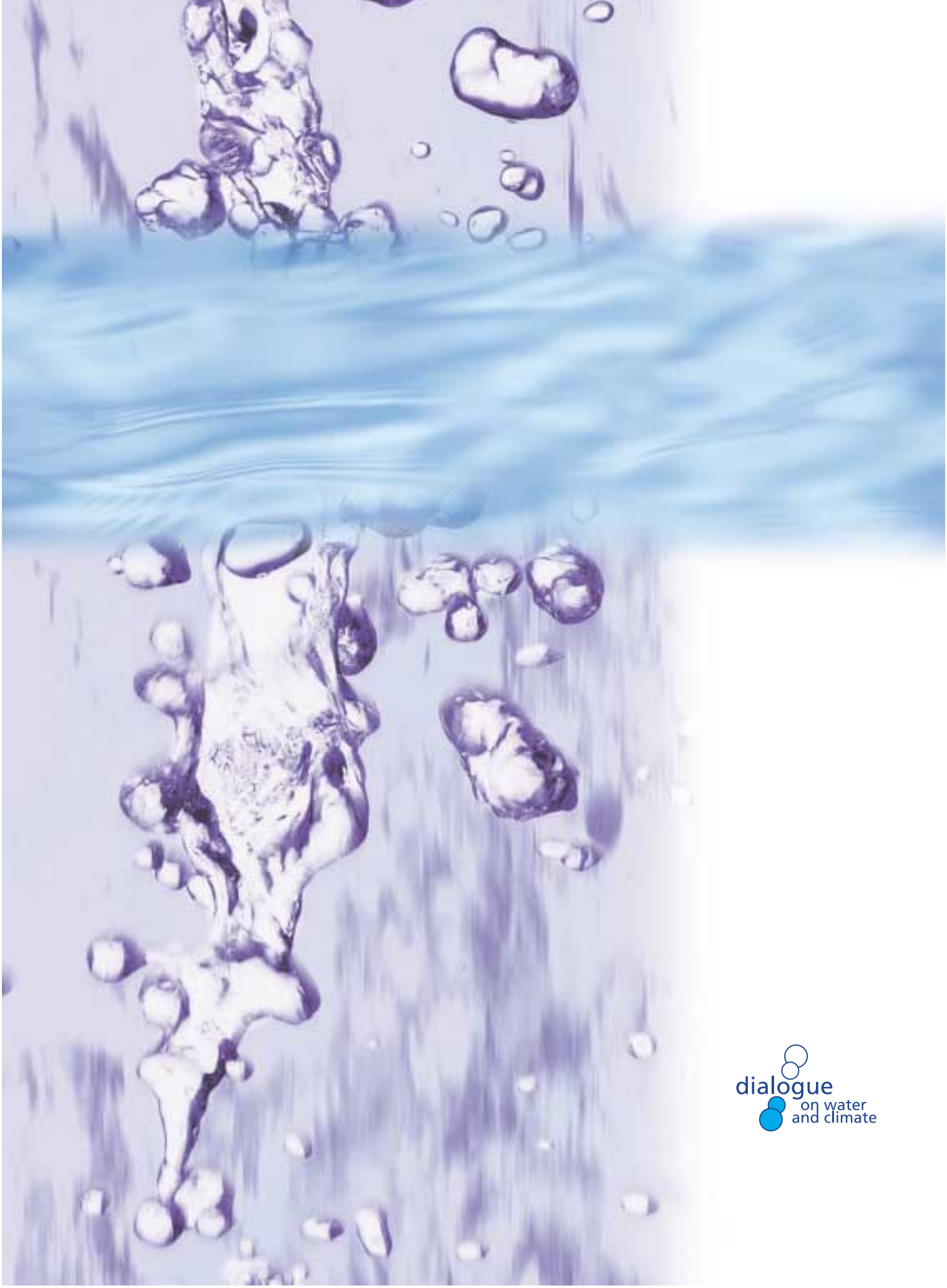
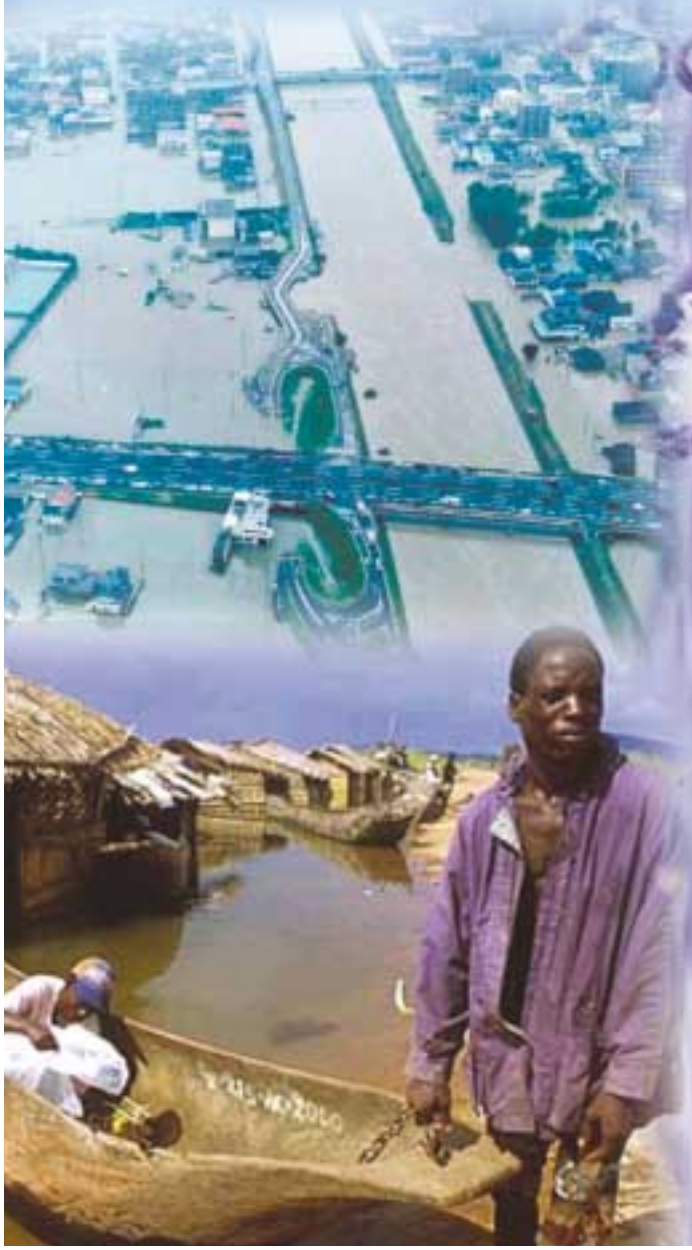


