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INFORMATION FOR CLIMATE CHANGE ADAPTATION: LESSONS AND NEEDS IN SOUTH ASIA

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OBJECTIVES AND BACKGROUND

Governments, businesses, and citizens in South Asia all need access to good information to make wise decisions in a changing climate. However, the uncertainty of climate change impacts, the complexity associated with climate vulnerability, and the lengthy time frame along which climate change will unfold make the "adaptation information agenda" unclear. Moreover, the region faces a range of data gaps and capacity challenges that further complicates the issue. Although these complications are not unique to South Asia, and there is no single answer as to what qualifies as "good information" to support adaptation, clearly several advancements are needed in information systems that aid improved adaptation decision making in the region.

Ideally, adaptation information will be tailored to meet the needs of information users: policymakers, project developers, planners, and others who need a sound evidence base for making and implementing adaptation-related decisions. However, in many cases, information is supply-driven—shaped in large part by the interests of researchers and the limited data available to them—and can often be challenging for users to access, understand, and apply. To support effective adaptation over the long term, systems for producing, managing, using, disseminating, and learning from information in South Asia may need adjustment, and significant new capacities will likely need to be developed.

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This paper serves as background for a South Asian regional workshop that will bring together adaptation information users and producers to inform likely new investments in the information base for climate adaptation. Convened by the World Resources Institute (WRI) and Development Alternatives, with support from the UK Department for International Development, the workshop will identify—

- priorities for information investment,
- opportunities for improving information use, and
- mechanisms for deepening dialogue between information users and producers in the region.

This paper aims to support progress toward these workshop objectives by—

- identifying barriers to effective information production, access, and application in the South Asian region;
- posing a practical vocabulary for characterizing relevant information types;
- articulating a concise set of uses for information in adaptation; and
- raising a set of critical issues around which to frame workshop discussions.

The paper draws on desk and interview research conducted by WRI from November 2011 through February 2012, as well as feedback obtained from a dinner roundtable held on the margins of the UNFCCC Conference of Parties-17 in Durban, South Africa.

THE ADAPTATION INFORMATION CHALLENGE

A growing body of practice makes clear that information plays a critical role in enabling adaptation. For example, the UNFCCC guidelines for developing National Adaptation Program of Action (NAPAs) call for a synthesis of all existing climate change information, as well as specific climate change vulnerability assessments, to determine urgent and immediate adaptation needs. Other national adaptation plans also base their adaptation activities on assessments of the vulnerabilities and impacts associated with climate change. A growing number of nongovernmental organizations (NGOs) have been pioneering innovative ways to bring climate change information to the local level in community-friendly forms and to share community-based observations of climatic change and lessons learned in adaptation.

Because of the importance of information for adaptation, there have been many calls for improvement of information provision and access. These calls have coalesced recently into a movement to build national and regional infrastructure for providing climate services akin to those provided by the UK Climate Impacts Program (www.ukcip.org.uk) and the proposed U.S. National Oceanic and Atmospheric Administration's Climate Services (www.climate.gov) (Columbia University 2011). These institutions act as central clearinghouses and repositories of climate information and can provide customized information products based on user needs.

There is also increasing recognition of the risk of delaying action in the pursuit of perfecting information systems. If decision makers wait for new, improved information about the future of the climate, action may come too late to be effective. Moreover, a key aspect of improving information—the development of reliable predictions of climatic change—may prove difficult to attain even without time pressure. Although some uncertainty about future climate is known and can be reduced through generation of more information, other types of uncertainty are irreducible. The long time frames involved in climate change decision making, in addition to our imperfect knowledge of the world climate system and future economic and technological development, result in "unknown unknowns." With unknown unknowns, "we find ourselves in total ignorance, unable to even know what uncertainty exists" (Malik, Rothbaum, and Smith 2010).

Uncertainty is inherent in adaptation decision making, particularly when it comes to climate predictions and forecasts. However, the importance of contending with uncertainty is often disregarded in current information collection and management systems and in decision-making processes. In response, a growing number of practitioners and researchers are testing approaches to adaptation that can be used now, even with imperfect climate information. These approaches are important to consider as information investments are shaped, so that scarce resources are not wasted on developing detailed climate predictions and forecasts that are not really needed (see section 4).

Because adaptation is a relatively new field, there is a window of opportunity to shape new information sources, products, and management systems over the next several years. Ideally, investments in information systems will be tailored primarily to meet the needs of information end-users, and serve to enhance decision making under uncertainty. However, developing countries, in particular, face data and capacity constraints that will limit the production of information, even after significant new investments. Moreover, the nature of the climate system is such that, even with the best possible data, uncertainties will prevent information providers from meeting some user expectations (see Annex B). For the foreseeable future, the type and quality of available information is likely to shape which adaptation options are appropriate, or even possible.

This workshop seeks to explore creative solutions to the adaptation information challenge in South Asia by addressing two over-arching issues:

- **IMPROVING INFORMATION:** Can we identify a core body of critical information that many users will want for adaptation decision making? How do we best ensure that this must-have information exists in South Asia and is made available to decision makers?

- **COPING WITH IMPERFECT INFORMATION:** Knowing that improvements in information may take some time, how can decision makers best leverage existing information? Which approaches to adaptation best help them avoid delaying action?

The next section of this paper locates these questions within the broader context of barriers to evidence-based decision making generally and current adaptation-related information issues in South Asia.

Barriers to Good Information Use

Adaptation faces a set of difficulties around evidence-based decision making that other areas of policy around the world also face. In particular, institutions and systems need improvement so that a variety of information sources used are relevant decision-making processes. Adaptation decision making in South Asia faces the following challenges related to information use:

Research and information production suffers from a failure to integrate different sources of information

- Overall, most climate change data and analysis tend to remain in institutional or sectoral silos. As a result, analysis is often unable to address the complex relationship between multiple scales and issues.

