established in 1988 by the World Meteorological Organization and the UN Environment Programme, the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change. The IPCC also works on methodologies and responds to specific requests from the Convention's[10] subsidiary bodies. The IPCC is independent of the Convention. (UNFCCC)

Invasive species and invasive alien species (IAS): A species aggressively expanding its range and population density into a region in which it is not native, often through outcompeting or otherwise dominating native species. (IPCC)

(Irrigation) water-use efficiency: Irrigation water-use efficiency is the amount of biomass or seed yield produced per unit irrigation water applied, typically about 1 tonne of dry matter per 100 mm water applied. (IPCC)

***Kareez*:** A water management system that uses a network of underground tunnels and canals in hot, arid and semi-arid areas (mostly hills and mountains) to provide a reliable supply of water to human settlements and for irrigation and drinking purposes. The technology was developed in ancient Persia, and was then spread to other cultures, especially after the Muslim conquests, to the Iberian peninsula, southern Italy and North Africa. Some *kareez* are still functional in Pakistan, Afghanistan and parts of India. (Definition adapted from Wikipedia definition)

***Kharif* crops:** In India, Pakistan and Bangladesh crops sown during the rainy season are *kharif* crops. The rainy season in northern India is generally between June and September. Paddy, maize, soybean, groundnut, cotton, are major *kharif* crops.

Kyoto Protocol: The Kyoto Protocol was adopted at the Third Session of the Conference of the

[10] "Convention" refers to the United Nations Framework Convention on Climate Change

Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC) in 1997 in Kyoto, Japan.

It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most member countries of the Organisation for Economic Cooperation and Development (OECD) and those with economies in transition) agreed to reduce their anthropogenic greenhouse gas emissions (CO2, CH4, N2O, HFCs, PFCs, and SF6) by at least 5% below 1990 levels in the commitment period 2008 to 2012. The Kyoto Protocol entered into force on 16 February 2005. (IPCC)

La Niña: See El Niño-Southern Oscillation (ENSO). (IPCC)

Landslide: A mass of material that has slipped downhill by gravity, often assisted by water when the material is saturated; the rapid movement of a mass of soil, rock or debris down a slope. (IPCC)

Livelihood: 'A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.' (' Adapted from Chambers, R. and G. Conway (1992) *Sustainable rural livelihoods: Practical concepts for the 21 st century.* IDS Discussion Paper 296. Brighton: IDS. (From DFID Sustainable Livelihoods Guidance Sheet: http://www.livelihoods.org/info/info_guidancesheets.html

Malaria: Endemic or epidemic parasitic disease caused by species of the genus Plasmodium (Protozoa) and transmitted by mosquitoes of the genus *Anopheles*; produces bouts of high fever and systemic disorders, affects about 300 million and kills approximately 2 million people worldwide every year. (IPCC)

Mangroves: Mangroves generally are trees and shrubs that grow in saline coastal habitats in the tropics and subtropics. The word is used to describe the habitat and entire plant assemblage, for which the terms mangrove swamp and mangrove forest are also used. (Wikipedia).

Marginality: The state where one is considered to be at a lower or outer limit, as of social acceptability. (http://www.thefreedictionary.com/marginality)

Market impacts: Impacts that can be quantified in monetary terms, and directly affect Gross Domestic Product – e.g., changes in the price of agricultural inputs and/or goods. See also non-market impacts. (IPCC)

Microclimate: Local climate at or near the Earth's surface. See also climate. (IPCC)

Millennium Development Goals (MDGs): A list of ten goals, including eradicating extreme poverty and hunger, improving maternal health, and ensuring environmental sustainability, adopted in 2000 by the UN General Assembly, i.e., 191 States, to be reached by 2015. The MDGs commit the international community to an expanded vision of development, and have been commonly accepted as a framework for measuring development progress. (IPCC)

Mitigation: In the context of climate change, a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other "sinks" to remove greater amounts of carbon dioxide from the atmosphere. (UNFCCC)

Monsoon: A monsoon is a tropical and sub-tropical seasonal reversal in both the surface winds and associated precipitation. (IPCC) [Commonly understood as the rainy season]

Montane: The biogeographic zone made up of relatively moist, cool upland slopes below the sub-alpine zone that is characterised by the presence of mixed deciduous at lower and coniferous evergreen forests at higher elevations. (IPCC)

Morbidity: Rate of occurrence of disease or other health disorders within a population, taking account of the age-specific morbidity rates.

