Chapter 6: Conclusions and recommendations

6.1 Undeniable evidence

The hydrological cycle is speeding up. That means more frequent and more extreme storms, floods and droughts in many parts of the world. The records show that it is happening already – six major flood disasters in the 1950s, seven in the 1960s, eight in the 1970s, 18 in the 1980s and 26 in the 1990s (see section 1.3.3). We know why it is happening – more of the sun's energy, trapped inside greenhouse gases, evaporates more water, warms the tops of the oceans and the bottom of the atmosphere, melts polar ice, and generally stirs up our weather cauldron (see section 1.5.1).

We can be sure too that it is going to get worse until the effects of global warming have stabilised a long way into the future. Meteorologists can predict with improving accuracy how the climate will change over time in different parts of the world. Using General Circulation Models, they can show how different patterns of human behaviour and socio-economic development in this century ("emission scenarios") would affect temperatures, rainfall and sea levels (see section 1.5.3). The projections confirm how important it is to continue efforts to control emissions of greenhouse gases: depending on the scenario, the average rise in global temperature between 1900 and 2100 will be between 1.4 and 5.8°C and the rise in sea level between 9cm and a massive 88cm.

Mitigation (cutting greenhouse gas emissions) alone is not enough. The problems of climate variability are with us now. Every year, floods kill many thousands of people, make millions homeless and destroy the lives and hopes of millions more. The economic cost is just as devastating: annual losses from hydro-meteorological disasters increased tenfold between the 1950s and the 1990s (see section 1.3.1) including a rise from US$75 billion in the 1980s to more than $300 billion in the 1990s; successive droughts in Kenya in 1997/8 and 1999/2000 are estimated to have cost the country more than 40% of its GDP (see section 4.4.3); and Mozambique suffered a 23% reduction in its GDP after the 1999 floods (see section 1.3.1). It is the poor in the developing world who suffer most. Their fragile livelihoods and precarious homes are the first to go when disaster strikes, while poverty constrains their capacity to protect themselves in advance or to recover afterwards. Repeated disasters set back national economic progress and threaten the achievement of Millennium Development Goals.

6.2 Challenges for water managers

"Climate changes the water rules". The title of this publication highlights the dilemma confronting water managers. They already face formidable challenges in planning for a time around the year 2040 when projected global demand for water will exceed availability (see section 2.1.1). Big fluctuations in seasonal rainfall and inter-annual river flows play havoc with calculations of reservoir operating rules and the amount of storage needed. Historic rainfall and streamflow data cannot be extrapolated without substantial allowances for anticipated trends in climate variability. Analysis of records from 29 of the world's biggest river basins has revealed that 16 out of 21 occurrences of the 100-yr flood were in the second half of the period covered by the data (see section 1.3.1). According to the same analysis, that same 100-yr flood will be as frequent as once every 12.5 years if and when CO_2 levels quadruple in the future (see section 1.5.5). Rainfall extremes like the 428mm in 24 hours that descended on the Japanese city of Nagoya in September 2000 (see Nagoya Dialogue Summary in Chapter 4) overwhelm drainage systems and flood defences designed on the basis of historic data (the previous record daily rainfall in Nagoya was 240mm in 1890).

Coping with natural climate variability is nothing new for water managers. Indeed, some variability is vital to sustain ecosystems, and to maintain soil fertility. It is the intensification of the hydrological cycle and the resulting weather extremes that put both ecosystems and people to the test. They test the water managers too, facing them with peaks and troughs that are off the scale of anticipated seasonal flows. The increasing trend towards integrated water resources management (IWRM) is adding to the managers' armoury, helping them to balance demands from people, industry, agriculture, power and nature with operational needs to moderate the effects of floods and droughts (see Chapter 2). The problems arise in assessing the "factors of safety" that need to be applied to account for future seasonal and inter-annual variability, and the extent to which extreme weather events can be anticipated and prepared for.

Climate prediction and weather forecasting are vital elements in the coping strategies. As well as improving their long-term predictions of climate change on a global and regional basis, meteorologists are getting better at tracking and forecasting extreme weather associated with cyclones and typhoons with reasonable accuracy over periods of a few days or weeks. Increasing understanding of the El Niño phenomenon means that predicting seasonal climate variations for specific regions is also becoming more accurate. An example might be the prediction of lower or higher rainfall in the next planting season in eastern Africa, or more violent storms in the coming monsoon season in southern Asia. What cannot be predicted with certainty is precisely where and when the weather extremes will occur, or just how extreme they will be. That is a vital gap. It creates uncertainty for managers who need to take a view on how to balance the risks of inundation or drought with the costs of protection and precaution. Meanwhile, their consumers, and the communities at risk from the next hydro-meteorological disaster, are voicing their concerns – and their desire to participate in finding the right solutions (see section 4.1).