- Although a few platforms and opportunities for sharing data, information, and expertise have been established, they are not always effective. A key challenge is that professionals and responsible institutions have limited incentives to share information.

- Many regions around the world, including South Asia, face a lack of capacity and resources at the central and lower levels of government to integrate the different sources of information needed for adaptation. In particular, there are a limited number of trained individuals who are able to conduct the cross-disciplinary work required for adaptation.

Data about many social and environmental processes, including about the climate, are poor

Many parts of the developing world remain data-poor. Data about the biophysical and socio-economic processes needed for decision making are often missing or non-existent. Data about climate change and its current impacts, as well as projections of future impacts, are often missing at the relevant scales where adaptation decisions need to be made.

Processes for information creation are often top-down and supply driven

- Most data gathering, analysis, and research work around adaptation is not driven by a thorough and coordinated analysis of user needs.

- In many cases, available information may not exist in a useful format (for instance, annual national mortality rates are not as useful for adaptation decision making as are monthly mortality rates, which can be more specifically correlated to disease outbreaks, natural disasters, etc.)

- Too little attention and few resources are spent on dissemination and sharing.

- Governments and bureaucracies often focus on top-down processes and hard scientific and numerical data, with little appetite for local-level, place-based and lived information. With a few rare exceptions, bottom-up engagement is limited, and local perceptions about climate risks or contextual information about a place are rarely incorporated in nationally run adaptation activities.

- On the other hand, issues with data quality, uncertainties, and lack of comparable methods mean that existing information may not always be used to make decisions even when such information exists.

- Data and information about transboundary flow of resources, particularly water resources, can be extremely politically sensitive, and governments with information may not be willing to share it with their neighbors.

Decisions are not always based on information alone, so new information may have limited value

Different drivers of the political economy, like competing interests, rent-seeking behavior, and differing incentives can influence adaptation decisions. For example, a decision about a particular adaptation priority may not solely be based on climate and vulnerability information, but on other priorities of the government. Lack of guidelines and best practices for judging trade-offs also makes it harder to make decisions around adaptation. While research is beginning to emerge to help navigate such trade-offs, for instance between the short and long term, information is still scarce. Older policies can also get locked in, especially if they create beneficiaries who become politically powerful and resist reforms. In such cases, more information is not always helpful.

Barriers to Information for Adaptation in South Asia

Increasingly scientists, practitioners, and communities are starting to observe noticeable changes in climate throughout the countries of South Asia. Temperatures are rising, and precipitation patterns have started to change (Cruz et al. 2007; New, Rahiz, and Karmacharya 2012). The intensity and frequency of extreme events globally have also increased (Intergovernmental Panel on Climate Change 2012), and South Asian monsoon dynamics could change as a result of climate change (Ashfaq, Shi, Tung, Trapp, Gao, Pal, and Diffenbaugh 2009). Higher intensity and frequent extreme events have begun to affect the region significantly, often causing loss of property and lives.[1] Events like the floods in Pakistan, cyclones in Bangladesh, droughts and water scarcity in India (Aggarwal et al. 2004; Poorest Areas Civil Society Programme 2008), increasing storm intensities in Sri Lanka, and changing monsoon dynamics in Nepal and Bhutan are signs of changing weather patterns in the region.

South Asia as a whole suffers from high levels of economic underdevelopment. Rapid urbanization and high reliance on agriculture result in high vulnerability of people, socioeconomic systems, and ecosystems to climate change impacts. The capacity of individuals and national governments to respond to the various risks of climate change generally tends to be lower compared to other, more affluent areas of the world. Rapid economic growth recently has led to increasing pockets of affluence across the region and to rapid societal transformation. Poverty, however, remains pervasive: Four of the countries in the region are categorized as least developed countries, and even countries like India, an emerging economy, have large populations living in poverty.

Increasingly, governments, academics, civil society organizations, and donors are paying attention to climate change adaptation needs and gaps across the region (Islam, Hove, and Parry 2011; Sterrett 2011). Information about climate change risks, existing vulnerabilities, and biophysical characteristics forms a critical foundation for the decision-making process that is needed to contend with climate change.

Many of the challenges described in Section II A above apply in South Asia. An expert's workshop and a review paper commissioned by the UK Department for International Development on climate change research and the state of information in the region (Department for International Development 2011) revealed the following issues:

- **UNEVEN CAPACITY:** Pockets of excellence, trained individuals, and research organizations that can make critical and important investigations into climate change risks exist across the region. However, the spread of such expertise is uneven across countries, and there are limited regional platforms or networks for sharing expertise.

1. For example, in 2007, Cyclone Sidr caused damages and losses worth US$1.674 billion in Bangladesh (Government of Bangladesh 2008) and in 2010, flooding in Pakistan caused approximately US$8.7–10.9 billion worth of direct damage (World Bank and Asian Development Bank 2010).

- **CONCENTRATED RESEARCH:** Although funding for research and other information-related activities exists, a small number of institutions capture most of that funding. Climate change research funding tends to focus on the "iconic" issues in the region—degradation of the Sundarbans in the Bay of Bengal, melting glaciers of the Himalayas, or sea level rise in Bangladesh.

- **BARRIERS TO GETTING QUALITY DATA:** The region, as a whole, exhibits a strong history of data collection on the part of governments. However, various factors prevent the use of existing information. There are problems with data quality, format, and accuracy. Often competing mandates, lack of coordination on data collection and systematization, costs of data collection, and lack of institutional systems to maintain observation stations and ensure the quality of collected data mean that information is rarely useful or applied to make adaptation-related decisions.