dialogue
on water
and climate

Changing the water policy climate:

A summary for policy makers of the report Climate changes the water rules



dialogue on water and climate

The Dialogue on Water and Climate

International Steering Committee

- World Water Council and the 3rd World Water Forum
- Global Water Partnership (GWP)
- The World International Union for the Conservation of Nature (IUCN)
- International Water Association (IWA)
- Netherlands Water Partnership
- WMO and UNEP: Intergovernmental Panel on Climate Change (IPCC)
- International Federation of Red Cross and Red Crescent Societies
- Food and Agriculture Organisation (FAO)
- UNESCO
- The World Bank
- United Nations Development Programme (UNDP)
- International Strategy for Disaster Reduction (ISDR)

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This booklet is a summary for water policy makers of the publication *Climate changes the water rules*, a report by the Dialogue on Water and Climate (DWC) on "how water managers can cope with today's climate variation and tomorrow's climate change". The full report is recommended reading for water planners, managers and policy makers and all those involved in responding to the growing number of weather and climate related emergencies in all parts of the world. Both the main report and this summary booklet can be viewed or downloaded at the DWC web site
http://www.waterandclimate.org
and they are available by mail from:

DWC Science Support Office,
P.O. Box 47, 6700 AA Wageningen,
The Netherlands.

The report contains the arguments and the evidence for review of water resources planning and management strategies, to cope with current climate extremes and future climate changes. In this booklet, the evidence is condensed into a few stark messages about the dangers, threats and costs of inaction. The main focus is then on what politicians, water managers and climate specialists can do now to adapt changes in the hydrological cycle.

Though the diagnosis is disturbing, the prognosis is encouraging. Adapting now to the challenges of more storms, floods and droughts will equip communities, governments and support agencies to combat the longer term effects of anticipated climate change. Building climate-sensitive planning into their sustainable development agendas will reduce the chances of governments' Millennium Development Goals being washed away by the next hydro-meteorological disaster. And pre-emptive investment in protection, mitigation and preparedness will help to slow the present escalating demand for humanitarian aid for the victims of extreme weather events.

CONTENTS

Water and climate: The gathering storm

Extreme weather events are becoming more common and more severe. It barely matters how much of this intensifying climate variability is part of a natural cycle and how much is created by human activities. What does matter is that the storms, floods and droughts bring mounting human suffering and escalating economic losses.

On 11-12 September, 2000, a total of 427mm of rain fell in 24 hours in the Japanese city of Nagoya, breaking the previous one-day record of 240mm dating back to 1890.

There is enough scientific evidence to show that the increasing variability in the hydrological cycle witnessed over the last 30 years in many parts of the world is not just a blip on the meteorological time chart. It is with us to stay and the chances are it is going to intensify further as global warming adds to the climatic turbulence. Perversely too it is the developing countries of the South that are most vulnerable to the effects of climate extremes. The growing number of weather-related disasters puts ever-increasing demands on humanitarian relief and is already threatening governments' poverty alleviation and sustainable development targets.

There is another ominous effect that compounds the impact of regular disasters. Water resource planners seek to match the forecast demands of future populations for water, food, power and industrial development with the supplies that can be made available on a sustainable basis from rivers, lakes, reservoirs and aquifers. Historically, a largely predictable hydrological cycle has meant that reservoir storage volumes and operating rules could be used to balance the effect of wet and dry seasons. Using past records of rainfall and river flows and allowing for evaporation and other losses, water engineeers and hydrologists could confidently design water management systems that would deliver dependable supplies throughout the year and regulate rivers to moderate the effects of seasonal fluctuations. Now those fluctuations have gone off the charts.

Sometimes, as in the Sahel region of Africa, it is a progressive fall in annual rainfall and average river flows that reduces the overall water availability. In other cases, like El Salvador, annual precipitation does not change, but the rain comes in brief intense storms interspersed with prolonged dry periods. The result is floods and droughts that overwhelm the capacity of the infrastructure to cope. What this means is that the hyrdo-meteorological design parameters may no longer be valid. Factoring in the intensified hydrological cycle and the predicted effects of climate change, for regions that already suffer from water shortage, will often mean that the average water yields are reduced, requiring storage capacity to be increased. Not always though: in the three most water-scarce regions of China, the yield from current storage facilities actually increases between now and 2050 for each of the development scenarios commonly used to model climate change.

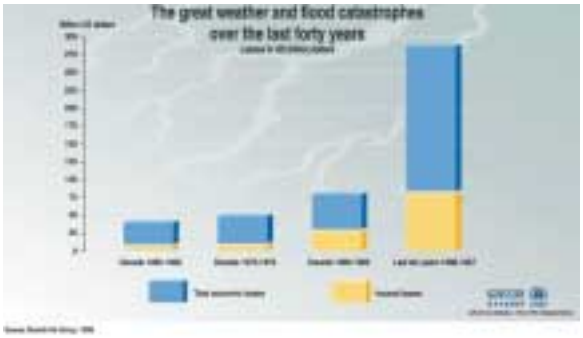
So, water policy makers face a double challenge: more disasters mean increasing recovery costs; and, for some regions, reduced yields make it even harder to meet the rising demands for water. The purpose of this document is to point to potential solutions.

