Climate, energy and environmental care - Capacity building for relevant water research

Experiences and lessons from UNESCO HELP

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Abstract
Climate change is real and poses a grimmer risk to livelihoods and the environment in particular in the developing world. Strategic capacity building and knowledge sharing structures are essential for generating positive sum solutions from these generally negative forces. Adoption and adaptation are main responses to climate change and environmental care but transaction costs are substantial. What knowledge is protected and at what cost will guide the balancing of costs and benefits across actors. Knowledge and capacity enhancement will become the inputs and outputs of environment care processes–scientific, political and socioeconomic. Agents with better knowledge imbedded in a functioning institution will be better able to cope with the climate change risks and to protect the environment.

This paper builds on an existing foundation of knowledge and exposure, with the Australian Murrumbidgee Catchment already recognised within world water resource circles globally as a leader through the UNESCO's Hydrology for the Environment, Life and Policy (HELP) program. The paper offers lessons and experiences for extending HELP to other catchments for capacity building. The HELP program aims to bring together scientific research in catchment management with practical application of policy and on-ground management practices. The HELP program has now moved into the implementation stage and includes 67 catchments from around the globe that are looking to better utilise their water resources for sustainable development. Of those 67 basins there are only 7 demonstration grade basins, one of which is the Murrumbidgee catchment in Murray-Darling Basin, Australia. Water is contextualized as an overarching theme within the continuum of climate change, the environmental care and capacity building for delivering real solutions in real catchments for real people. The usefulness of HELP approach in capacity building under conditions of resource scarcity is demonstrated. Principal research thrusts and outstanding research issues for capacity building are identified. Emerging opportunities at global scale and cutting edge regional issues for climate change hotspots are juxtaposed for regional priority setting for financing water related capacity building. The main message is that we need to think differently about water in the wake of climate change and environmental care. We must consider climate and environment as legitimate clients for maintaining and enhancing the multifunctional productivity of water and ecosystem resources so as to optimise physical, economic, social, and environmental benefits without compromising the quality of these resources–truly positive sum solutions for mankind.

Key words: HELP, climate change, environment, water, capacity building.

1. Global climate cycle

Climate change is real and impacting the environment and the livelihoods of millions around the globe. Prolonged and severe droughts, extreme rainfall, flooding, hurricanes and storm surges from rapid changes and unseen variability in century scale climatic patterns are posing a grimmer risk to livelihoods and the environment. Strategic capacity building and knowledge sharing structures are essential for generating positive sum solutions from these generally negative forces. Adoption and adaptation are main responses to climate change and environmental care but transaction costs are substantial both due to the common good nature of climate change and the environmental care as well as due to the geopolitical economy and inequitable distribution of costs and benefits among various social groups, locally, nationally and globally. What knowledge is protected and at what cost will guide the balancing of costs and benefits across actors, essentially involving tradeoffs and societal value judgement. Knowledge and capacity building will become the inputs and outputs of environmental care processes–scientific, political and socioeconomic.

Climate change is a 'century-scale' problem and a 'global common' issue requiring global as well as local actions. Inadequate action has demerits of impacting productivity, impacting water resources, and degrading ecosystems irrespective of the global climate change debate. Inaction has more grim consequences especially for more vulnerable communities scraping against less than $1-a-day and living at the bottom of the pile, some 800 million poor people around the globe. Vulnerable communities can not wait for global actions; local actions are needed now to protect rural and regional communities and our fragile ecosystems that generate host of services to mankind. Maintaining the climate and consequently the environment within habitable boundaries is probably the greatest 'public goods game' played by humans and the greatest gift to our grandchildren (Milinski et al., 2006).

Do nothing is not an option. We must act now and act faster.

With inaction the possibility of sudden, dramatic climatic shifts means that sometimes very small, innocent changes can trigger huge changes when thresholds are crossed leading to growing fear over a sharp climate shift (McFarling 2001; Yancheva et al. 2007). According to a report published by the Centre for Global Development based in Washington DC, world agriculture production faces serious declines from global climate warming. The report by the Peterson Institute of Institutional Economics in Washington found that global warming will cut Australia's farm productivity by predicted 27 percent, with the worst-felt impacts in the northern wheat and sheep belt with a 70 percent decline and 25 percent in the eastern wheat belt (Cline 2007). With capacity building for adaptation the impacts can be mitigated. For example, early findings from research conducted by the UNESCO-HELP International Centre of Water for Food Security, Australia shows that climate forecast information can offset reduction in gross margin by 5-7 percent on average in a major irrigation area, which could translate into millions of dollar in direct losses averted for the regional farming communities (Khan et al. 2008).