WRI also conducted a limited set of key informant interviews in the region. We found the following general issues with information for climate change in South Asia, many of which are common across the developing world:

Data Collection

- New observation stations and systems for data collection are needed in many parts of the region. There is a bias toward urban and more populated areas, where most observation stations are located.

- Different adaptation decisions have different data needs. Central planners may require climate projections for the next decade or two. City planners, however, may require more real-time information and forecasts for shorter periods of time. Farmers may want daily and seasonal forecasts. This full variety of climate information is not readily available throughout the region.

- The quality and availability of information for creating baselines for particular activities varies by country and sector. Some countries like India—and sectors like agriculture and water—may have more detailed information for setting robust adaptation baselines for the purpose of tracking progress. Other countries and sectors face a dearth of information for more comprehensive analysis.

Information Management

- Centralized systems of data and information management for climate change are weak. Although some data exist, they are scattered and not available in a central, digitized repository. Studies on vulnerabilities and impacts also exist but are also scattered and not in a central place. Database management is particularly weak in the region.

- Existing data are not translated into formats that are useful and can be understood easily by users. For example, small farmers in rural Nepal have limited ability to understand complex scientific information that has not been explicitly translated into forms that they can digest. Local, place-based and indigenous forms of knowledge that such farmers have is often missing in adaptation policymaking.

Information Dissemination

- There are limited resources and capacity to translate data for local-level decision makers. Although most hydro-meteorological departments in South Asian countries collect rainfall and temperature data, they have difficulty transmitting it to farmers and fishermen that need such information in a timely manner. For instance, at present, Indian farmers receive weather information bulletins that are faxed to local government offices and then disseminated, often too late to use in decision making.

- Decisions about climate change need to be made at different scales, but finding data for the relevant scales is difficult. Often, data and information from models, forecasts, and other types of scientific data are not applicable at local levels where many decisions are made about adaptation.

- Decision makers in the region could benefit from information about actions that are primarily aimed at improving livelihoods and restoring ecosystems but help adaptation. These actions need to be done even without climate change and can be termed "no-regret" actions. Similarly, decision makers could use information about general benefits that could be derived from particular adaptation activities.

UNDERSTANDING INFORMATION FOR ADAPTATION DECISION MAKING

Although choices are not made on the basis of information alone, it is an integral input for decision making. The previous section provided background on the challenges of using information for adaptation decision making. This section defines data, information, and knowledge (Liew 2007; Bellinger, Castro, and Mills 2004); outlines their characteristics; and characterizes their use in adaptation decision making. The purpose of this section is to provide the vocabulary for discussing how the information system may be improved and how information may be used in different decision-making strategies (section IV).

- *Data* are raw facts that are collected and represented without interpretation or relation to other things. They represent the building blocks for information and knowledge.
- *Information* is created by integrating several sources and types of data. Therefore, the connections by which data are linked give rise to information. Information is created and used to address an issue or to provide input for a decision.
- *Knowledge* is the understanding that results from a combination of information and experience and is the ability to collect the appropriate information and contextualize it in a relevant way.

Although knowledge creation is a vital aspect of adaptation decision making, it is largely outside the scope of this paper. Data and information serve, together with experience, as the foundation for knowledge. If the availability, quality, or usability of data and information is undermined, so also will be the generation of knowledge. The authors focus here on the use of information for decision making because the point of use represents the moment where information meets experience. Knowledge requires reflection on that experience and represents a subsequent step.

One of the challenges in using information for adaptation is that the potentially relevant body of data and information is large and diverse. The case studies commissioned for this project reflect several of the various types of information used in adaptation decision making (see Annex C for more information on the case studies). The following section explores some characteristics of data and information and attempts to identify different ways in which information can be used during adaptation decision making.

Characteristics of Data and Information

This section identifies important characteristics of data and information that can inform climate change adaptation. These characteristics are listed in Box 1 and Table 1, and illustrated for data in Table 2. Details and definitions about the characteristics of data and information have been included as Annex A. Because information is made up of data, all the characteristics identified for data apply to information as well.

Figure 1 | **Progression from Data to Information to Knowledge**

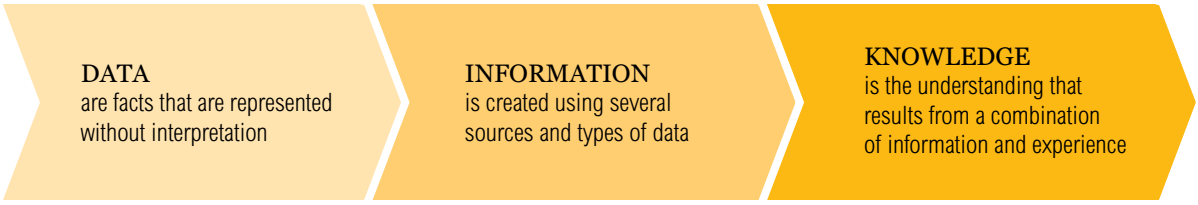

Table 1 | **Characteristics of Information**

CONTENT	FORM	CONTEXT
■ What data were used to create the information? ■ What does the particular information describe? For instance, does it describe climate change impacts, institutions and their functions, or a population's vulnerability?	■ Common forms for presenting information include tables, charts, reports, stories, and maps. ■ The recent revolution in information and communications technology (ICT) has diversified information forms and given information providers new opportunities to put information in forms that are especially relevant to particular uses or user groups.	■ Analytic Methods ■ Source ■ Purpose

Characterizing Information Use in Adaptation Decision Making

Information can be used for adaptation decision making in various ways and ultimately will be shaped differently for diverse uses. To assist in matching appropriate information to different applications, we propose to characterize information use according to four parameters:

1. The *purpose* for which a user might seek the information with regard to needs that differ at different stages in a decision-making cycle;
2. Whether the adaptation effort is a *discrete or integrated* one;
3. The *geographic scale* of the adaptation effort; and
4. The *decision-making scope* (policy, plan, or project) in which the adaptation effort takes place.

