CLIMATE CHANGE: PAST AND CURRENT RESEARCH AT IWMI

The main premise and overall framework for climate change-related research work at IWMI has been that by understanding and adapting to existing climate variability better, society will develop resilience to climate change (CC), i.e. be better equipped to withstand its adverse consequences. For example, CC will further increase river flow variability and associated magnitude/probability of both low- and high-flow events which often, even in present day conditions, fall outside the bounds of existing institutional designs, and are not properly managed.

In this regard, IWMI carries out significant research in the field of drought assessment and mitigation. Drought is a major impediment to development of rural livelihoods, which hits millions of people in Africa, Asia and Latin America. The world trend is to move away from 'drought response' (reactive approach, focusing primarily on drought relief after it had happened) to drought mitigation (pro-active approach, when anti-drought actions are taken in advance). The reactive approach is still dominating most of the developing world. This, if not changed, will adversely affect the ability of many developing countries in the region to adapt to CC. The recently completed project in South-West Asia aimed to identify technical, institutional and policy gaps which existed in drought research and management in three countries in the region (India, Pakistan and Afghanistan), enhance regional cooperation in drought management and suggest recommendations for effective drought mitigation in the mentioned countries. The project addressed a variety of technical and social issues, including, developing a remote sensing data based, regional drought monitoring system, analysis of drought frequency and magnitude using precipitation time series, drought analyses software development, socio-economic surveys of rural population, review and analysis of drought-related institutions and policies, review / assessment of the potential of water harvesting technologies to withstand droughts. The Project was carried out in collaboration with a number of local research institutes and NGOs.

A range of current drought research activities at IWMI include quantification of drought risks and low flows in Iran, CC-induced impacts on irrigation schemes in Morocco, global mapping of drought-related indicators which reflect various aspects of drought – from drought hazard and vulnerability of water resources systems to drought - to indicators of drought preparedness, etc. The attempts are being made to initiate drought-research projects in East and West Africa. The details of IWMI drought work are available at IWMI Drought Information Center web site (http://www.iwmi.cgiar.org/drw/),, which also contains information on drought research in other CG Centers.

An example of research which directly examined the various adaptation strategies to CC in various regions, is the ADAPT project (Water, Climate, Food and Environment under Climate Change: An Assessment of Global and Regional Impacts and the formulation of Adaptation Strategies for River Basins). ADAPT included studies in seven contrasting river basins: Rhine (Western Europe), Sacramento (USA), Syr Darya (Central Asia), Volta (Ghana), Mekong (Southeast Asia), Walawe (Sri Lanka) and Zayandeh (Iran), where GCM predictions were downscaled to river basins for hydrological modeling and comparing different response strategies to protect the environment, improve food production and enhance industrial capacity.

IWMI coordinated the study, simulated adaptation strategies to sustain food security in all study basins and carried out full studies in Sri Lanka, Iran and Mekong. IWMI is currently working with Mekong River Commission (MRC) to incorporate IPCC CC scenarios into the MRC development scenarios and analyze impacts on the Mekong river flow.

IWMI has developed a global model (WATERSIM) to analyze various scenarios of food-water-environment nexus. The model is based on water accounting, fully integrates water and food modules, uses a combination of hydrological and administrative boundaries and allows the following issues of global change and adaptation to it to be examined:

- tradeoffs between irrigated and rainfed agriculture in food production
- impacts international agreements on trade and water use at regional and basin level
- impacts of alternative investment strategies in water infrastructure and agriculture
- impacts of environmental regulations on agricultural production
- impacts of rainfall and water resources variability on food production

Capacity is also available at IWMI to analyze both hydrological and atmospheric components for basin water management, derive local climate scenarios from meso-scale climate models and use them to assess impacts of land-use change on climate (recently completed for the Sudd case in the Upper Nile), as well as impacts of CC on land use (ongoing).