Morbidity indicators include chronic disease incidence/prevalence, rates of hospitalisation, primary care consultations, disability-days (i.e., days of absence from work), and prevalence of symptoms. (IPCC)

Mortality: Rate of occurrence of death within a population; calculation of mortality takes account of age-specific death rates, and can thus yield measures of life expectancy and the extent of premature death. (IPCC)

National adaptation programmes of action (NAPAs): Documents prepared by least developed countries (LDCs) identifying urgent and immediate needs for adapting to climate change. The NAPAs are then presented to the international donor community for support. (UNFCCC)

No regrets policy: A policy that would generate net social and/or economic benefits irrespective of whether or not anthropogenic climate change occurs. (IPCC)

Non-market impacts: Impacts that affect ecosystems or human welfare, but that are not easily expressed in monetary terms, e.g., an increased risk of premature death, or increases in the number of people at risk of hunger. See also market impacts. (IPCC)

Non-governmental organizations (NGOs): Organizations that are not part of a governmental structure. They include environmental groups, research institutions, business groups, and associations of urban and local governments. Many NGOs attend climate talks as observers. To be accredited to attend meetings under the Convention, NGOs must be non-profit. (UNFCCC)

Opportunity costs: The cost of an economic activity forgone through the choice of another activity. (IPCC)

Orographic Effect: An orographic effect occurs when an air mass is forced from a low elevation to a higher elevation as it moves over rising terrain. As the air mass gains altitude it expands and cools adiabatically. This cooler air cannot hold the moisture as well as warm air can, which effectively raises the relative humidity to 100%, creating clouds and frequent precipitation.

***Panchayat*:** The *panchayat* is a South Asian political system at the lowest level. '*Panchayat*' literally means assembly (*yat*) of five (*panch*) wise and respected elders chosen and accepted by the village community. Traditionally, these assemblies settled disputes between individuals and villages. (Adaptation Study Team)

***Parishad*:** A local council [in Bangadesh] that governs an administrative district.(MSNEncarta)

Pastoralism: A system of agriculture in dry grassland regions based on raising livestock such as cattle, sheep, or goats (http://www.thefreedictionary.com/pastoralism)

Particulates: Very small solid exhaust particles emitted during the combustion of fossil and biomass fuels. Particulates may consist of a wide variety of substances. Of greatest concern for health are particulates of less than or equal to 10 nm in diameter, usually designated as PM10. (IPCC)

Peat: Peat is formed from dead plants, typically *Sphagnum* mosses, which are only partially decomposed due to the permanent submergence in water and the presence of conserving substances such as humic acids. (IPCC)

Peatland: Typically a wetland such as a mire slowly accumulating peat. (IPCC)

Peri-urban: Areas immediately adjoining urban areas. (http://www.allwords.com/word-peri-urban.html)
[In this report we link the term with the wider process of economic diversification, intensification and migration that has been called the "desakota" phenomena.]

Photosynthesis: The synthesis by plants, algae and some bacteria of sugar from sunlight, carbon dioxide and water, with oxygen as the waste product. (IPCC)

Projection: The potential evolution of a quality or set of quantities, often computed with the aid of a model. Projections are distinguished from predictions in order to emphasise that projections involve assumptions – concerning, for example, future socio-economic and technological developments, that may or may not be realized – and are therefore subject to substantial

uncertainty. See also climate projection and climate prediction. (IPCC)

Purdah: *Purdah* or *pardaa* (literally meaning "curtain") is the practice of preventing men from seeing women. This takes two forms: physical segregation of the sexes, and the requirement for women to cover their bodies and conceal their form. *Purdah* exists in various forms in the Islamic world and among Hindu women in a few parts of South Asia. (Wikipedia)

***Rabi* crops:** In India, Pakistan and Bangladesh crops sown in the winter and harvested in the spring are known as *rabi* crops. The term *rabi* means "spring" in Arabic, which is reflected in two months of the Islamic lunar calendar, *Rabi' al-awwal* and *Rabi' al-thani*. The season spans mid/late April to mid/late June. Wheat and mustard are two of the major *rabi* crops.