Purpose

The specific purpose for which an adaptation decision maker may need information will reflect many factors and will vary across location and sector. However, the following division of purposes, structured by the phases of a decision-making chain, can apply across a wide variety of adaptation efforts and may assist in identifying relevant information, based on the function that information is expected to support:

- **PROBLEM DEFINITION** is to identify and describe the key issue that adaptation action tries to resolve. Often this includes assessing the role of climate change in worsening vulnerabilities, in increasing exposure to climate change risks, and in assessing the future impacts of climate change.
- **ADAPTATION OPTIONS SELECTION** is the process of choosing a strategy or course of action that will address key issues or threats. It normally occurs after a vulnerability, risk, or impact assessment and is often carried out using a variety of tools like cost-benefit or multi-criteria analysis and involves making decisions about a particular activity or technology to deploy.
- **MONITORING AND LEARNING** include the continuous review and analysis of information during implementation, and the application of this learning to adjust adaptation in response to changing conditions.

Developing an understanding of vulnerability to, and the risks and impacts of, climate change is critical for adaptation action. Thus far, most adaptation-related information in South Asian countries is tailored toward this purpose of problem definition. Although new efforts are being made to monitor adaptation activities that lead to learning and improved effectiveness, there is still very limited focus on creation and use of information that can form a bridge from problem assessment to the choice of solutions.

Box 1 | Characteristics of Data

Data Domains
- Socio-economic
- Biophysical
- Climatic

Temporal Character
- Historical
- Current
- Predicted

Data Origin
- Observed
- Modeled

Data Type
- Qualitative
- Quantitative

Geographic Scale
- International
- Regional and transboundary
- Subnational
- Local, community-level, and site-specific

Adaptation Type

Discrete or stand-alone adaptation activities are those for which adapting to climate change is the primary objective. Typically, these activities take place in the context of an adaptation project that would never happen if the climate were not changing. Activities are often those most targeted to specific climate change impacts, such as building a sea wall against rising sea levels or switching crop seeds for drought-resistant varieties when more intense or more frequent dry periods are expected.

Integrated adaptation consists of activities where adaptation is undertaken to achieve development objectives in spite of climate change. For example, the climate-proofing of an agricultural development policy or the inclusion of climate indicators in coastal zone management planning both could be considered integrated adaptation decisions.

Table 2 | Examples of Data Classified According to Its Different Characteristics

EXAMPLE OF DATA	DATA DOMAIN	DATA GATHERING METHOD	DATA ORIGIN	GEOGRAPHIC SCALE	TEMPORAL CHARACTER
National government expenditure on natural disaster relief	Socio-economic	Quantitative	Observed	National	All
Daily rainfall data for a city for a 50-year time period	Climatic	Quantitative	Observed	Local	Historical
Farmers' observations about changes in crop planting over the previous decade	Socio-economic	Qualitative	Observed	Local	Current
Statistically generated air quality data	Biophysical	Quantitative	Modeled	Subnational	Current
Likelihood and consequences of flooding of glacial lakes	Biophysical	Quantitative	Observed	Subnational	Current and Predicted

The distinction between discrete and integrated adaptation is not a hard and fast one. However, we use the two categories here because they tend to be undertaken by different actors and use different analytic tools, leading to differences in what information is wanted and how it is used. Discrete adaptation tends to draw directly on climate change information. Integrated approaches are more likely to draw more on sector-specific information and tools that typically have not yet been modified to incorporate climate change.

Geographic Scale

As is the case with data, discussed in section IV A, the geographic scale at which adaptation takes place is an important parameter defining the use of information for adaptation. Getting the scale of information to match the scale of the decision is a challenge consistently cited by practitioners and researchers. Aggregating data across scales to create information at higher geographic scales is a common aim, but gaps in the comparability, availability, and quality of data can contribute to the challenge of doing so.

Scope of Decision Making

As with other types of decisions, the scope of adaptation decisions depends on variables such as their time horizon and intended influence. Here, the authors propose a set of three scopes within which adaptation decisions are commonly made:[2]

- **A PROJECT** has a relatively short time frame for completion (often a matter of a few years or less) and is location-specific with concrete outcomes. It will have a relatively narrow sphere of influence in terms of sector or geography. Examples include building a dam, applying for a pollution permit, and training a particular set of people. A project may be part of a broader plan, such as one designed to improve sanitation services in municipalities throughout the country. Although the majority of projects are local, they may occur at any geographic scale.

- **A PLAN** or course of action is also time-bound and location-specific but tends to have more general intended outcomes. A plan will have a broader or more diverse sphere of influence than a project in terms of geography, sector, stakeholders, or time frame. Plans are intended to influence and determine decisions, actions, and resource allocation. Examples include the National Adaptation Program of Action (NAPAs) and Sri Lanka's Coastal Zone Management Plan (CZMP).

- **A POLICY** is typically not time bound, and will usually have more broadly defined intended outcomes than a plan. Policies are normative and refer to a broad statement of intent that focuses the political agenda and may set a decision cycle in motion. For instance, the climate change policy of Nepal has catalyzed efforts including ensuring that at least 80 percent of total funds available for climate change activities flow to the grass-roots level and mobilizing additional technical and financial resources from mechanisms like carbon trade to reduce the impacts of climate change (Nepal Climate Change Policy 2011).