Climate change and variability can play havoc to regional communities. For example, NASA believes a climate shift dried out Mars (Bibring et al. 2005; 2006); the destruction of the Chinese Tang Dynasty and the demise of Classic Maya Civilization in Central America was due to abrupt shifts in the monsoon cycle and a general shift towards a drier climate which crippled the irrigation systems (Haug 2003; Yancheva et al. 2007). A shift of the weather pattern caused the Dust Bowl droughts, that devastated the Great Plains in the 1930's (Weart 2003). Climate shift caused the mass death of Auklet's chicks in Canada due to a strong "anomaly" in the climate off the Alaskan coast (Canada 2006); and climate shift threatens California with devastating consequences for wine grapes and cows producing less milk, while fundamentally disrupting California's water rights system (Hayhoe et al. 2004).

2. Global energy cycle

Anthropogenic climate change is an energy consumption problem. Though agriculture is not a major consumer of fossil energy, yet carbon emissions from agriculture are substantially. Agriculture is also a major sink for greenhouse gases and largest sequester of carbon. Energy prices are driven by geopolitical events and forces well beyond agriculture sector yet the impacts are felt disproportionately by the sector. Oil prices in global markets crossed the $100 per barrel mark during January 2008. The current vitality in energy prices may continue for quite some time, putting pressure on agriculture to use energy more efficiently. Farmers may switch to energy crops as the demand for biofuels surges and bioenergy crops become more profitable. Large scale bioenergy production may have consequences for hydrological processes (incl. floods and droughts), water consumption, biodiversity and food production and might compromise the capacity of the local communities to withstand price shocks and protect the natural environment.

Example: Biofuels and Food Security

Higher energy prices affect agricultural water use and food security in four ways (de Fraiture et al., 2007):

- The demand for biofuels increases with potential impacts on water resource allocation and food security.
- The cost of pumping irrigation water, in particular groundwater, surges.
- The viability of desalinization as a source of irrigation water falls.
- Fertilizer prices and the unit costs of other oil-based inputs increase. Some farmers choose to expand irrigated area rather than improving yields on existing land, possibly leading to higher aggregate water demand.

Biofuel crop production is a consumptive use of water that might compete with food crop production for water and land resources. For example, one of the Millennium Ecosystem Assessment scenarios foresees that by 2050 one-quarter of the global energy supply will be met by energy from biomass (currently: 10.7 %). Producing the necessary 8 billion tons of biomass would require 5,500 cubic kilometers of crop water consumption, roughly 75% of what is needed for the production of global food today (de Fraiture et al. 2007).

With rising energy prices the cost of (ground-)water pumping will increase. If India and other countries discontinue energy price subsidies, irrigation might become unaffordable for millions of smallholder farmers jeopardising their food security. But subsidies are often inefficient and distort the markets. Smart subsidies including a basic minimum subsidy for power for production of staple food and block tariff pricing for cash crops are a promising way forward, but their economic and social feasibility is not well understood.

3. Global water cycle

The impacts of climate change on agricultural production and water resources are uncertain, with potentially greater spatial variation, but there are enormous implications for agriculture and well-being of the poor farmers touching all aspects of life over the developing world.

Global. Semi-arid and sub-tropical areas in Asia, Sub-Saharan Africa, Latin America, and the Middle East and North Africa will likely be affected the most through higher temperatures, greater rainfall variability, and greater frequency of extreme events (IPCC 2007). Most climate change models indicate a strengthening of the summer monsoon. In Asia this might increase rainfall by 10–20%. Even more important, it might generate a dramatic increase in inter-annual rainfall variability. For paddy farmers this might imply less water scarcity but more damage from flooding and greater fluctuations in crop production. Some arid areas might become even drier, including the Middle East, parts of China, southern Europe, north-eastern Brazil, and west of the Andes in Latin America.