6.3 Stakeholder partnerships

Although climate is driven largely by global processes, adapting to its extremes means taking action at local and national level. Starting in the first half of 2002, the Dialogue on Water and Climate (DWC) extended support to a total of 18 locally initiated stakeholder "Dialogues" – eight at river basin level, two national and eight regional. As well as bridging the divide between water managers and climatologists, the Dialogues brought together representatives of the community, local government, NGOs and the private sector. Their aim was to assess and prepare responses to the water/climate situation in their own part of the world. The results, summarised dialogue-by-dialogue in Chapter 4, showed the power of partnership and the enthusiasm of community members to participate fully in developing and implementing measures to cope with climate extremes.

All dialogues were driven by their own perceptions on the impacts of climate on the water sector, and their own action agenda. Some (Lena, Aral Sea, Western Africa) sought to verify these perceptions through scientific assessments of their vulnerability to floods or droughts. In others, local perceptions of more frequent and more intense weather events were enough to stimulate initiation of coping plans (Small Valleys, Bangladesh). However, even the most enthusiastic bottom-up partnerships need outside support to help establish early warning systems, or to finance storm shelters, flood defences or the seed and fertiliser for drought-proof crop sowing. Financial support is not unlimited, and both governments and donors like to prioritise. That means comparing the needs of one community for storm-surge protection with those of another for more reservoir storage to combat drought. Measuring vulnerability then becomes an issue.

6.4 Assessing vulnerability to climate extremes

To assess the vulnerability of basins or communities to climate impacts, scenarios are needed which give high resolution of climate parameters in time and space. There are promising operational research developments in spatial and temporal downscaling of the General Circulation Model outputs to basin level. The next step involves integrated assessment models that use climate scenarios from the General Circulation Models (GCMs), but which provide only a coarse top-down methodology for combining "susceptibility" and "adaptive capacity" of countries or geographic regions into proxy indicators of vulnerability (see sections 2.1.1 and 3.2 to 3.6). Helpful as these exercises may be in highlighting global or regional priorities, they cannot home in on the threats and coping capacities in an individual river basin or local community. There are also methodologies being developed for grassroots level vulnerability assessments combining socio-economic and environmental indicators with projected climate threats in a highly focused way (megacities, rural areas, ecosystems, coastal areas, poor neighbourhoods). Section 3.4.1 has an example showing how over the next 30 years Bahrain will start to catch up with the Comoros Islands as the small island most vulnerable to sea level rise. The "Climate Vulnerability Index" used in that exercise has considerable promise, but is still in the development phase, along with other methods being researched by the World Bank, the Red Cross and UNEP/WMO/IPCC (see section 3.1 and agency summaries in Chapter 4).

6.5 Capacity building and financial support

The self-help potential of local agencies is limited by available resources – technical, institutional and financial. Many governments too require significant outside support to implement adaptation strategies for coping with changes in climate. There are three prime reasons why donor governments, relief agencies and other external support agencies should be sympathetic to requests for support (see section 5.1):

1. The polluter pays principle: Greenhouse gases come predominantly from the industrialised countries, but it is primarily the developing countries that suffer the worst impacts.

2. Extreme weather and climate events are having devastating impacts on progress towards the shared developmental goals of poverty alleviation and sustainable development. Precautionary investments in disaster preparedness and adaptation will help to protect developmental progress.

3. Support for local adaptation pays dividends in savings on relief and recovery costs when the extreme event arrives. The Red Cross estimates that each dollar spent on prevention saves from four to ten dollars in relief (see South-East Asia Dialogue summary in Chapter 4).

In international circles, there is a growing consensus on the need to mainstream adaptation to climate variability into the poverty reduction and sustainable development agenda. Adaptation to climate change will soon be fundable through the Global Environmental Facility (GEF), but the limitations on funding through National Adaptation programmes of Action (NAPAs) remain quite restrictive (see section 5.4.3). While the debate goes on about the extent to which adaptation to climate variability is part of coping with climate change, other avenues of support have to be opened up. They will come through the regular dialogues between governments and the international development assistance community and will be hastened by governments committing themselves to mainstreaming adaptation to climate into their national water, poverty reduction and sustainable development programmes.