Annex C maps the case studies undertaken for this project against these scopes of decision making. The case studies were commissioned to provide insight into how information is currently being used in adaptation decision making.

NEW APPROACHES TO ADAPTATION DECISION MAKING

The assumption that decision makers need to rely on accurate, precise assessments of future impacts of climate change in order to create successful adaptation interventions is being increasingly questioned. A growing number of researchers argue that there will always be "some level of irreducible ignorance in our understandings of future climate" (Dessai, Hulme, Lempert, and Pielke 2009a); as a result, the traditional predict-and-plan approach to making decisions often does not work well for adaptation, even as climate projections improve and reach decision-relevant scales (see Annex B).

Uncertainty surrounding climate change is inherently high because of the complexity of our global climate system, the large number of variables that influence it, and the dynamic interactions between them. Moreover, the uncertainty increases the further into the future you look (Kinzig and Starrett 2003) and does not necessarily diminish—in fact, may increase—with better scientific research (Wardekker 2011). In response, different strategies for adaptation that manage uncertainty, instead of seeking to reduce it, are receiving growing recognition.

2. These definitions are modified from World Resources Institute 2007, Access Initiative Research Tool. Washington, DC: World Resources Institute. Available online at: http://research.accessinitiative.org.

These innovative approaches for managing uncertainty in making adaptation decisions do not rely solely or heavily on climate model outputs. Nor do they necessarily rely on especially high quantities or quality of data, which is often lacking in developing countries. Several of these strategies are flexible enough to be used in either information-rich or -poor contexts, and the strategies can incorporate information gathering as part of the decision-making process.

As distinct from traditional predictive planning strategies, alternative decision-making strategies use a different set of criteria for picking adaptation options. Instead of focusing on finding an optimal decision for an expected future, they use criteria such as flexibility, robustness, and participation to determine the appropriate adaptation options for uncertain future climate contexts. These criteria , which are drawn from the World Resources Report 2010-2011, are described below, with a brief example to illustrate how they can be used in adaptation decision making (WRI et al. 2011a).

Robustness

An optimal decision is the best adaptation decision for a specific future climate change scenario. A robust decision is one that may not be the optimal one for a specific scenario but will fare well across a range of scenarios, any of which are possible (Dessai, Hulme, Lempert, and Pielke 2009b). Robust decisions make use of scenario development and the comparison of interventions across a range of different scenarios. Robust decision making can be implemented in a more technical manner[3] or in a more participatory way that focuses on the principle of robustness.

Example of robust decision making:

Although Yemen has faced a 10 percent decrease in precipitation since the 1920s, there is no consensus on the projected annual precipitation levels. The climate models' annual rainfall outputs range from -34 to +56 percent. In addition to the high uncertainty of climate projections, there is also high vulnerability of several populations. Yemen has chosen to focus on robust climate strategies and low-regret adaptation measures, such as development of integrated coastal zone management plans (Dessai and Wilby 2011), which should help the country adapt, regardless of whether it will face increased or decreased precipitation.

Flexibility

Flexibility is an important criterion in several decision-making strategies, given the uncertainty inherent in our understanding of, and ability to plan for, future climate scenarios. Flexibility can be incorporated into decision making in different ways and, importantly, without the use of future climate change scenarios. For instance, one flexible decision-making strategy involves the creation of pathways that set specific, predetermined benchmarks at which new decisions will need to be taken. At each benchmark, any number of future decisions can be made. Another flexible decision-making approach might involve making a decision that is constantly monitored. As changes in understanding of the shifting climatic or societal contexts occur, the decision can be altered. Flexibility is critical when we know that courses of action may need to be changed frequently or when the ability to respond rapidly to surprises is important.

Example of flexible decision making:

In this example the criterion of flexibility is integrated in the institutional structure of the decision-making process, rather than the options identification phase. The Australian Centre for Climate Change Adaptation Program is implementing a research and development project to develop flexible coastal adaptation pathways for local communities throughout the island state of Tasmania. The government chose this adaptation decision-making strategy as it had little information on the comparative costs and benefits of different adaptation options, and it wanted to avoid the high cost of over-engineering and having to decide on one set of adaptation options for all vulnerable locations in the state (which could lead to maladaptation) (Australian Government Coastal Adaptation Decision Pathways Project n.d.). In this way, flexibility is built into a state-level project that is implemented by different local-level councils. To work well, flexible, learning-based decision-making processes that can accept new information and be modified according to it do require some degree of institutional flexibility (Adger and Tompkins 2003).

3. For instance, Robust Decision Making by the RAND Corporation. As background, Robert Lempert from RAND Corporation discusses Robust Decision Making: http://www.rand.org/multimedia/video/2010/04/2/robust_decision_making.html.

Participation

Stakeholder buy-in is vital for a decision-making strategy to be contextually relevant. Depending on how technical in nature the strategy is and the process by which the strategy is implemented, stakeholder input will look different. However, it is possible and important to incorporate input and feedback from a range of stakeholders during adaptation decision making. This criterion is important because it works to reduce the ambiguity that results from people bringing their individual world views to the decision-making process. These world views arise from a range of factors, including having varied opinions and having differing tolerance for risk. Participation may occur at the point of scenario development, choice of adaptation interventions, or even awareness building. Participatory processes build legitimacy with stakeholders, which is an important aspect of the long-term sustainability of adaptation interventions.

Example of participatory decision making:

Participatory Scenario Development (PSD) is a process that involves stakeholders in exploring the potential future in a policy-relevant way. PSD elicits information from stakeholders about their experiences with the shifts in climate and identifies alternative responses to these shifts (WRI et al. 2011b). In 2010 the World Bank Group commissioned a PSD workshop in Bangladesh where participants discussed the impacts of climate change, such as increased cyclones, floods, and droughts. The participants also raised the social aspects of climate change impacts, such as fewer marriages because the wedding season traditionally coincides with the rainy season, and marriage plans are increasingly being delayed or disrupted by flooding. This contributes to more fragile community support systems. Lastly, the workshop participants identified adaptation interventions that they prioritized over the short, medium, and long term (World Bank 2010).

