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Lessons from the freshwater sector for climate change adaptation

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Abstract

This paper assesses adaptation in the freshwater sector to derive lessons on what motivated societies to change, which factors led to more successful adaptation, and how interventions may best be sustained. We compared the lessons derived from three portfolios adaptation research projects, namely the WWF - ANU assessment of six developing country cases, Institute for Social & Environmental Transition (ISET) in South Asia and START's adaptation research program Assessments of Impacts and Adaptations to Climate Change (AIACC) globally. The key conclusions for more effective climate change adaptation are that:

1. Robust adaptation interventions that reduce key risks should commence now despite uncertainties as to the precise magnitude of climate impacts;
2. Sustainable development and adaptation measures can be compatible;
3. Adaptation should be mainstreamed, not implemented separately;
4. Strengthening key institutions, knowledge sharing, and building human resource capacities are crucial to effective adaptation;
5. Adaptation strategies are strengthened by: community ownership and subsidiarity; concurrent and linked action at different geopolitical scales and in different sectors; consistent funding; and long term, iterative programs;
6. National governments can best help by facilitating climate risk communication and knowledge sharing opportunities for adaptation; building adaptive management into their institutions and policies, mandating and supporting sub-national institutions; removing barriers to funding sub-national institutions; and allocating funding for adaptation.

Key words: climate change, freshwater, adaptation, adaptive management, sustainable development

Introduction

In many regions, climate change is being felt most immediately through changes to hydrological systems, with changes in precipitation, warmer temperatures and increased evaporation and evapotranspiration influencing the severity of floods, droughts, and eutrophication events, and altering runoff and aquifer recharge. In addition to these direct climate effects, climate change is acting as an additional stressor on water resources already strained as a result of over-allocation and extraction, industrial pollution, and siltation. There is a huge variability in freshwater availability in different parts of the world and freshwater has already become critically scarce in many places (WWAP 2009). Much of the developing world, in particular, faces a precarious situation with respect to water availability and quality that is likely to further deteriorate with climate change, industrialization, and increased population pressure. Water is truly central to the future sustainability of ecosystem services and economic growth under a changing climate, as reflected in observations from the 3rd World Water Development Report (WWAP 2009:68-69):

- "Climate change may not fundamentally alter most of the world's water challenges, but as an additional stressor it makes achieving solutions more pressing."
- "The main impacts of climate change on humans and the environment occur through water."
- "Anthropogenic climate change can also directly affect demand for water."
- "The decisions and policies put in place today for mitigation [carbon capture & storage, hydropower, biofuels, reafforestation, etc.] and adaptation [rain-water storage, etc.] can have profound consequences for water supply and demand."

Adapting to changes in water resources imposed by climate change will require a comprehensive response from society that addresses both the climatic and nonclimatic drivers of vulnerability. In this respect, all, or nearly all, water management interventions represent a form of adaptation (or maladaptation). As the Intergovernmental Panel on Climate Change says (Kundzewicz 2007:196): "*Adaptation to changing conditions in water availability and demand has always been at the core of water management*." For this reason we assert that society can learn much about what triggers adaptation, how it can be most effectively undertaken, what pitfalls to avoid, and how to sustain it by considering the most common form of adaptation, autonomous adaptation. This is defined by the IPCC as (Bates 2008:48): "*adaptations … that do not constitute a conscious response to climate stimuli, but result from changes to meet altered demands, objectives and expectations which, whilst not deliberately designed to cope with climate change, may lessen the consequences of that change*."

This paper represents the outcome of an assessment of adaptation programs in the freshwater sector to derive lessons on what motivated societies to change, which factors led to more successful adaptation, how interventions may best be sustained, and what the implications of these lessons are for adaptation beyond the water sector. We compared the lessons derived from three portfolios of autonomous adaptation case studies and adaptation research projects.

One was an ANU assessment of six consistently designed freshwater adaptation case studies from six developing countries around the world (Pittock in press), based on projects of the conservation organization WWF. These included cases from India (Gujja in press), China (Yu in press), Mexico (Barrios in press), Brazil (Pereira in press), the lower Danube basin (Ebert in press) and Tanzania (Kashaigili in press), representing diverse empirical case experiences within a coherent project. Also considered were lessons from the work of the Institute for Social & Environmental Transition (ISET) in South Asia (Moench and Stapleton 2007) and START's global adaptation research program Assessments of Impacts and Adaptations to Climate Change (AIACC) (Leary 2008) which considered both autonomous and planned adaptation and the linkages therein.