Africa. According to most climate models, the absolute amount of rainfall in Africa will decline as variability increases (incl. more intense storms and longer dry spells). In semi-arid areas where rainfall already is unreliable, this might have severe impacts on crop production, food security, livelihoods and the economy. Irrigation might help smooth out variability, but is only useful if the total amount of rainfall remains sufficient to meet crop water demands, and it requires significant investment and infrastructure and capacity. Small scale, decentralized innovations (e.g. rain water and flood water harvesting) to support rainfed agriculture has to potential help to mitigating the effects of climate change.

Asia. Climate change might also affect agriculture if it causes substantial melting of glaciers that feed major rivers that are used for irrigation. Such melting could affect millions of hectares of irrigated land on the Indo-Gangetic plain. Millions of cubic meters of water are stored during the winter months in the form of snow and ice and gradually released as melting water in spring. The warmer spring weather coincides with the start of the growing season. The disappearance of ice caps may change this flow, leading to greater summer runoff for some time, but on the longer run the total water resources will decrease. This will go in hand with a change of the temporal regime of the snow and ice melt flood pulse with significant impacts for the ecology and the water availability for agriculture. Without additional storage to capture temporarily increased summer runoff, much water will flow unused to the ocean, leading to water scarcity in the drier months.

Again Africa will be one of the major hotspot of climate change. The main challenges facing Africans will emanate from tropical storms, floods, land slides, droughts, and other extreme events. These will increase problems of productivity variations, water availability, land and water degradation, health, environment, infrastructure and production technologies. Livestock productivity may be adversely impacted, with huge implications for poverty and food security. This may jeopardise food security of shifting cultivators and nomads and trigger transboundary and local conflict over water resources. It is worth mentioning, that the capacity to adapt to climate change is generally lower in Africa compared to other continents, yet the need for adaptation is high.

Capacity Building Responses. Global climate change is linked to global community's goal of food security, poverty reduction, and environmental sustainability under the UN's Millennium Development Goals. We must help to bring the drivers of global climate change into water management research and capacity building agenda for the ultimate benefit of the developing countries.

As an international public research programme, the UNESCO-HELP's challenge is to mobilize the best of science for poor farmers at risk. Our research must help poor farmers to adapt to the consequences of climate change and mitigate its deleterious effects on food security and livelihood security. It must answer the environmental care needs as well.

We need to work with our partners to develop innovative solutions in areas such as agro forestry, fisheries, climate change modelling, food policy, international trade, as illustrated by the UNESCO-HELP in the following chapter.

4. UNESCO-HELP

HELP is a joint initiative of the United Nations Educational Scientific and Cultural Organisation (UNESCO) and the World Meteorological Organisation (WMO). HELP began following the 5th UNESCO/WMO International Conference on Hydrology in February 1999 and is led by the International Hydrology Program. HELP aims to address key water resource issues in the field and integrate them with policy and management needs therefore introducing a new approach to integrated catchment management. The new approach is to use real catchments, with real water related problems as the environment within which hydrological scientists, water resources managers and water law and policy experts can work together.

Internationally there is a major lag between research and management policy since most water management policy is based on outdated knowledge and technology and there is often a paradigm lock between water scientists and policy makers (Fig-1). In many basins stakeholders are unaware of what technical facilities are available and scientists do not appreciate to become part of real solutions. HELP initiative is aimed to bridge the gap between the water policy, water resource management and scientific communities from the setting of research agenda to the free flow of information and knowledge for use in management and policy making.