In its report, *Climate changes the water rules*, the Dialogue on Water and Climate has put together a wealth of evidence on climate variability and climate change. With the help of 18 multi-stakeholder Dialogues across the globe, and inputs from thematic experts on water resources management and wider development issues, DWC has assembled a "Compendium" of coping options – a menu of actions that can help communities, governments and support agencies to adapt to today's and tomorrow's turbulent climate.

First, a bullet-point summary of the reasons why we need to act now.

Facing the facts

- **Financial and human losses are escalating.** In the 1990s, damage from storms, floods and droughts cost the world economy more than US$50 for every man, woman and child on earth. The $300 billion costs of repairs and relief were up by a factor of four on those of the 1980s (see section 1.3.1*). One of the world's biggest reinsurance companies Munich Re has estimated that global warming could push *annual* losses to more than US$200 billion by 2050, unless the various



Economic losses from weather-related disasters are rising fast

** The references are to sections of the main report* Climate changes the water rules, *where readers can find evidence for the points being made.*

stakeholders, including governments, act quickly to adapt to our changing climate. The human cost is also huge and rising. According to statistics reported by the World Meteorological Organization (WMO), hydrometeorological disasters (storms, floods and droughts) claimed more than half a million lives during the decade 1991-2000. In all, the number of people affected by the disasters topped two billion. Many of these victims are the poorest members of society, driven by circumstances to settle in flood plains or on other marginal land. For them, being "affected" by a flood or drought can mean losing everything they possess and relying on emergency relief until they can start again to rebuild their fragile livelihoods.

- **National development is at risk.** The immediate effects of extreme weather events are tragic and costly, but they are not the end of the story. At the community level, lost homes, livelihoods and infrastructure can take years to replace. For governments, the impact of lost crops, lost power generation and physical damage to transportation and other infrastructure can wipe out decades of development. It has been widely reported that Hurricane Mitch set back economic development in

several Central American countries by 20 years. Successive droughts in Kenya in 1997/8 and 1999/2000 are said to have cost the country 40-49% of its GDP (section 4.4.3*), while in Mozambique GDP is reported to have fallen by 23% as a result of the 1999 floods (section 1.3.1*). The Millennium Development Goals to tackle hunger and poverty are put at risk by the threat of more frequent climate extremes.

- **Nature is a victim too.** Climatic variations are an essential part of nature and many aquatic ecosystems depend on seasonal fluctuations in rainfall and river flows. Over the years though, escalating withdrawals of water for human consumption, food production and industrial use have meant diminishing availability of water to preserve ecosystems. Realisation has been growing recently that safeguarding ecosystems brings multiple benefits, while losing them has serious social costs on top of the environmental ones.

When the effects of intensifying climate extremes are superimposed on increasing water demands for all uses, protecting nature is both more vital and more challenging. In the floodplains of the River Niger in West Africa, steadily declining river flows have meant a reduction of as much as 60% in the area of land used for recession rice cultivation and near collapse of the fishing industry in the inner Niger delta (section 2.4.1*).

- **The poorest are the most vulnerable.** Extreme weather causes damage wherever it strikes. The impacts though are different from place to place. Flood-swollen rivers periodically lead to extensive property damage and big insurance claims in Europe, the USA and Japan. Significantly more flood protection and modified land-use planning are going to be necessary in many industrialised countries to adapt to changing climate regimes. In the developed world, impacts are on a wholly different scale, as the headline-making floods in Bangladesh and Mozambique have amply demonstrated. Deaths, disease and displacement of disadvantaged communities are the devastating impacts of severe floods in the lesser developed countries (LDCs). In these countries too, the capacity to cope with climate extremes depends on more than the severity of the event. The availability of human, technical and financial resources conditions both the preparedness and the response. When donors and relief agencies seek to determine priority areas on the basis of vulnerability to climate change or climate variability, the local capacity to cope is a critical factor. A new "Climate Vulnerability Index", still in the developmental

** The references are to sections of the main report* Climate changes the water rules, *where readers can find evidence for the points being made.*

stages, seeks to combine developmental, geographic and environmental parameters with climate projections, to compare the vulnerabilities of different countries and regions (section 3.3*).

Vulnerability is a gender issue too. Women's traditional roles as providers of household water and food and custodians of family health become very much more stressful and burdensome in the aftermath of a major flood. The informal and agricultural sectors are often the most impacted by natural disasters, leaving women unemployed. Women in informal sector work, such as street vending, child care and domestic work, or owners of small home-based businesses, may lose their jobs and have no means of securing compensation from recovery programmes. On the other hand, focusing solely on women's vulnerability can be misleading, since they often have untapped skills, coping strategies, and knowledge that can be used to minimise the impacts of disaster. For example, drawing on experience gained from managing large extended households, individual women have turned their homes into feeding centres and shelters for displaced members of their communities. Women's shared commitment to the welfare of their families and communities often leads them to form spontaneous women's organisations during disasters. At other times, existing women's organisations focus their activities to respond to community needs caused by disasters. These special attributes of women are rarely recognised formally in any disaster-preparedness plans, though they do tend to emerge spontaneously when disaster strikes.

Combining climate and water skills

Until recently, changing climate was a peripheral issue for water managers. Their attention had rightly been focused on the challenge of managing available water resources in the optimum way, to satisfy the growing demands of people, agriculture, industry and nature. Integrated water resources management (IWRM) was recognised as the primary tool for achieving water use efficiency and sustainability.