Each of the programs presented their key adaptation lessons at the University of Copenhagen's conference "Climate change: global risks, challenges and decisions" on 11th March 2009 before more than 60 peers. Incorporating the discussion between presenters and the audience, this paper now summarizes the issues of learning from ongoing adaptation in the freshwater sector, primarily in developing countries, and draws out common lessons for more effective climate risk management and climate change adaptation.

Discussion:

1. Adaptation, uncertainties and urgency

The case studies demonstrated that key decision makers are not sufficiently addressing threats posed by climate change due to the immediacy of responding to non-climate issues (especially for sustaining water resources), uncertainty as to the magnitude of the likely climate change impacts, and the inconsistent and often contradictory nature of climate change communications, all of which act to constrain planning for adaptation. Moreover, the case studies concluded that societies respond to multiple stressors, not just those generated by climate risks; thus, effective adaptation will require integrating climate change vulnerability and risks within a framework of multiple and integrated drivers of change. Regrettably many of the best cases of adaptation discussed at the conference involved reform opportunities that arose in response to instances of disasters and environmental collapse (Pittock in press).

Moving from indecision or complacency to action will require mobilizing resources to effectively communicate climate risks and to enhance knowledge transmission for adaptation. An initial effort should be targeted at assessing uncertainty in climate projections and trends, and developing a means of resolving or at least better understanding these uncertainties, and prioritizing efforts to limit what are clearly maladaptive responses with respect to future climate change. However, even with the best available projections and trend assessments, considerable uncertainty often remains. The example of Australia's Murray Darling Basin was raised, where despite extensive investment in downscale modelling, the range in possible changes reported for 2030 in inflows to the river system is between +7% to -24% and a range of potential river outflows is +20 to -69% was identified (CSIRO 2008). In our view

there is an opportunity cost to be considered with investment in further downscale modelling versus commencing robust adaptation measures now.

At the very least, a more informed approach for interpreting and applying climate model output is needed. In using climate model projections, it is important to consider an ensemble of model outputs, in which information about future conditions is estimated from the mean of multiple climate models linked to a range of future emissions scenarios, rather than reliance on one single model or emission scenario. In cases of high uncertainty, developing a series of discrete climate scenarios and risk assessments can help to define a strategic response. In this case regional climate models can be combined with data from other sources, such as water planning models, to inform a series of "what if" scenarios—what if the droughts periods are *n* years longer, if temperatures increase n degrees, if the flood return period is reduced by *n* years. Decision makers are then able to describe the realized and potential hydrological, biological, and socioeconomic vulnerabilities of key indicators, prioritize their relative importance, and envision how these systems can and should change under future climate scenarios. This approach can provide a means to focus planning efforts that does not rely exclusively on climate model output to drive decision making.

In most of the case studies discussed at the conference, climate change trends were apparent and many no and low regrets adaptations (for example, those that will sustain ecosystem services like environmental flows) could be identified for immediate implementation. Where local institutions had been encouraged to think of adaptation measures that would have multiple benefits under a range of circumstances, these organizations took ownership of the challenge and substantial benefits were evident in relatively short time periods (1-3 years). Furthermore, in a number of the case studies, the expectation of the need for expert-led climate impact assessments was raised as a reason for delaying adaptation actions, whereas there were a number of examples where initial no and low regrets adaptation measures led to more sophisticated interventions (including Sao Joao in Brazil and Chihuahua in Mexico).

Our discussion raised the issue of whether many types of autonomous adaptations would be overwhelmed as key threshholds are passed with greater climate change, for instance, whether the greater water efficiency measures would be inadequate to sustain local communities with more frequent drought in the Ruaha River (Tanzania) and Rio Conchos (Mexico) examples. Yet many of the autonomous and decentralized adaptations could readily be scaled up, such as the village water tanks in the Godavari basin (India) and floodplain restoration in the Danube basin (eastern Europe) and Yangtze River (China) to at least address risks from near and medium-term climate change impacts. Further, while it is accepted that some physical adaptation measures may simply buy some time, it was considered that many of the institutional strengthening measures, such as establishment of self-reliant water users' associations, could provide a basis for ongoing adaptive management to climate change. Climatic and hydrologic systems are likely to continue to change for the forseeable future, and we believe that adaptation needs to be seen as an ongoing journey along a pathway, a reiterative process, and not a one-time or short term intervention to reach a perceived endpoint. In this context, adaptation strategies are

needed that both reduce and spread risk in order to avoid severe impacts (Moench and Stapleton 2007).

Some potential maladaptations were also discussed, including non-conjunctive management of surface and groundwaters, and the construction of water treatment infrastructure vulnerable to flood events and sea level rise. In many of these cases the problems were not limited to climate change impacts and corrective measures were being instituted, such as conjunctive water management in the Rio Conchos (Mexico).