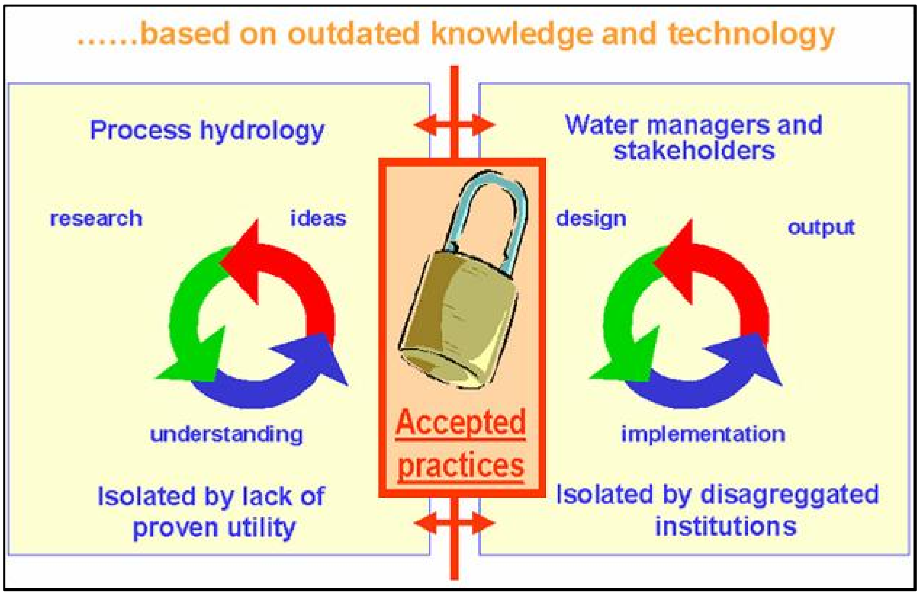

Figure-1 Paradigm lock between scientists and policy makers (Reference???).

Global HELP Perspectives. HELP is founded on a global network of catchments. National or local authorities can suggest catchments to be included, which will need to fulfil the HELP criteria for baseline physical and socio-economic data exchange. A new catchment must also have adequate local capacity to increase sharing of expertise, to improve access to data and the findings from other HELP catchments, and to provide opportunities for funding and building capacity in water institutions.

The HELP catchments are distributed between the developed North (N America and Europe) and the South (rest of the world) in the approximate ratio 40:60. The basins reflect a vast range of geographic and demographic properties, from the Aral Sea basin with five countries (1.6m sq km and population 42.5 m) to the Talise basin in Vanuatu covering 6 sq km and 400 people. Eight basins were larger than 1 million sq km and nine were less than 1,000 sq km. 23 basins had populations greater than 1 million and 11 basins had populations less than 100,000. This is a remarkably diverse set of river basins, providing a unique range of challenges and opportunities for developing good governance and Integrated Water Resource Management (IWRM) globally. Table 1 and Figure 2 show the distribution of basins by region and the final classification.

Table 1 Regional classification of HELP basins

Region	Basins Total	Demonstration	Operational	Evolving	Proposed
North America	**7**	**2**	**2**	**2**	
Central and South America	**7**		**5**	**1**	**1**
Europe	**21**	**1**	**11**	**5**	**3**
Africa	**12**	**2**	**2**	**4**	**4**
Middle East	**2**			**1**	**1**
Asia	**13**		**4**	**6**	**3**
Australasia	**5**	**2**	**2**	**1**	
Total	67	7	26	20	12

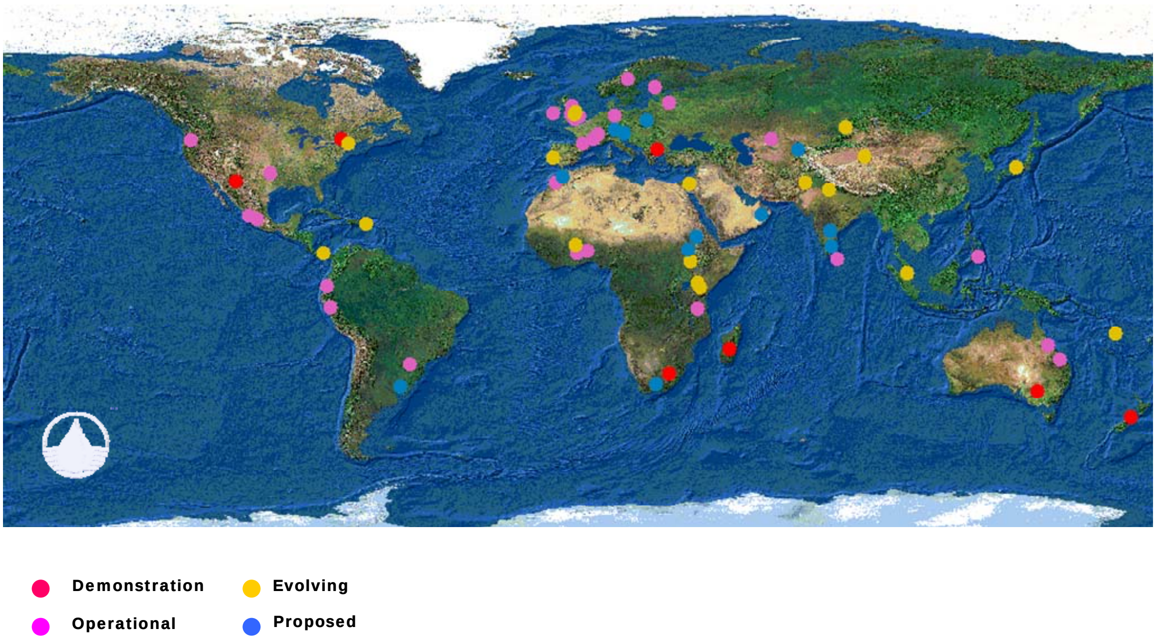

Figure-2 Current UNESCO HELP Basins (Reference???).