An ongoing study analyzes, for the first time, the multiple trans-boundary water treaties to examine a range of mechanisms that mitigate the negative impacts of changes in trans-boundary water availability, associated with climate variability and change. The study considers strategies in trans-boundary water law formation which are both politically feasible and can mitigate the impacts of variability on riparian relations. It is acknowledged that CC impacts will likely be most significant in Africa, where large water developments will also take place in the next decades. Therefore making water resource variability an integral part of the trans-boundary water management (e.g. in the Nile basin) is particularly important if the impacts of CC on African poor are to be alleviated

Another current project examines links between malaria incidence and climate variables in Sri Lanka. It aims to develop early warning tool that may be able to predict, amongst others, the impacts of CC on malaria hazard. IWMI also leads a System-wide Initiative on Malaria and Agriculture (SIMA), which aims to increase the understanding of links between malaria and agriculture, and to test innovative interventions for malaria control under different agricultural systems and, potentially, CC scenarios.

Several on-going projects (e.g. African wetlands), focusing on wetland assessment and management, develop research on adaptation to CC through the medium of water. They are looking at it from both an environmental and food production perspective aiming to find adaptation mechanisms that do not entail a conflict between the two. Part of the on-going research focuses on how changes in ecosystems as a consequence of CC compound existing feedbacks (e.g. or spread of invasive species or water quality changes) on agriculture and potentially constrain local and institutional adaptation.

IWMI has done a significant research in the field of environmental flow assessment and management at different scales - from global to individual river basins. Environmental flows,

which are rising high on the global water agenda, are being considered in a broader context of how to allocate water under climate variability for *multiple* purposes and to assess their effectiveness in terms of the provision of wider ecosystem services, including food. Some of the on-going projects (e.g. in Mekong tributaries, Volta Basin) examine the assimilation of environmental flows into future basin water allocation models under CC scenarios.

Ongoing research examines some implicit hydrologic dimensions of international efforts to mitigate CC, like those of the Clean Development Mechanism (CDM) – "carbon sink" provisions of the UN Framework Convention on Climate Change's Kyoto Protocol – on global, regional and local water cycles. Conversion of large land areas to forestry, which is promoted by the CDM, impacts the redistribution of water use (through increased evaporation, reduced runoff, etc.) thus being the major component of CC mitigation process. Global and local datasets are used to simulate CDM-related changes in land-use and farming systems and their consequences for local communities and overall food security. A similar modeling approach is applied to examine regional and basin-wide water use impacts associated with CC. GCM scenario climate variables are used as inputs, and both the implications of CDM carbon sink projects under changing climatic conditions, and land-use changes in general, are examined. Potential water scarcity hotspots are thus being identified under combinations of land-use change and CC.

IWMI has contributed directly and indirectly to several international assessments on water, food and environment that take into account climate variability and change impacts (e.g. Comprehensive Assessment of Water Management in Agriculture, Millennium Ecosystem Assessment, International Assessment of Agricultural Science and Technology for Development, Global Environment Outlook). IWMI researchers have participated as expert reviewers of the IPCC's Fourth Assessment Report. IWMI is one of three CG centres, along with ICRAF and CIFOR, accredited with the UNFCCC, and as such can participate in the annual Conference of the Parties as an Intergovernmental Organisation (IGO).

IWMI leads a theme "Integrated Basin Water Management Systems" of the Challenge Program on Water and Food. The theme's research agenda focuses on how basin water and land resources could be better managed to enhance agricultural output, productivity and profitability in a sustainable way. Issues on climate variability, CC and adaptation to them that are addressed by the theme include: understanding climate variability (particularly floods and droughts), assessing vulnerability of the poor to these extreme events and identification of coping strategies.

IWMI developed World Water and Climate Atlas, which provides information on climate and moisture availability for agriculture and is of direct relevance to CC researchers, planners and those carrying out adaptation activities. IWMI also leads the CGIAR Consortium for Spatial Information (CSI), which provides framework data for global spatial analysis and modeling conducted by various CG centers. The CSI activities include, amongst many others, the development of a spatial database of CC scenarios, which aims to promote and support CC analysis by a broader scientific community.