Numerous international agencies already provide information sharing, capacity building and research support (see section 5.3 and the agency summaries in chapter 5). There is also considerable help and information available for advance warning of extreme weather. Once water managers, climate specialists and support agencies are working in harmony, it is possible to develop effective early warning systems and disaster-preparedness strategies.

The Dialogue on Water and Climate has been successful in bringing together appropriate water-and-climate stakeholders at different levels. What is needed now is the linking of basin-level dialogues with corresponding national and regional ones, to ensure that the local adaptation strategies benefit from the optimum support at higher levels.

6.6 A Water and Climate Alliance

On the basis of lessons learned from the 18 Dialogues, the international organisations that have been the Steering Committee and partners of DWC are committing themselves to continuation of the multi-stakeholder approach and the building of bridges between the climate and water communities. The alliance will continue. It is proposed that an Associate Programme of the Global Water Partnership (GWP) should be the mechanism for supporting the ongoing and new activities. It will have a work programme that includes promoting and facilitating capacity building at all levels, assistance to countries in obtaining technical and financial support for adaptation plans, and continuous advocacy for relaxation of GEF rules to accommodate national adaptation plans that respond to the accelerating hydrological cycle.

6.7 Recommendations for action

The recommended follow-up activities have implications at all levels. They are set out in tabular form alongside, identifying the need for action at basin, country and regional level, and the types of external support needed to make the most of national adaptation strategies.

RATIONALE

DIALOGUES
The 18 dialogues at the national, basin and regional level have shown that bringing together different stakeholders from the government, private sector, NGOs and the information/knowledge sector does stimulate a process to start up awareness raising, information collection and sharing, and preparations for action on the impacts of climate change and increasing climate variability in the water sector.

NATIONAL ADAPTATION PLANS OF ACTION (NAPAs)
The NAPA for LDCs and National Communications for non-LDCs of the UNFCCC, which are eligible for support by the GEF LDC Adaptation Fund provide a useful mechanism for adaptation plans, but GEF support is limited to climate-change impacts and excludes climate-variability impacts. To be relevant to the water sector, the NAPAs should also include adaptation to increasing climate variability.

VULNERABILITY ASSESSMENT
Top-down scenario-based model studies for assessment of national vulnerability to climate change are fairly well developed, relatively easily accessible and frequently used. Grassroots-level tools to assess the vulnerability of particular communities, cities, ecosystems, coastal zones, etc, are still being developed, and are not locally available. These tools are vital to complement the 'top down' assessments and for national/basin/regional planning and priority setting.

PREDICTION AND PREPAREDNESS
Present predictions can provide water managers with reasonably accurate short-term weather information (days up to weeks). Predictions for the longer term (seasons or even a few years) are improving in reliability.

THE CLIMATE AND WATER RESEARCH AGENDA
There is a widely recognised gap in predictive capacity when it comes to forecasting climate at basin level over seasons or years. That is the information needed for water resource planning to cope with climate variability. Temporal and spatial downscaling of predictions from Global Circulation Models is an urgent need. Research is needed on multi-disciplinary tools for integrated assessment f vulnerability on a local scale.

RESEARCH, MONITORING AND KNOWLEDGE SHARING
DWC's Coping Compendium (Chapter 4) highlights a wide range of adaptation options, many still in their infancy in relation to coping with climate variations.
Research and information sharing will accelerate understanding of how to build resilience and moderate the impacts of extreme weather and climate.
The private sector and relief agencies share a common interest in effective protection and preparedness.

CAPACITY DEVELOPMENT
To cope with increasing hydrological variations and weather extremes, water managers need new skills. Climatologists too have to work in different ways to provide the right help to their water colleagues. Both parties can benefit from training, tools development and knowledge sharing, as can the partner agencies involved in the adaptation dialogues

PUBLIC AWARENESS
The 18 dialogues have demonstrated the value of awareness raising to motivate local action.

WATER AND CLIMATE ALLIANCE
The Dialogue on Water and Climate has been an effective networking vehicle to encourage closer collaboration between the climate community (meteorology and hydrology) and the water community. That work needs to continue and expand.