Rangeland: Rangeland refers to expansive, mostly unimproved lands on which a significant proportion of the natural vegetation is native grasses, grass-like plants, forbs, and shrubs. Rangeland also consists of areas seeded to native or adapted introduced species that are managed like native vegetation. Rangelands include natural grasslands, savannas, shrublands, many deserts, tundra, alpine communities, coastal marshes, and wet meadows. Rangeland is generally arid, semi-arid, sub-humid or otherwise unsuitable for cultivation. (Wikipedia)

Reforestation: Planting of forests on lands that have previously contained forests but that have been converted to some other use. (IPCC)

Relative sea-level rise: See sea-level rise.

Remittances: Remittances are transfers of money by foreign workers to their home countries.(Wikipedia).
[The term has also been used in this report to describe money transfers by migrants between urban and rural areas.]

Rent Seeking: In economics, rent seeking occurs when an individual, organization or firm seeks to make money by manipulating the economic and/or legal environment rather than by trade and production of wealth. The term comes from the notion of economic rent, but in modern use of the term, rent seeking is more often associated with government regulation and misuse of governmental authority. Rent seeking generally implies the extraction of uncompensated value from others without making any contribution to productivity, such as by gaining control of land and other pre-existing natural resources, or by imposing burdensome regulations or other government decisions that may affect consumers or businesses. While there may be few people in modern industrialized countries who do not gain something, directly or indirectly, through some form or another of rent seeking, rent seeking in the aggregate may impose substantial losses on society. (Wikipedia)

Reservoir: An artificial or natural storage place for water, such as a lake, pond or aquifer, from which the water may be withdrawn for such purposes as irrigation or water supply. (IPCC)

Resilience: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change. (IPCC)

Resilience relates to a system's inherent flexibility to respond to changing conditions. (Adaptation Study Team)

Riparian: Relating to or living or located on the bank of a natural watercourse (such as a river) or sometimes of a lake or a tidewater. (IPCC)

River discharge: Water flow within a river channel, for example expressed in m^3/s. A synonym for streamflow. (IPCC)

Runoff: That part of precipitation that does not evaporate and is not transpired. (IPCC)

Safe fail designs: A property of a system which can recover from failure. (http://pespmc1.vub.ac.be/ASC/SAFE_FAIL.html)

Salinization: The accumulation of salts in soils. (IPCC)

Salt-water intrusion / encroachment: Displacement of fresh surface water or groundwater by the advance of salt water due to its greater density. This usually occurs in coastal and estuarine areas due to reducing land-based influence (e.g., either from reduced runoff and

associated groundwater recharge, or from excessive water withdrawals from aquifers) or increasing marine influence (e.g., relative sea level rise). (IPCC)

Scenario: A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a 'narrative storyline'. See also climate (change) scenario. (IPCC)

Sea-level rise: An increase in the mean level of the ocean. Eustatic sea-level rise is a change in global average sea level brought about by an increase in the volume of the world ocean. Relative sea-level rise occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise and/or land level subsidence. In areas subject to rapid land-level uplift, relative sea level can fall. (IPCC)

Sea wall: A human-made wall or embankment along a shore to prevent wave erosion. (IPCC)

Semi-arid regions: Regions of moderately low rainfall, which are not highly productive and are usually classified as rangelands. 'Moderately low' is widely accepted as between 100 and 250 mm precipitation per year. See also arid region. (IPCC)

Sensitivity: Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise). (IPCC)

Sequestration: See carbon sequestration.

Shuras: Village councils in Afghanistan comprised mainly of tribal elders, clerics and administration officials. (Adaptation Study Team)

Silos: The division of activities by sectors or disciplines. A 'silo' approach solely redressing climate change effects sidesteps the fact that vulnerability is due to an existing state of multiple economic, social, cultural and possibly non-climatic stresses and constraints that weaken people's adaptive capacity. Additionally, adaptation is a more complex process of decision-making, weighing options and is enabled by supportive social, financial and technical resources or constrained by the lack of them. (Adaptation Study Team)

Sink: See carbon sink and carbon reservoir

Snowpack: A seasonal accumulation of slow-melting snow. (IPCC)

Stakeholder: A person or an organisation that has a legitimate interest in a project or entity, or would be affected by a particular action or policy. (IPCC)

Streamflow: Water flow within a river channel, for example, expressed in m^3/s. A synonym for river discharge. (IPCC)

Surface runoff: The water that travels over the land surface to the nearest surface stream; runoff of a drainage basin that has not passed beneath the surface since precipitation. (IPCC)

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (UNFCCC)

Structure: "Structure" refers to those factors such as social class, religion, gender, ethnicity, customs etc… which seem to limit or influence the opportunities that individuals have. (Wikipedia) See also agency.