But, effective IWRM needs up-to-date information. In the past, hydrological calculations have been based on historic records of rainfall and river flows. From these records, different kinds of hydrographs allowed water engineers to compute reservoir sizes to balance seasonal supply and demand, the height of embankments and the sizes of designated flood plains to handle floods with an acceptable return period, and urban drainage systems to contain design storms without flooding city streets with sewage.

Floods in Albania are about more than water. Destroyed livelihoods come on top of high unemployment and malnutrition. Photo by courtesy of IFRCRC.

The battery of extreme floods and droughts in recent years brought a new sense of urgency among water managers to consider changing rainfall and runoff patterns in their design calculations. In 2001, the Dialogue on Water and Climate (DWC) was created, with a mandate to foster co-operation and collaboration among climate and water specialists. The specific goal was to address the problem of managing water resources in a world of increasing hydrological variability.

** The references are to sections of the main report* Climate changes the water rules, *where readers can find evidence for the point being made*

Eighteen multi-stakeholder "Dialogues" were established, to assess and prepare responses to the climate/water situation at river basin (eight Dialogues), national (two) and regional (eight) levels. As well as bridging the divide between water and climate specialists, the Dialogues brought together representatives of the community, local and national government, NGOs, the private sector, and international knowledge institutions in the climate field. The results, summarised in the "Yellow Pages" of Chapter 4 in *Climate changes the water rules*, have amply demonstrated the power of partnership. They have shown too that committed and empowered dialogues can develop impressive self-help ideas for adapting to climatic variability and change. Among the main report recommendations is one to continue initiating dialogues at national, basin and regional levels, and to prepare knowledge-based guidelines on how to conduct these multi-stakeholder dialogues.

Alongside the Dialogues, DWC sponsored some 25 Thematic Papers by recognised experts, to produce a broad analysis of all the key issues that might affect strategies to cope with the influences of climate on water resources management. The outcome is the first ever "Coping Compendium"

Coping options explored

While it is essential that continuing efforts are made to mitigate the primary cause of climate change by reducing emissions of greenhouse gases, for the water resources sector the main focus needs to be on "adaptation" to the effects of climate variability and change. The Coping Compendium (Table 1) is an attempt to draw together options available to water managers seeking to adapt to the challenges of climate variability and climate change. It is presented as a menu of activities, described only by brief titles. In many cases, the listed activity is linked to one or more of the 18 Dialogues. In that way, readers can find more information about how the activity relates to climate concerns in those specific circumstances, by referring to the Yellow Pages, or via the appropriate full Dialogue

A sample abstract from the "Yellow Pages" of Climate changes the water rules

report. The individual Dialogue reports are available via the DWC website (www.waterandclimate.org).

DWC presents the Compendium as a starting point for what it hopes will become a handbook for practitioners and a start-up tool for future dialogues. Readers of the report are encouraged to supplement the Compendium by contributing their own experiences of coping options, to help build up a dossier of case studies.

Responses to the impacts of climate variability and climate change involve coping actions at many different levels. Internationally, treaties, conventions and global accords are the foundation for concerted action to mitigate global warming. Regional cooperation and transboundary agreements provide a basis for better management of international rivers to prepare for and alleviate extreme events. Information sharing, early warning systems, climate forecasting and modelling all help water managers to prepare coping strategies. But it is on the ground, in the individual river basins and communities, that the vital coping actions have to be taken. The strong message going out to governments, donors and disaster relief agencies is that locally planned, locally managed adaptation to changing climatic circumstances is practical, beneficial and cost effective.

ADAPTATION OPTIONS	DRAWN FROM DIALOGUE(S)
POLICY INSTRUMENTS	
International	
International Conventions on Climate Change	Caribbean, Pacific Islands, Mediterranean, Southern Africa, West Africa, Central America, Netherlands, Bangladesh
International policy - to mitigate or to adapt?	Netherlands
International Trade (particularly WTO)	Mediterranean, Bangladesh
Polluter-pays principle influences ODA/Funds	Southern Africa
Regional	
Regional Adaptation Plans of Action	Southern Africa, West Africa, Caribbean, Central America, Mediterranean
Regional Strategic Action Plans for IWRM	Southern Africa, West Africa, Pacific
Transboundary plans and interstate cooperation	San Juan, Aral Sea, West Africa,
Informal bi-national cooperation	San Pedro
Regional institutions	Caribbean, Small Valleys Programme
National	
National Poverty Reduction Strategies	Thukela, West Africa, Southern Africa
National strategic interests	Lena
National Water Policies and Laws	Thukela, Lena, Yellow River, Bangladesh, Netherlands
National Adaptation Plans of Action	Bangladesh
Disaster Management Policies	Bangladesh
National Drought Action Plans	Murray Darling
Economic instruments and water markets	Murray Darling, Yellow River, Aral Sea
Risk management cross-cutting in development plans	San Juan, Bangladesh, Pacific, West Africa, Netherlands
Strengthened functions of River Basin Authorities	San Juan, Thukela, West Africa
Integrated catchment management	Murray Darling, Yellow River
Water management strategy under climate change	Lena
Non-water planning, eg urban areas, refuges	Nagoya
TECHNOLOGICAL AND STRUCTURAL INSTRUMENTS	
Storage and Reticulation	
Surface water	
Large Reservoirs	Nagoya
Small Reservoirs	*
Groundwater	
Artificial Recharge	*
Borehole Drilling	*
Sand Dams	*
Scavenger/Gallery Wells	*
Related options	
System Maintenance	
Supply Leakage Control	*
Irrigation equipment maintenance	*
Irrigation Canal Leakage	*
Rainwater Harvesting	Nagoya, Caribbean
Water Re-use/Recycling	Mediterranean, Bangladesh, Yellow River, Nagoya, Aral Sea
Desalination	Caribbean
Flood/Storm Surge Control	
Structures (Levees, Dykes)	Netherlands, Bangladesh, Nagoya
Preventative operations	Lena
Early Warning Systems	
Near Real Time (Hours to Days)	Bangladesh, Small Valleys Programme, Nagoya, West Africa
Short-Term (Days to Weeks)	Bangladesh
Medium-Term (Month to Season)	West Africa, Southern Africa, Pacific
Long-Term (Years to Decades)	Caribbean, Pacific
Communicate Forecasts to End-Users	Mediterranean, Netherlands, Thukela, Bangladesh, Nagoya
Operations/System Improvements	
Reservoir Operations Rules	Nagoya
Integrated, optimised reservoir systems	Nagoya
Retrofitting Existing Structures	*
Irrigation scheduling	Murray-Darling
Water Demand Management	Mediterranean, Bangladesh, Yellow River, Nagoya, Aral Sea
Indigenous Coping Strategies	*
Precipitation Enhancement	*