RECOMMENDATIONS FOR FOLLOW-UP

ACTIONS BY COUNTRIES, BASINS AND REGIONS	EXTERNAL SUPPORT
Water managers, in co-operation with national governments, NGOs, etc.) should continue to be encouraged to start multistakeholder dialogues at basin, national and regional level to prepare adaptation plans for climate change/climate variability. The aim should be to link basin dialogues with appropriate country and regional dialogues, to cover the most vulnerable basins and regions	International institutions and agencies are urged to provide technical and logistical support for the activities of new dialogues. Bilateral and multilateral development support agencies can support the operations of the dialogues, where national governments demonstrate that they are integrated with priority developmental objectives. Target: Five new Dialogues per year
Countries (in particular the most vulnerable) should prepare a comprehensive water sector NAPA or National Communication within the overall goals of development and sustainability, following the WEHAB framework as described in the Plan of Implementation of the WSSD and including poverty and vulnerability reduction targets laid down in the Millennium Development goals.	It is recommended that an interagency working group is established under GEF with representatives from multilateral and bilateral agencies including GWP and international NGOs (IUCN, Red Cross) to develop a financial support mechanism for water sector NAPAs for the long term, and also to develop a transitionary financial support facility to support water sector adaptation plan preparation and implementation.
Identify the water sector-related social, economic and environmental vulnerabilities to climate change and extremes through both scenario-based model studies and the best available grassroots vulnerability assessments for specifically vulnerable areas such as coastal areas, marginal lands, cities, small islands, ecosystems, the poor. BUT: take local action without waiting for priority comparisons.	Support is urgently needed for the further development of grassroots-level assessment methodologies like the Climate Vulnerability Index, and their use by regional, country and basin level governmental, science and NGO organisations. International organisations can help with research, co-ordination and finance.
Vulnerable basins or communities should work with best available short term (2-5 days) prediction information and establish early warning systems and response strategies. This may include rehabilitating defunct hydrological monitoring stations and sharing information across international borders. Seasonal prediction and early warning/response systems should be introduced where expected to be feasible and effective.	International river basin authorities/commissions can and should make valuable data on prediction freely and readily available to downstream countries. Technical and financial support from donors/UN agencies can help with early warning systems (from short term to seasonal) and preparedness/response plans.
Work with climatologists, meteorologists and hydrologists in the international specialist agencies to develop best available forecasting and prediction models to suit basin and national needs. Co-operate in pilot testing and data gathering to improve models, and share data across networks of water and climate specialists.	UNESCO, WMO, IRI, Hadley Centre and other international partners have a comprehensive agenda to assist regional and country level water managers with tools for planning purposes that take account of the impacts of climate variability and change on water resources management for people, food, energy and ecosystems. The compendium on coping options should be completed based upon best practices and field level experiences. The compendium should be made available via capacity development activities and on the web.
Research, record and share information on innovative adaptation options. Involve the private sector in micro-credit and risk-sharing initiatives; exchange knowledge internationally on policy instruments, technology, ecological vulnerability/resilience, land-use planning, etc.	WHO, IUCN, WB, UNDP, UNESCO and universities with local partners draw up an agenda for research, methodology development and monitoring systems to study resilience of social, economic, human health and ecosystems to impacts of climate on the water system and the effectiveness of innovative adaptation options. Involve private and non-governmental sectors in risk sharing and innovative financing.
Organise workshops, training courses, distance learning and exchange programmes, to build the capacity of water managers, climatologists and extension workers to address water-and-climate issues. Review institutional frameworks and develop capacity for co-operation in adaptation strategies	UNESCO-IHE, PI, IRI, UN Universities, CAPNET, GWP (tool box) and other capacity development networks further develop, train and apply the tools, including the Coping Compendium, capacitating local level water managers to cope.
Use media, publications, posters and appropriate local communication networks to raise awareness of weather hazards and coping options. Mobilise women's groups, religious leaders and teachers to disseminate key messages	Disseminate publicity materials widely, use internet communications and websites to spread international publicity. Issue timely warnings of impending climatic extremes or El Niño events.
Convert the outcomes of basin, country and regional dialogues into co-operative adaptation strategies and contribute to an expanding global network on water-and-climate issues.	Continue the activities of the DWC through a Water and Climate Associate Programme of the Global Water Partnership, with support from funding agencies. Initiate the proposed Work Programme to support NAPAs and National Communications. Encourage the identified international partners of the WCAP to develop and continue to support programmes and activities on the recommendations above.