The Demonstration and Operational basins each have several years of practical experience of working within the HELP framework. In some cases longstanding scientific programmes have been developing further through the application of sustainability and good governance. The HELP initiative provides them with international recognition of progress achieved in this new direction. The high proportion of Operational basins in Europe is a result of developments in the European Union. Many of these projects have benefited from EU funding, or national funding linked to EU legislation. Most projects in the South are linked to local recognition that water problems are best approached through Integrated Water Resources Management (IWRM). Currently HELP basins are exploring twining opportunities to share their experiences in integrated water resources management. Further information about individual HELP basins can be found at www.unesco.org/water/ihp/help.

HELP Action Areas. Gibbons et al. (1994) distinguishes two approaches to knowledge production: traditional research is Mode 1, in which there are narrow fields of study and separate roles, with academics developing the knowledge and passing it on to the practitioners. In Mode 2, knowledge is produced by a cross-disciplinary team that includes the practitioner, and the learning is immediate for all--it is part of the discovery process. The role of the practitioner is central to Mode 2 throughout the entire research process. The HELP initiative is encouraging Mode 2 knowledge production. HELP is designed to develop scientific research in the application of integrated water resources management (IWRM) through Hydrology for Environment, Life and Policy (IHP, 2001). Examples of HELP success in active involvement of university teaching, policy-making and facilitating (water and land resource managers groups) to set the policy agenda and ensure the scientific results will benefit societal needs through the revision of policy and management practices in Australia are given by Khan (2004).

HELP has currently six major action areas for promotion of Mode 2 science as described below.

I. Water and Climate

The major research question into water and climate area is: "How can knowledge, understanding, and predictive modelling of the influence of global climate variability and change on hydrological variables and remotely sensed data can be used to improve the management and design of water resource, agro-hydrological and eco-hydrological systems?"

Subsidiary issues for this interest area include:
- How significant is the relationship between the statistics of hydrological variables and observable global phenomena, and how does this change with location?
- How can remote data capture, and advanced information transfer technologies best be applied to improve the management and design of water systems?
- How can predictions of seasonal-to-interannual variations be used to improve the management of water, including for disaster prevention (floods and droughts)?
- How significant are multi-decadal fluctuations in climate, and how can knowledge of such fluctuations be used to improve the design of water systems?
- What is the hydrological significance of potential anthropogenic climate change, and how can predictions of such change best be used to improve design of water systems?

II. Water and the Environment

The level of environmental protection to be provided in any basin is a matter of political choice and commitment. Developing countries will usually be least able or willing to consider the issue of the water required for environmental protection – their first priority usually is to take care of the immediate, basic needs of their population. This HELP initiative is aimed to raise the awareness so that these two objectives are not contradictory and there are pathways to strike a balance. Major issues include the potential impacts on the environment of:
- population growth
- industrialisation and pollution
- land cover/land-use changes
- species extinction and introduction of new species perceptions and attitudes of society towards the environment

HELP research questions include:
- What role does the environment play in securing water resources?
- How do we place a value on the "natural" environment?
- How can we identify the impacts of environmental change on water resources?
- How do we minimise conflicting environmental and human requirements?
- What is the effectiveness of environmental law on water resources?

III. Water Quality and Human Health

This HELP objective aims to develop the necessary integrated view of how catchments work, in order to understand the relations between water quality and water quantity at variable spatial and temporal scales. There is need to understand how water quality is affected by varying land uses and management approaches – that is, to understand the basic evolution of water quality. The understanding of processes linked with contaminant transfer and temporary adsorption (or absorption) through the land system – before these enter into rivers and streams – is extremely poor. HELP aims to promote appropriate water-quality monitoring programmes in its network of basins.