2. Adaptation and development

We consider that the goals of climate risk management (or adaptation) and development are strongly complementary, given that the development challenges stemming from poverty, poor governance, lack of social safety nets, poor access to resources, and resource base degradation exacerbate the risks of impacts due to climatic and hydrologic variability and change. Further, climate impacts on biodiversity and ecosystem integrity are amplified by existing stressors, thus addressing degradation of the natural resource base is a critical first response (Leary *et al*. 2008).

In much of the developing world, there is a strong need to first address the 'adaptation deficit' with respect to current climate variability, namely an inability to effectively cope with current climate risks. Reducing this adaptation deficit is an essential starting point, and it provides a foundation upon which to develop and implement longer-term strategies. Some of the more tangible examples of interventions to reduce this deficit discussed from the AIACC projects included (Leary *et al*. 2008): improved access to agricultural inputs; more environmentally and socially sustainable livestock management; rainwater harvesting; and livelihoods diversification.

Integrating adaptation with development planning can realize synergies between the two and it provides a basis upon which to engage a broad range of stakeholders across society. We consider that adaptation is more than just "coping": it is about "doing well", however this is judged. There are many cases where multiple benefits have been derived from no and low regrets adaptations for people and nature. Examples were provided of significant increases and diversification of incomes, and reduction in risks to livelihoods from climatic variability, in Tanzania, India and China in particular. Immediate benefits (<1 year in time) have been delivered in these examples of enhanced climate risk management that provided the basis for adaptation, such as securing local water supplies and increasing incomes, and in so doing have bought community support for longer term and more sophisticated adaptation measures, such as provision of environmental flows.

Responding to climate change will require the development of tangible strategies that are technically effective, economically efficient, and socially equitable. In many cases, effective response strategies emerging from the above type of process will require fundamental changes away from standard approaches that depend for their effectiveness on the ability to project future climate conditions to ones that assess risks and are resilient under highly uncertain and variable conditions, and that help vulnerable groups to better manage current climate risks so as to provide a basis for

adapting to future climate change. In an example from Uttar Pradesh, for instance, the cost benefit ratio of combining physical and institutional interventions was greater than any single intervention. Most approaches involve social trade-offs, so it is important to target the most vulnerable, and to have a mixture of measures to reach a larger number of people (Moench and Stapleton 2007).

Where flood management is concerned, for example, most large scale infrastructure for water control depends on the ability to project future flows with a relatively high level of accuracy that is often not available. In contrast, more open basin approaches to flood risk management are able to deliver benefits under much higher levels of uncertainty regarding future conditions, through, for example, strategies to live with active floodplains. In an example from Rawlpindi, river floodplain restoration had an order of magnitude great cost-benefit ratio than alternative infrastructure-based options (Moench and Stapleton 2007). Similar issues apply in other areas of water and energy management.

3. Strengthening institutions and other societal capacities

How groups manage climate risks is governed by: community awareness and education, the level of socio-economic development; strength of community organizations and other supporting institutions; locally available natural resources; and local traditions and cultural norms. Capacity building and institutional strengthening are in themselves a key adaptation response, particularly in regions where institutions are poorly resourced and scientific capacity for understanding and communicating climate change risks is low. Sharing of knowledge between science, policy, and practitioner communities is essential for developing a foundation to sustain adaptation. This requires support for processes that enhance knowledge generation, interpretation, distribution and sharing, and application. These efforts should be targeted at a broad range of sectoral interests, such as agriculture, forestry, fisheries, water resource management, meteorology and climatology, energy, public health, disaster management, urban planning, and rural development. Given the high degree of variation between regions and even within communities, identification of specific interventions depends heavily on shared learning processes supported by a combination of technical, economic, social and institutional analysis to enable the integration of local and global information toward the identification of tangible response strategies.

In the example of the Rio Conchos basin (Mexico), the major adaptive management was summarized as education and "better social organization". A 2004 WWF survey in the three main cities of the Rio Conchos basin (Chihuahua, Delicias and Camargo) showed that the majority of the population did not know where the river originated or that its ecology had been impaired, while a large minority were unaware of how the river water was used (A. Rodriguez, pers. comm.). Consequently public education was essential to implementing practical solutions to water scarcity. The creation of the multi-stakeholder Interinstitutional Working Group (GIT) facilitated adaptation by: a) the promotion of the basin concept; b) providing a forum not owned by any one organization where government agencies can present, refine and gain support for their programs; and c) participation of a broad range of stakeholders in developing, owning and implementing projects to achieve a common vision (Barrios *et al*. in press).