ADAPTATION OPTIONS	DRAWN FROM DIALOGUE(S)
RISK SHARING AND SPREADING	
Insurance	
Primary Insurers	Caribbean
Re-Insurance	*
Micro-Insurance	*
Finance	
Development Banks	*
Private	*
Micro-Lenders	*
CHANGE OF USE, ACTIVITY OR LOCATION	
Land Use Measures	
Conservation Structures	
Adaptive Spatial Planning	Nagoya
Tillage Practices	
Crop varieties	San Juan
Resettlement	

ADAPTIVE CAPACITY	DRAWN FROM DIALOGUE(S)
KNOWLEDGE, SKILLS AND PARTICIPATION	
Participatory Approaches in Decision-Making	
Stakeholder Dialogues	All
Awareness raising	San Pedro, Lena, Nagoya
Stakeholder surveys	Bangladesh, San Pedro, San Juan
Networks of action	Small Valleys Programme
Advocacy through stakeholder River Basin Committees	Thukela, San Pedro
Knowledge Consolidation	
Common adaptation frameworks	Mediterranean
Piloting adaptation options	West Africa
Baseline studies	Nagoya
International information sharing	Bangladesh, Pacific, Caribbean
Integrated information systems	Yellow River, Aral Sea
Research and Development	
Improved climate modelling	Yellow River
Integrated science programmes	Murray Darling, Yellow River
Integrated management tools with climate embedded	Murray Darling, Aral Sea
Risk mapping	Netherlands, Mediterranean, Caribbean
Observation of basic data	
More intensive observation systems	Nagoya, Lena
Skills	
Technical and operational capacity	Southern Africa, West Africa
Forecasting	Small Valleys Programme
Drought Resistant Crops	Mediterranean
Specific skill needs	Caribbean, Small Valleys Programme

MITIGATION OPTIONS
REDUCING EMISSIONS OF GREENHOUSE GASES
Energy
Energy mix
New sources of energy, (low-carbon and renewables)
Energy conversion technologies
Energy demand management
Technological
Improved efficiency of end-use devices
Reduction of industrial by-products
Reduced process-gas emissions
ENHANCING CARBON SINKS
Conserving the existing carbon pools
Increased sequestration through new carbon pools
Substitution of sustainably-produced biological products

*denotes options originating from sources other than the 18 Dialogues.

Table 1 *Compendium of Coping Options*

In the Coping Compendium, adaptation options are divided into four categories:

- **Policy instruments**
- **Technological and structural instruments**
- **Risk sharing and spreading**
- **Change of use, activity or location**

A further heading: **Knowledge, skills and participation** lists activities intended to increase the adaptive capacity of the country or community initiating a coping strategy.

Policy instruments

Over the centuries, societies and ecosystems have adapted to climate variability and climate change in an evolutionary way. Today, the rapidity of changes in hydrological regimes requires more immediate and more concerted efforts. Policies and operating rules focused on optimum exploitation of available water resources need to be adjusted. The hydrological rules have changed. Continually updated assessments of meteorological and hydrological data need to be an integral part of water resources planning and management. That is rarely the case now. A fundamental aspect of any coping strategy therefore must be mainstreaming of climate issues into national water management policy.

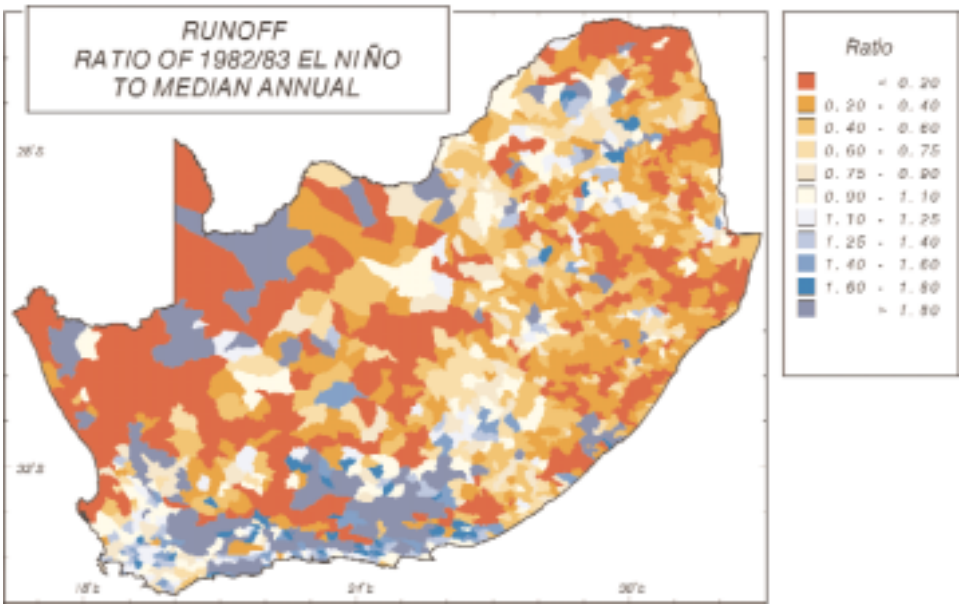
At the global level, the International Convention on Climate Change is influential in stimulating follow-up action at regional and national scales, so its principles and recommendations carry significant weight. The dialogues in West Africa and the Caribbean Islands both call for stronger representation in the processes of the Convention. The World Trade Organisation (WTO) negotiations have emerged as important in determining a nation's ability to cope (highlighted in the Bangladesh and Mediterranean Dialogues). It is higher level politics that will largely determine what happens in this arena, but with the implications for water-use changes implied by freer global food markets, water and climate issues need to be on the WTO agenda.