These criteria are, of course, not mutually exclusive, and often there are synergies among them. For instance, a robust decision can also be responsive to contextual changes and may have been created through consultation with stakeholders. As with all decisions, contextual factors will guide the decision-making strategy that is adopted. These factors include planning horizon, current forms of decision making, information availability and access, and other goals of decision makers.

MEETING THE ADAPTATION INFORMATION CHALLENGE: ISSUES FOR DISCUSSION

Although the decision-making approaches discussed above are useful in data- and information-poor contexts, the greater the availability, quality, and applicability of information, the more informed and sustainable a decision can be. For example, a flexible approach to decision making may benefit from a process of setting benchmarks for future adaptation pathways, which requires information for identification of thresholds. Although these approaches do not hinge on climate projection information, they may require new analyses and new approaches to integrate current and historic data and information from socio-economic, biophysical, and/or climatic domains.

Cycling back to the two framing questions raised on page 3, the adaptation information challenge is clearly twofold: On the one hand, there is a need for improved information; and on the other hand, a need for adaptation decision approaches that fare well even under high uncertainty and limited information. This section discusses questions for moving forward: What are the next steps for South Asia in improving the information base and exploring alternative decision-making approaches? Four focus areas are introduced that may be the foundation for recommendations for an information action agenda for the region.

1. Data Gaps

Gaps occur both in terms of the quantity and quality of the data collected. The quantity of data may be improved by increasing the number of data gathering stations, or having volumes of data collected more frequently at a specific site. The quality of data pertains more to the sustainability of the data collection and whether the data collected are relevant and timely. For instance, it is easier to create a weather monitoring station than it is to maintain that station over time. Capacity, when it comes to the production of information, is often framed in terms of technology, proficiency, and availability and quality of raw data. A key need for effective adaptation is to prioritize addressing capacity gaps in these three areas with the end goal of effective decision making in mind.

- How can information users and producers jointly craft a process for prioritizing the data gaps to fill, based on a thorough assessment of decision-makers' needs?
- What are the barriers to establishing a network of data gathering stations that can provide a greater quantity of higher quality data?
- What capacity exists for improving the data gathering network through both formal and informal means?
- What critical entry points enable institutional investments to improve this maintenance?

2. Information Accessibility

Existing information fails to reach prospective users for a variety of reasons. Many of these are related to form rather than content and reflect failures to package information in user-friendly ways. At the same time, South Asia is also home to several innovative information packaging and transmission efforts aimed at engaging communities in information creation and at leveraging Information and Communication Technologies (ICTs) to reach small-scale farmers and other hard-to-reach users. What lessons can be learned from these pilot efforts? What other changes to the form of information could promote better access? Other considerations in access to information include—

- Which user communities are most aware of information available for adaptation? What are the options for improving awareness of information availability so that decision makers know where to look for information when they need it?
- How does the location and storage of information affect who uses it? Is there a logical central location for adaptation-related information in the region, or is a more distributed model more appropriate?
- When are the costs of obtaining information a barrier to use of information for adaptation? If so, what cost reduction options could be explored?
- To what extent may the legal mandates of government institutions and the rights of citizens to have access to public information need to change?

3. Integration and Analysis of Information

Integration of diverse information relevant to adaptation comes up time and again as a critical need. Unfortunately, information actors from different domains—and those working with different methods, forms, and content within domains—lack incentives and systems for sharing data, conducting joint analysis, and learning from one another. This can result in static information products of limited relevance to decisions. An example is vulnerability maps based on coarse proxy indicators with little investigation of what factors contribute most significantly to climate vulnerability among particular groups or in a particular place. Similarly, few vehicles exist for bridging the region's promising bottom-up community-level information gathering with official top-down analytic processes. Transboundary information issues carry yet another set of well-known challenges with significant political dimensions.

- How can integration of information across disciplines, sectors, scales, and international boundaries be improved?
- What capacity-building efforts can support better integration of information across scales, sectors, and administrative jurisdictions?
- How can uncertainty be integrated into analysis of information and decision-making processes?
- What are other linkages among institutions that would enable information to flow upward for aggregation from a local-level station to a national or regional point of analysis?

4. Action orientation

To date, production and use of information for adaptation in the region have focused primarily on problem definition, that is, understanding and describing climate change vulnerability, risks, and impacts. As attention turns increasingly to adaptation action, new analysis and tools may be needed to support identification and evaluation of options. The most frequently cited requests for information in this sphere focus on cost-benefit analysis. Other approaches—for example, better methods for analysis of multiple criteria, methods that integrate stakeholder preferences with scientific evidence, and scenario-based analyses—may also be needed to support options assessment, especially in cases where uncertainty limits the utility of cost estimates. Some of the issues that require consideration include—

- How can demand-driven information needs be systematically identified and prioritized?
- What are the information barriers to identification and evaluation of adaptation options?
- How can uncertainty be better incorporated into adaptation option selection? How can the assumptions that arise out of uncertainty, made during adaptation decision making, be discussed without undermining the decision?
- What information investments and other measures can help adaptation practice move from problem definition to identification and selection of practical actions?

ANNEX A: CHARACTERISTICS OF DATA AND INFORMATION

Characteristics of Data

This section identifies important characteristics of data that can be used in adaptation decision making. These characteristics attempt to categorize the wide range of data that can inform climate change adaptation.