IV. Water and Food

The major HELP challenge in terms of water and food is "how can the efficiency with which water is used in agriculture be improved and how do the need, scope and methods for achieving this vary regionally and locally? "

HELP is aiming to facilitate research on some of the following questions:

- the most appropriate techniques for reducing water losses from agricultural fields due to surface runoff, soil evaporation and drainage;
- how much water could be saved by improving transpiration, and what techniques can be used to do this;
- how much water efficiency could be improved by using different crops and/or crop mixtures;
- the relative savings to be made in rain-fed and irrigated agriculture, and potential for the complementary use of water between the two;
- whether significant efficiency gains can be made through assessing the way water can be used in different places and at different times across an entire catchment;
- the downstream impacts of increasing water-use efficiency in agricultural areas;
- the reasons local farmers do not adapt apparently straightforward technologies for improving water-use efficiency.

V. Water and Conflicts

HELP includes a component on the role of hydrological data, information and process understanding in management of water resources, as well as in co-operation on water management and avoidance and resolution of conflicts.

HELP aims to promote development and application of Alternative Dispute Resolution (ADR) techniques to water management through:

- studying the role of hydrological information in creating the basis for rational management of water by a nation and among neighbouring countries;
- encouraging basic studies of conflict management integrated with a research programme that has the necessary databases linked with process hydrology.
- supporting studies of specific cases in selected river basins;
- conducting real-world simulations in support of joint management.

VI. Improving Communications

HELP aims to encourage multilevel stakeholder engagement to:

- provide a reduced set of reliable and comparable information on the state of catchments;
- interpret science in a way useful to managers;
- include water resources, environment, social and economic criteria;
- capture the "essence" of the catchment in a few statistics;
- provide comparison between countries and regions;
- indicate trends over time and space;
- measure success (and failure) of catchment management, programmes and policies.
- ensure comparability between projects.

Participants from the partner basins at the HELP Symposium at Kalmar, Sweden (18–22 August 2002) identified the lack of following elements to wider societal acceptance of hydrology research:

- awareness of issues/ownership/stakes
- adequate information
- appropriate communication/liaison strategy
- reciprocal trust and transparency
- overall engagement
- common level of operation
- direct relevance to stakeholders and issues
- formal and informal education at different levels
- local people to convey project results
- identification of stakeholders

A number of HELP strategies such as assessment of communication needs before the start of a HELP project were identified to overcome societal acceptance barriers to help achieve integration of community aspirations with scientific research.

5. Some Thoughts on Future Research and Capacity Building with Focus on Developing Countries

Goal

Contribute to increased productivity, food security, poverty eradication of small-holder farmers and sustainable use of all resources through development-oriented research and capacity building.

Principal thrusts

- Socio-economic and equity impacts of climate change via water link
- Performance assessment of climate mitigation measures
- Management models and transfer issues for tackling climate change
- Capacity building, knowledge generation and sharing in areas with scarce resources
- Need of a critical mass of people working in Research and Development for economic development (cf. Human Development

Report 2006, and Van der Zaag, 2007).

Constraints

- Bilateral project financing not sustainable
- The need for capacity building often not a high priority
- Lack of critical mass of trainees and trainers.

Emerging issues

These include: water sector adaptations to climate change; biofuel impacts on water and biodiversity, food-crop competition for land and water; carbon sequestration markets on wastelands; interstate water allocation and transboundary water management issues in the wake of water scarcity–millions revolt in the making in India; irrigation infrastructure modernisation/financing, water pricing, cost recovery and financial sustainability of irrigation system; water and energy nexus; participatory watershed development; rainwater water harvesting and municipal and industrial wastewater management, etc.

Lack of scientific knowledge can lead to erroneous decisions with consequences for (un)sustainable use of resources, health of the environment and humans. A specific example would help to put the issue in perspective:

Estimates by Gupta and Deshpande (2004) for?? which case study??show that conservation of water through rainwater harvesting and artificial groundwater recharge can generate about 125 km^3/year (provide water at local scale where people live and engage in productive activities who are also direct beneficiaries); similarly recycling of municipal wastewater can generate another 174 km^3/year (nutrient capture plus water augmentation effect; for peri-urban aquiculture and agriculture; prevents pollution and ecological hazards too). Inter-basin transfer such as Linking of the Rivers project can generate about 174 km^3/year only (but have complex political, technological, and financial requirements; can generate power for groundwater pumping and provide water for inland navigation). This example suggests that an important new area for capacity building would be:

Water audits and socioeconomic and distributional equity analysis.