Regional initiatives can bring economies of scale and often a high level of political will. Regional Adaptation Plans of Action are now being actively pursued in five of the eight Dialogue regions. At national level, water-and-climate is a cross-cutting issue affecting many aspects of social and economic development. Poverty reduction and sustainable development are the two most obvious targets for mainstreaming climate issues, because of the threats to progress in these areas from extreme weather events.

Technological and structural instruments

The list of coping options under this heading in the Compendium will seem to many readers like a catalogue of obvious water management operations and forecasting techniques. It is true that, in most cases, coping with climate need not involve many innovative or new processes. What it does mean is reviewing existing water management operations in the light of today's hydrological circumstances. In doing so, managers will move a long way towards coping with future climate changes.

A first condition for effective coping should be the existence of forecasting and early warning systems based on short to medium-term weather forecasts and up-to-date hydrological information and linked to an effective disaster-preparedness organisation. Regrettably, such systems are too often not in place. They require a high level of local participation and credibility, as well as a strong network for data gathering and dissemination. The *Flood Vulnerability Reduction and Development of Local Warning Systems* programme in Central America, featured in the Small Valleys Dialogue, shows that such systems can be relatively cost efficient. Another example is the advanced early warning system operational in Bangladesh (see box), which expresses hydrological data about impending floods in ways



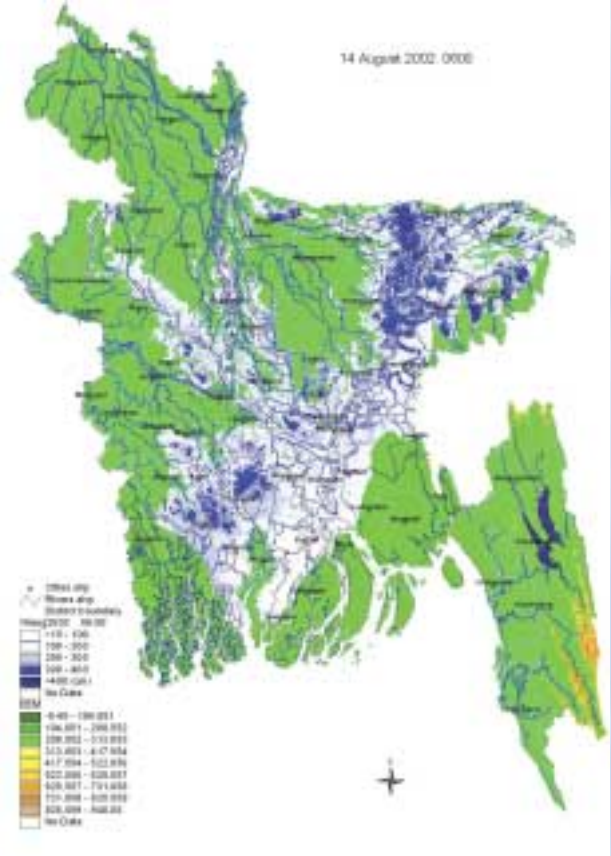
Dramatic effects of the 1982/83 El Niño in the Thukela region of South Africa. Red areas indicate areas with less than 20% of the mean annual run off.

Flood forecasting and warning in Bangladesh

To predict water level conditions in Bangladesh, the Flood Forecasting and Warning Centre (FFWC) collects measurements of water level and rainfall, reviews satellite pictures and simulates the water level conditions using a numerical model of the Bangladeshi river network. Every day during the monsoon season, the model simulates the water levels for the previous seven days (hind-cast simulations) and the coming three days (forecast simulation). Results from the model simulations are used to provide flood forecasting and warning.

The outcomes of the work at FFWC are to a large extent measured and simulated water levels. Water levels can be transformed into inundation maps like the one shown here.

To produce the flood inundation map a digital elevation map (DEM) of Bangladesh is used. Measured, hind-cast, forecast and transformed water levels are all determined with a given precision, but also influenced by errors originating mainly from the measurements. Water levels forecast by the system are not precise, partly because the model boundary conditions (water level boundaries at the Indian border and at the Bay of Bengal and rainfall over Bangladesh) need to be extrapolated. The upstream water level boundaries at the Indian border in particular limit the possible forecast time. Today it is not possible to forecast the flood level in Bangladesh more than three days ahead. If the boundaries could be moved further upstream, i.e. inside India, it would be possible to give longer forecasts.
Source www.ffwc.net



Flood inundation map of Bangladesh for 14 August 2002. Created by combined use of a digital elevation model (DEM) and water levels forecast by the FWWC.

that can help to determine basin-wide impacts. DWC also reports flood early warning systems in Europe, and a community-operated early warning system in Guatemala.

Seasonal up to inter-annual prediction systems are especially relevant for agriculture. Regional and local seasonal predictions are being improved and successfully linked to agricultural extension in, for example, Brazil, southern Africa and the Indonesian archipelago.