Threshold: The level of magnitude of a system process at which sudden or rapid change occurs. A point or level at which new properties emerge in an ecological, economic or other system, invalidating predictions based on mathematical relationships that apply at lower levels. (IPCC)

Transpiration: The evaporation of water vapour from the surfaces of leaves through stomata. (IPCC)

Tree line: The upper limit of tree growth in mountains or high latitudes. It is more elevated or more poleward than the forest line. (IPCC)

Tsunami: A large wave produced by a submarine earthquake, landslide or volcanic eruption. (IPCC)

Uncertainty: An expression of the degree to which a value (e.g., the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgement of a team of experts). (IPCC)

United Nations Framework Convention on Climate Change (UNFCCC): The Convention was adopted on 9 May 1992, in New York, and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. It contains commitments for all Parties. Under the Convention, Parties included in Annex I [generally the developed countries] aim to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The Convention entered in force in March 1994. See also Kyoto Protocol. (IPCC)

***Upzillas*:** The districts of Bangladesh are divided into subdistricts, or *upzillas* (*upojela* in Bengali). The *upzillas* are the lowest level of administrative government in Bangladesh. (Wikipedia)

Urbanization: The conversion of land from a natural state or managed natural state (such as agriculture) to cities; a process driven by net rural to urban migration through which an increasing percentage of the population in any nation or region come to live in settlements that are defined as 'urban centres'. (IPCC)

Note: The Adaptation Study Team sees urbanization as a much more complex process than suggested by this definition. See also peri-urban and desakota.

Vector: A blood-sucking organism, such as an insect, that transmits a pathogen from one host to another. See also vector-borne diseases. (IPCC)

Vector-borne diseases: Disease that are transmitted between hosts by a vector organism (such as a mosquito or tick); e.g., malaria, dengue fever and leishmaniasis. (IPCC)

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

Note: The Adaptation Study Team sees urbanization as a much more complex process than suggested by this definition. The conceptual frame we bring to the analysis of research gaps focuses on vulnerable people in vulnerable places. We define human vulnerability to climate change as a function of exposure susceptibility (lives, livelihoods, relationships and assets that are either directly or indirectly susceptible to major impacts from climate change) and the capacity to shift strategies in ways that reduce such exposure. The capacity to shift strategies is, in turn, seen as a function of: (1) access to underlying infrastructure, knowledge, communication, economic and other systems; (2) relationships within those systems; and (3) assets, particularly convertible assets. This is closely related to the IPCC definition which relates vulnerability to the degree systems are susceptible to and unable to cope with the adverse impacts of climate change. According to their definition: "Vulnerability is a function of the character, magnitude, and rate of climate change and the variation to which a system is exposed, its sensitivity, and its adaptive capacity." It is important to recognize that our definition of human vulnerability to climate change is specifically intended to incorporate the factors contributing to social exclusion as well as recognizing the fact that is dynamic, and varies over space and time. Access and relationships are central concepts underlying our definition. The factors that determine whether or not individuals can access systems and assets depend on social relations including gender, economic status (poverty), ethnicity and the myriad of other factors that contribute to social or political exclusion.

Water logging: Water logging occurs when the soil surface area becomes saturated. Soil pores (spaces) are full of water and the excess water cannot drain away. Water logging can occur with periods of heavy rain, poor irrigation management, poor drainage, rising water table, over-watering with irrigation causes water logging.(www.dubbo.nsw.gov.au/repositories/

files/Salinity%20(pg8).pdf)

Water stress: A country [or other location] is water-stressed if the available freshwater supply relative to water withdrawals acts as an important constraint on development. Withdrawals exceeding 20% of renewable water supply have been used as an indicator of water stress. A crop is water-stressed if soil-available water, and thus actual evapotranspiration, is less than potential evapotranspiration demands. (IPCC)

Note: The Adaptation Study Team views water stress as a much more complicated phenomenon than this definition suggests. Water stress can occur in any situation where water availability or quality, both of which are highly dynamic over time and space, result in insufficient high-quality water availability to meet human or ecosystem needs. Water quality is as important in determining water stress as the physical availability of supplies. (Adaptation Study Team)

Wetland: A transitional, regularly water logged area of poorly drained soils, often between an aquatic and a terrestrial ecosystem, fed from rain, surface water or groundwater. Wetlands are characterized by a prevalence of vegetation adapted for life in saturated soil conditions. (IPCC)

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