Water resources management and planning are likely to be affected by a range of emerging issues where the HELP approach could help seize the opportunity. These include:

- Climate change-poverty-water sector adaptations
- Water-poverty-environment nexus
- Energy-water-poverty nexus
- Demand for biofuels ensuing competition for land and water resources used for food production
- Globalization and trade policies for food security
- The changing role of state and local actors in water sector
- Gender and the feminisation of agriculture
- Genetically modified food and cash crops

These areas are less well understood and global research and development community must re-orient itself accordingly.

Regional priority setting for financing capacity building
A regional approach to capacity building can generate positive sum solutions for stakeholders. Regional capacity building priorities are areas of work best handled at the regional level; not a substitute for or derivative of global priorities, but these can complement national or global agenda. They must respond to the concerns that are felt in several countries and, consequently, strengthen transboundary cooperation . They can increase the attractiveness of funding from national budgets or local/regional donors, and to help convince potential partners to team up, and to further develop the network of organizations collaborating on capacity development projects of regional significance.

In some sense, the regional approach already operates within nations, and large countries such as India, China, and South Africa. The regional agenda must be embedded into the national agenda to derive monies from a central source as well as to the global agenda to generate some global divided from regional activities. This would be a key challenge as the priorities of different regions will be difficult to compare, and it might be difficult for the sub-regions to identify shared concerns. It is meant to contribute to rural and national development through better capacity building and knowledge sharing. Regional training priorities are best expressed in terms of development problems that need to be addressed locally. But synergies are still possible. For instance, many of the issues are similar eastern and Southern Africa; Central Asian countries also encounter some shared issues, post-USSR; shared issues in Indian and Pakistan Punjabs are other examples. However, capacity building needs in environmental care through better water governance and management would be far greater in some settings than others, for example, in Africa. Therefore, a regional approach to address the capacity building needs can be quite efficient as demonstrated by the capacity building and knowledge network for Southern Africa Waternet that is discussed further by Van der Zaag (2008, same issue).

The regional capacity building priorities must be expressed as a regional agenda, to allow many partners to buy in along the research-to-development continuum, and to from collaborations where consortia, alliances, networks, and individual organizations may all find their place both to fund it and to benefit from it.

BOX ONE

An Alternative way to Increase the Research Capacity in Africa: The Advanced Institute on Global Environmental Change and the Vulnerability of Water Resources in the Context of the Millennium Development Goals

The primary aim of this Advanced Institute is to enhance the capacity of developing country researchers to undertake inter-disciplinary and integrative assessments of the impact of global environmental change on water resources and possible proactive societal responses. The Advanced Institute consists of: (1) the three-week Intensive Seminar; (2) one-year research grants for successful Institute Fellows (advanced PhD or post-doc level); and (3) a synthesis workshop that will follow completion of the research. The Advanced Institute is supported by the Global Change System for Analysis, Research and Training (START), in a partnership with the Global Water System Project (GWSP), and with financial and intellectual support from the Norwegian Agency for Development Cooperation (NORAD), the Swedish International Foundation for Science (IFS), and the Dutch Cooperative Programme on Water and Climate (CPWC).

The 19 Advanced Institute Fellows were selected in 2007 from candidates from sub-Saharan Africa through a competitive procedure with an international call for Research Pre-Proposals following a blind review process involving an international review panel. In the Intensive Seminar, the Institute Fellows examined the relationship between climate change and water, not only in physical terms but also in terms of the processes of policy making.

UNESCO-IHE Institute for Water Education, Delft, and the Institute for Environmental Studies at Vrije Universiteit Amsterdam organized jointly the three-week Intensive Seminar on Global Environmental Change and Water in Delft during the period September 24th to October 12th 2007.The Intensive Seminar concluded with 19 research proposals submitted by the participants for the one-year funding. Follow-up activities include web-based discussion groups to facilitate communication between the participants and their mentors; submission of final proposals to IFS, and two workshops – one at the start and one at the end of the research process.

Ton Bresser, Managing Director of the Advanced Institute (UNESCO-IHE, Delft)
Joyeeta Gupta, Academic Director of the Advanced Institute (IVM, VU Amsterdam, and UNESCO-IHE, Delft)

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