4. Elements of stronger adaptation strategies

From our programs we identified a number of common elements to bolster adaptation planning:

- Ownership. As opposed to 'top down' strategies, broad community awareness and ownership of the necessary adaptation measures and participation in their implementation at the most relevant scales is critical to success. This is particularly the case with adaptation and a decentralized resource like water where most governments can only effectively govern the resources with the active consent of the local society. It is also apparent that the full gamut of sub-national institutions needs to be involved in making adaptation tangible and effective. Subsidiarity - empowering the most local scale of institutions practically able to undertake relevant adaptation measures is critical for developing awareness, ownership and effective implementation. Approaches that are tailored to specific contexts and sources of vulnerability were assessed as being most effective. Clarifying rights and access to natural resources was critical for enabling adaptation to occur (Leary *et al.* 2008).

- Scale and sectors. Effective adaptation will in most cases depend heavily on a combination of concurrent and complementary measures and conditions that occur across multiple, nested scales, from global to local, and across sectors and their respective institutions. As a result, while broad strategic approaches may be possible to replicate widely, the specific interventions or approaches needed to respond to climate change must be tailored to local conditions.

- Funding. Experience shows that the most effective adaptive management institutions, such as river basin organizations and water users' associations, are those that have a consistent income stream, such as from local user fees, payments for watershed services, or other taxes. Even if this income does not fully cover program costs, these funds enable leverage of other resources. In a number of the cases discussed, the newly established adaptation institutions appeared to be fragile as provincial or national governments had either prohibited a key self-financing capacity (such as payment for watershed services) or had not instituted the reallocation of funds to sub-national institutions as promised.

- Iterative programs. Case studies also show that the most successful adaptation is the result of long term programs based on iterative cycles of medium term targets and interventions. In the examples discussed, flood risk reduction through floodplain restoration of the lower Danube River and delta has to date taken over 10 years work based on long term strategies, and the Sao Joao water quality restoration program in Brazil is on its third work plan.

By contrast, warning signals that adaptation strategies may not work include strategies that involve (Moench and Stapleton 2007):

- Dependence on specific event characteristics;
- Long lead times;

- High initial investments;
- Long-term institutional dependence;
- Large distributional consequences.

5. National government facilitation

As a result of the research results presented at the Copenhagen conference, we consider that national governments can better facilitate climate change adaptation by:

- Encouraging mechanisms that enhance risk communication with respect to climate change impacts and opportunities for adaptation, to encourage all institutions to build no and low regrets climate change adaptation into their existing programs regardless of the scientific uncertainties on likely climate change impacts;
- Building adaptive management into their institutions and policies. This includes stronger support for developing and sustaining national and regional networks of scientists, and for fostering dialogues between scientific and policy making/decision making communities.
- Mandating and supporting sub-national institutions to act by giving them the legal authority, enhancing their terms of reference, and supporting innovative policies;
- Removing barriers, such as: legal restrictions on payments for environmental services needed to fund sub-national institutions; prohibitions on broader stakeholder membership of river basin management and other organizations; inconsistencies between sectoral laws, and local enforcement of sustainability regulations;
- Allocating funding, including by expediting hypothecation of relevant fees and taxes, and reallocating appropriate national funds.

Conclusions:

Our assessment of climate change adaptation and freshwater concluded that society needs to understand that climate will continue to change so that approaches to water management should be both responsive and anticipatory. In other words, water management needs to be approached as a journey along an adaptation pathway rather than with a view to arriving at a single destination. This means that societies should favour adaptation decisions that are robust to uncertainty in both climatic and non-climatic pressures, as well as in ecosystem responses. In part, this requires our societies to track emerging climate patterns, assess risks, and adjust associated responses by strengthening monitoring networks and freshwater indicators (Matthews in press).

In assessing the lessons derived from the WWF, ISET and AIACC adaptation work globally, we believe the following common conclusions can strengthen climate change adaptation programs:

1. Adaptation interventions should commence now despite uncertainties as to the precise magnitude of climate impacts;
2. Adaptation and development are largely compatible;
3. Adaptation should be mainstreamed, not implemented separately;

4. Strengthening institutions, knowledge sharing, and other societal capacities are crucial to effective adaptation;
5. Adaptation strategies are strengthened by:
    - Community ownership and subsidiarity;
    - Concurrent, linked action at different geopolitical scales and in different sectors;
    - Consistent, if not substantial funding;
    - Long term, iterative programs;
6. National governments can best help by:
    - Communicating the risks and opportunities for adaptation;
    - Mandating and supporting sub-national institutions to act;
    - Removing barriers to funding sub-national institutions;
    - Allocating funding.

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