DATA DOMAINS

Adaptation researchers and practitioners frequently group adaptation-related data into three domains:

- **Socio-economic data** describes a diversity of social and economic factors, such as population growth and income levels. This may also include wide ranging data and information about vulnerabilities, culture, politics, and institutions.
- **Biophysical data** describes the physical environment and biological functions of the natural world, for example stream flow, soil quality, ecosystem services.
- **Climatic data** involves variables of the climate system, such as temperature, rainfall, humidity, atmospheric pressure, and wind.

Many decision makers often mistakenly assume that the climatic data domain is the most important for climate adaptation, when in fact climate data alone cannot provide an adequate basis for adaptation decision making. Socio-economic and biophysical data are increasingly being recognized as important in making decisions about adaptation. However, the breadth of data available makes it difficult for practitioners and decision makers to know what kinds of data are useful and when they should be used. It can also be extremely challenging to integrate data across these different domains, for a variety of reasons, and to form a comprehensive picture of climate change and its potential impacts.

TEMPORAL CHARACTER

The temporal character of the data is typically quite important for making decisions about climate change adaptation. Future predictions of climate change impacts tend to be important for climate adaptation; however, historical and current observations may be equally important to make appropriate decisions. The temporal characteristics of data for adaptation can be divided into three categories:

- **Historical data** consist of data collected about variables from the past. Examples include daily rainfall data from the last decade and gross national income data for the last five years.
- **Current data** include data collected at present, that which is relevant to current adaptation decision making. Examples include real-time data on stream flows, precipitation, and temperature.
- **Predicted data** consist of outputs from models or other types of scenario-building exercises. Examples include temperature data in 2050 and gross national product figures for the next five years.

Hundred-year climate forecasts, for example, may not be very useful for current decision making. However, decadal and seasonal forecasts may be critical for adaptation decision making in the nearer term. Frequently, the temporal aspects of data are linked only to climatic data, but they actually can apply to any of the three characteristics of data identified above. Many climate change experts now suggest that, instead of relying on specific information about climate impacts from predictions, planners and decision makers ought to focus on using historical and current information to greater effect.

DATA ORIGIN

The origins of data can determine what other data can be integrated and how they may be used. There are two important ways of describing the origins of data:

- **Observed data** are collected without being altered in any way, for instance rainfall and other hydro-metrological data.
- **Modeled data** cannot be observed, but they may be based on or extrapolated from observed data. For example, if there are only a limited number of air quality monitoring stations, modeled data can be created using a statistical model. This may also include future temperature and precipitation projections using Global Circulation Models (GCMs).

The vast majority of adaptation-relevant data is observed, but modeling is critical in several instances where current data are unavailable and where modelers are making efforts to project into the future. We see modeled origins most often in economic and climatic data.

DATA TYPE

Data can be gathered using a variety of techniques and approaches. There are two distinct methods for gathering climate change adaptation data:

- **Qualitative or narrative data** that characterize and explain attributes, but do not necessarily measure them. This is a descriptive method of providing data.
- **Quantitative data** that can be expressed numerically or measured using units of some form.

These two types of data gathering methods are complementary, and it may be worth the effort to use both methods. Integrating data gathered through these different methods can be extremely challenging and may require considerable capacity and methodological sophistication. The method of data collection often can map closely to other characteristics of data discussed above. For example, data about biophysical characteristics lend themselves to quantitative methods, while information about vulnerabilities at the local level in data-poor environments may lend itself more to qualitative and narrative methods.

GEOGRAPHIC SCALE

The geographic scale at which data are collected matters a great deal for the utility of the data. A typical way of describing geographic scale includes:

- **International data** that are relevant to, and can be compared across, more than one region of the globe, such as economic data expressed as GDP.
- **Regional and transboundary data**, such as data about a river that crosses national borders.
- **National data** that pertain to an entire country, such as data describing forest cover and stream flow.
- **Subnational data** collected or used at a scale smaller than national but larger than local, for instance at the scale of a state or a watershed.
- **Local, community-level, and site-specific data**, such as the number of houses and people affected by a flooded river.

Ultimately, decision makers will need data at the same scale for which they are making a particular decision, and it is often a challenge to match the granularity of the data with the scale of the decision needed. This is particularly true for climatic information where GCM projections or other downscaled model outputs about future climate impacts do not correspond to the scale at which decisions need to be made for adaptation (see Annex B).This same data challenge is relevant when decisions are made across multiple scales, for example when a community-based adaptation intervention is being undertaken within the context of regional watershed vulnerabilities.

Characteristics of Information

In considering the usefulness of information for adaptation, it can be helpful to describe information according to three characteristics: content, form, and context.

CONTENT

The content of a piece of information is determined by—

- What the particular information describes. For instance, does it describe climate change impacts, institutions and their functions, or a population's vulnerability?
- What data were used to create the information? Because information is made up of data, all the characteristics of the data (see section IV A) that were used to create a piece of information apply.

As was noted earlier, the diversity of potential information content that may apply to adaptation is significant. However, the relevant content narrows down quickly when considered within a particular sector or issue area and when seen through the lens of a particular decision or need. In most cases, however, relevant content seems to reflect all three major data domains (socio-economic, biophysical, and climatic).

FORM

Information can be presented in many forms. Common forms include tables, charts, reports, stories, and maps. However, the recent revolution in information and communications technology (ICT) has diversified information forms, and given information providers new opportunities to put information in forms that are especially relevant to particular uses or user groups.

Use of information can be hampered if it is not in an appropriate form, because the form of the information affects where and how it can be disseminated, as well as whether and how potential users understand its relevance to their needs. A key factor shaping the form of information is the media through which it is transmitted: radio, television, telephone, print, Internet, or oral transmission. Each of these media tends to emphasize or exclude different details and shapes information to be accessible to different audiences with different assets and capabilities.