Climate forecasting tools are getting better, covering longer and shorter time horizons and larger and more local spatial scales. At regional level and for long time scales, climatologists are now able to produce weather forecasts of modest accuracy particularly for the tropics, though there remain substantial uncertainties in climate projections, particularly for the higher and lower latitudes. The 1997/98 El Niño events were the first to be detected and made known through alerts to a network of organisations in many regions of the world and this led to significant savings in lives and property.

Although long-term climate scenarios cannot meet the operational needs of today's water managers, short and medium-term weather and climate forecasts can be of huge benefit. Further improvement in short-term forecasting (3, 15, 30 and 90-days) is seen as one of the more important technological breakthroughs that will improve adaptive capacity. However, these forecasts are not yet being used in many parts of the world in water management, partly for lack of capacity, but also because the potential has not yet been realised by water managers.

Increased storage is a logical option to cope with changing hydrological parameters (rainfall and runoff). New dams and reservoirs are not always a popular solution though. They raise controversies over environmental and resettlement issues and have been

blamed for spreading vector-borne diseases like schistosomiasis and malaria. In December 2000, the World Commission on Dams produced a comprehensive report Dams and Development: A New framework for Decision-Making, promoting five "core values" – equity, sustainability, efficiency, participatory decision-making, and accountability. The framework and guidelines are to guide projects for new construction and for rehabilitation of dams, but they have not yet factored in climate change/variability. Alternative storage options that need to be explored in this context are ground water storage and rainwater harvesting.

Boosting *groundwater storage* through aquifer recharge can have advantages over surface water storage, because of the reduction in evaporation losses. By way of example, if 50% of the surface water storage for the supply of Windhoek, Namibia, was transferred to underground storage, the decrease in evaporative losses would equal about 60% of the water demand of Windhoek. Water for aquifer recharge may be diverted urban stormwater runoff, irrigation return flows or, with appropriate controls, reused municipal wastewater. At local level, *rainwater harvesting* is growing in popularity as a cost-effective way for the unserved poor to obtain improved water supplies. It has the additional benefit that it adds to the resilience of community water supplies.

For cities and coastal regions susceptible to floods and/or storm surges, each disastrous event prompts a review of control structures. River bed deepening and widening, diversion channels and extra flood basins are among the protection measures that are normally recommended. Raising flood embankments (dikes) is a common, if expensive solution. It can also be a risky one, as future overtopping and failure of raised flood defences will add to the perils of those "protected" by them. In the light of increasing risks of extreme events, the effectiveness of these “solutions” needs to be critically reassessed. Other coping options may well be more effective. For example, the disaster shelters constructed in Bangladesh after the 1991 cyclone killed 140,000 people are considered to have been very effective in saving lives during later storm surges.

Risk sharing and spreading

New insurance products and mechanisms are constantly under development. Crop insurance and microinsurance mechanisms are providing risk transfer to individual (often poor) farmers and other groups who lack access to traditional formal insurance and finance. Both Morocco and Cambodia are investigating and piloting a risk management approach to alleviate loss of agricultural income due to natural hazards. The Government of South Africa is in the process of debating legislation to stimulate a market in crop insurance. Despite the seemingly insurmountable odds against government-run multi-peril crop insurance programmes for the small scale, traditional or subsistence farmers, there are a growing number of specialists who believe that a modified crop insurance scheme for small farmers can be developed and implemented in a viable and sustainable manner.

At household level, microfinance enables families and groups to rebuild economic activities and livelihoods after disasters and to help themselves out of poverty. For example, in Bangladesh, Grameen Bank lends US$30 million a month to 1.8 million borrowers, BRAC provides loans of between 1000 thakas (US$20) and Tk 20,000 (US$400). Governments provide several types of support for disaster response, with workfare programmes successfully maintaining livelihoods for affected people (e.g. Frente de Trabalho in North-Eastern Brazil), providing employment in periods of drought.

Not all forms of risk-spreading involve money. Farmers have traditionally dealt with risk by spreading their resources. They have always taken steps to build-in their own insurance through their cropping and planting strategies, careful that one failure will not prove to be a catastrophe. It is an approach that can be developed and enhanced by better forecasting and co-operative action with support for alternative crops and planting schedules.

Change of use, activity or location

Sea level rise, shrinking natural lakes and desertification all force changes of land-use and livelihoods. The increasing susceptibility of flood plains to extreme events means that governments have to consider prescriptive spatial and land-use planning as a coping option. In some cases, like the examples of the Netherlands and Japan described in the main reports Yellow Pages (Chapter 4), coping measures include an *a priori* acceptance of some degree of risk and controlled damage, as opposed to maximum protection. With increasing climate variability and future climate change, “living with floods and droughts” is likely to become a much more common coping strategy. Resettlement is neither popular nor desirable, but it may eventually become inevitable. In

Pedro is a 39 years old Mozambique Red Cross volunteer, who in the year 2000 lived in Chókwè, a district of the Mozambique's Gaza province, with his wife and two children. He started his activities with the Red Cross during the years of war, in the early 90's. When the flooding started in Chókwè, Pedro had already been helping the local authorities to spread the message that people should move to higher ground, because the waters would rise to the level of the 1997 ones, which affected this area quite badly. At the time he was passing on the message he could not see any signs of the announced waters, so he thought he had time to take his cattle and a few other things with him next morning before the waters would reach his village. The water came very suddenly at three in the morning, while everybody was still sleeping. They were wakened by the frightening noise of large quantities of water, which washed away everything around.

When Pedro fell off his bed, he realized that the water was up to his knees and just managed to open the door of his small house and get out. Then he went out to the already flooded area around him and joined other people, who were screaming and trying to run away. A small wooden boat already full of people was waiting ahead of him. Pedro managed to get into the boat with his wife and children just before it started moving. The boat dropped them at a higher and safer place and went back to rescue more people who were desperately trying to escape the fury of the waters. In the morning everybody started walking under the guidance of the local authorities until they reached Chihakelane resettlement area.

This was the first group to arrive there, but Chihakelane grew into a resettlement area with some several thousand people within a very short time span. Various organizations provided relief support to the people at this resettlement area, from shelter, to food, drinkable water and clothing. In Chihakelane, Pedro joined the local Red Cross volunteers from Macia (a district nearby), who formed teams to provide first aid and help set up tents, build latrines and chlorinate water among other services.

Thousands of people were rescued by small wooden boats piloted by local volunteers during the Mozambique floods

We met Pedro in a tent, which was functioning as a first aid post, close to the local Ministry of Health centre. Together with three more Red Cross volunteers, Pedro provided first aid to an average of 100 people daily. This kept them working several hours a day until more volunteers could be recruited and trained to help with the huge demands.

Pedro only managed to get back to Chókwè some months later, after the dead bodies of people and animals were removed and the authorities gave permission for people to return. He still lives in Chókwè in a house rebuilt with support from an NGO operating in the area. He has recently undergone more training in Disaster Preparedness issues, conducted as part of the RC disaster preparedness activities. A Red Cross office with a small warehouse has been built in Chókwè and a small relief stock is being kept there for future disasters, so warehouse management was also part of the training for Chókwè volunteers.

When asked whether he would not prefer to live in a safer place, Pedro explains that this would be very difficult, since he would not find the same plot (machamba) to grow his crops and feed his family or trade for other products they need in their daily lives: "Here I don't have to dispute my land with anyone. Everybody knows that this is the Chambal's plot and I don't need to argue about it. I will grow similar trees as the ones I had before the floods and if God helps me I will be able to make enough income to buy again a pair of cattle to restore my life and help my children grow healthy. After all floods like those we will have again only after some 100 years and then we will not be in this world anymore".

Will the next serious floods in Mozambique really occur only after 100 years? Whether Pedro's prediction is right or wrong, still remains the question we are searching answers for, but the responsibility to help him to be prepared to face future disasters with the minimum possible damage to his life, lies which each and everyone of us.

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Presented at the Conference on Disaster Preparedness and Climate Change held in the Netherlands in June 2002 and at the World Summit on Social Development, held in South Africa in December 2002.

the Dialogues it became clear that, even in bottom-up strategic planning, switching livelihood practices could not be excluded.

Progressing the adaptation agenda

Continuation of multistakeholder dialogues

The multistakeholder Dialogues have been a useful contribution to improving participation, knowledge and skills. They have brought together stakeholders from many different camps – often camps that do not commonly interact. Advocacy and awareness-raising has influenced river basin committees and government agencies and brought water-and-climate issues to the attention of the general populace and the politicians – so securing a broad and political basis for action. Practical examples of local action include Nagoya and the San Pedro and Lena basins. Other examples in community-based flood mitigation are Bandung City in Indonesia, the tsunami disaster reduction awareness programme in Papua New Guinea, and the NGO-driven floodwater campaign of the Rhine.

A combination of ice jams and high spring discharges can raise water levels 15-20 metres above normal in the Lena basin in eastern Siberia.

The Dialogues have shown there to be a large amount of knowledge already out there, but there are evident areas where this can be improved – particularly in consolidation and focus. Fruitful areas for action are seen to lie in common adaptation frameworks, baseline studies, international information sharing, integrated information systems and the piloting of adaptation options. Information systems on disasters have mushroomed in recent years, including Relief web, the Southern African Flood and Drought Information Network, the National Natural Disaster Knowledge Network (Nanadisk-Net) in India and the Australian Disaster Information Network (AusDIN).

Vulnerability assessments

Hazard (or vulnerability) assessments can be of a great help to planners and managers in their prevention of serious damage through land-use planning and disaster management. Hazard maps are finding routine applications in several countries, including the US, UK, Japan, France, Norway and some developing countries. ESCAP/WMO initiated the *Flood Hazard Mapping* project for the Typhoon Committee area as a means to share information amongst member countries.

Most currently available vulnerability assessment methodologies adopt a "top-down" approach. The aim is to provide a comparative overview of the regions that may require priority attention from the development assistance community. There are problems though with these assessments (see Chapter 3 of the main report). The resolution scale of most global models is too small and the timescale too long to encompass local climate variability. Though some grassroots level vulnerability assessment methodologies are becoming available, they are still under development and their use is quite limited. Much greater use is to be encouraged, both alone and in combination with top-down assessments.

There is scope for research and development to improve the scale and focus of the climate models – to help planners to plan better, and to give primary stakeholders some sense of what might really be going to happen. Despite increasing predictive skills, there is still a widely recognised gap in the capacity to forecast climate at basin, regional or national level over seasons or years. There are calls for development of multidisciplinary, grassroots level vulnerability assessment tools. There are also calls for integrated science programmes – linking climate to epidemiology, or linking food productivity under water shortages to calorific intake. The overall direction is towards integration – merging climate with other factors so that it can be assessed in a wider context during decision-taking. All these activities depend on data. Over the years, many hydrological observation stations in developing countries have fallen into disrepair and disuse. Restoring and extending the hydrological data base is a pressing need and an important condition for adaptation progress in many countries.

Building capacity to cope

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:

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 the South-East Asia Dialogue summary in Chapter 4 of the main report).

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 should by 2005 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).

Towards a Water and Climate Alliance

The Dialogue on Water and Climate has started an alliance of local, national, basin and regional initiatives. On the basis of lessons learned from the 18 Dialogues, the international organisations that have been part of the Dialogue intend to continue building bridges between the climate and water communities. It is proposed that an Associate Programme of the Global Water Partnership (GWP) should be the mechanism for supporting the ongoing and new activities following on from DWC. This programme will include 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.

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.