CONTEXT

Understanding the larger context within which information is created can help to determine its usefulness for meeting different adaptation needs. This is especially important when information was not created specifically for adaptation and is being borrowed from another sphere. This context is above and beyond the characteristics and content of data and information discussed above. Contextual issues to consider include—

- **Temporal:** when the information was created, what time period it covers, and whether it is information created once or if it will be periodically updated.
- **Analytic Methods:** how the data were synthesized in order to produce the information and how that might affect their usefulness. For instance, whether stakeholder interviews were conducted to increase buy-in and legitimacy.
- **Source:** where the information was created and who was responsible for creating it.
- **Purpose:** whether the information was created for a particular use or application and for whom it was created.

ANNEX B: UNCERTAINTY AND THE CHALLENGE OF DOWNSCALING

Decades of research into Earth's climate system have produced an increasingly refined set of GCMs that are used to project how the climate may change over time under different possible levels of greenhouse gas emissions. Unfortunately, GCM output resolution is most often too coarse for direct use in adaptation planning. The models describe climatic changes at global, continental, and, at best, regional scales, not at the national, subnational, and local levels where decision makers can take action.

In an effort to solve this problem, climate scientists have used GCM outputs to create Regional Climate Models (RCMs) and further downscaled climate model outputs to provide more site-specific information. RCMs use physics-based equations to incorporate data from GCMs and information about regional geography to create regional-level projections that make use of both local and global data. RCMs are, however, strongly dependent on the boundaries established for the GCMs, which often do not include all the feedbacks and forcing of our climate system. Although additional information, such as higher-resolution spatial analysis of land use, is incorporated in a regional model, the errors and uncertainty from the GCM remain and can be made worse in RCMs and other downscaled models derived from these GCMs. As a result, the higher granularity that downscaled outputs provide may cause significant errors and uncertainties that may render them less useful for local-level decision making.

Although downscaling requires a great deal of data, many downscaled models have parameters that are estimated from limited data of uncertain quality (UK Climate Impacts Programme 2003). Dynamic downscaling makes use of RCMs by nesting them within GCMs to capture smaller-scale climate phenomena, such as the influence of mountains or coastlines (Evans 2011). This method is very computationally demanding and is sensitive to the boundary choices made for the GCM (Wilby 2002). Statistical downscaling is based on the statistical relationship between large-scale climatic factors and local-level variables. While this method is computationally inexpensive and makes use of observed relationships, its basic assumption (that the relationships will remain unchanged) is not verifiable and the statistical relationship may not hold true under future climate scenarios (UKCIP 2003; Wilby 2004).

The uncertainty in downscaled climate models is important to note when models are used in an impact study or decision-making process. Additionally, increased resolution of the models is not equivalent to increased confidence of the projections (Wilby 2004). Uncertainty can be characterized in three forms: epistemic uncertainty (due to imperfect knowledge), ontological uncertainty (due to inherent variability), and ambiguity (due to multiple ways of interpreting a system). Uncertainty also has several sources, including uncertainty about input data, model uncertainty, and context uncertainty (for example, the boundaries of the model) (Refsgaard et al. n.d.).

ANNEX C: CASE STUDIES

COUNTRY	AUTHORS	CASE STUDY	SCALE	SCOPE	ADAPTATION TYPE	INFORMATION USE EXAMINED
Sri Lanka	Sonali De Silva & Mihiri Gunewardena - Public Interest Law Foundation (PILF)	The Coastal Conservation Department's Use of Information in the Revision of the Coastal Zone Management Plan (CZMP) in Sri Lanka.	Subnational (Sector-specific)	Plan	Integrated	Information used to create the CZCRMP includes site-specific hazard maps and regional trends from the IPCC, as well as biophysical data on rainfall, storm surge, and sea level rise.
Bangladesh	Golam Rabbani, Natasha Haider, Ali Emran & Nazzina Mohsin - Bangladesh Centre for Advanced Studies (BCAS)	Application of Information in Current Adaptation Projects under the Bangladesh Climate Change Trust Fund (BCTF).	National	Project & Policy	Discrete	The 66 adaptation projects under the BCTF used a wide range of information, including vulnerability assessments, climate impact assessments, flood maps, and information about salinity, drought, flood, crops, public health, and early warning systems.
Nepal	Aarjan Dixit - World Resources Institute (WRI)	The Use of Information in the Creation of the National Adaptation Programmes of Action in Nepal.	National	Plan	Discrete	The government of Nepal used an innovative approach to gathering local data about coping practices and risks for developing adaptation projects that meet urgent and immediate needs under the UNFCCC-mandated National Adaptation Programmes of Action (NAPA), including vulnerability assessments, and climate scenarios.
India	Mustafa Ali Khan, Anand Kumar and K. Vijaya Lakshmi - Development Alternatives (DA)	Adaptation for Agriculture: Information Access, Use and Application.	Subnational (state level)	Project	Integrated	This project in the Bundelkhand region of India used climate scenarios developed by the Indian Institute of Tropical Meteorology along with information and data from a range of other sources to identify adaptation intervention options.
India	Sreeja Nair, Suruchi Bhadwal, and Sneha Balakrishnan - The Energy and Resources Institute (TERI)	What Information Can Help Decision Makers? A Case Study about Climate Change Impacts on Water in the Indo-Gangetic Basin.	Regional	Policy	Discrete	A key challenge for this project is incorporating bottom-up socio-economic data and top-down climate model data. The socio-economic scenarios considered changes in industrialization and agriculture intensification, while the climate scenarios focused on future temperature, evaporation, and precipitation.

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