World Water Council
World Water Forum

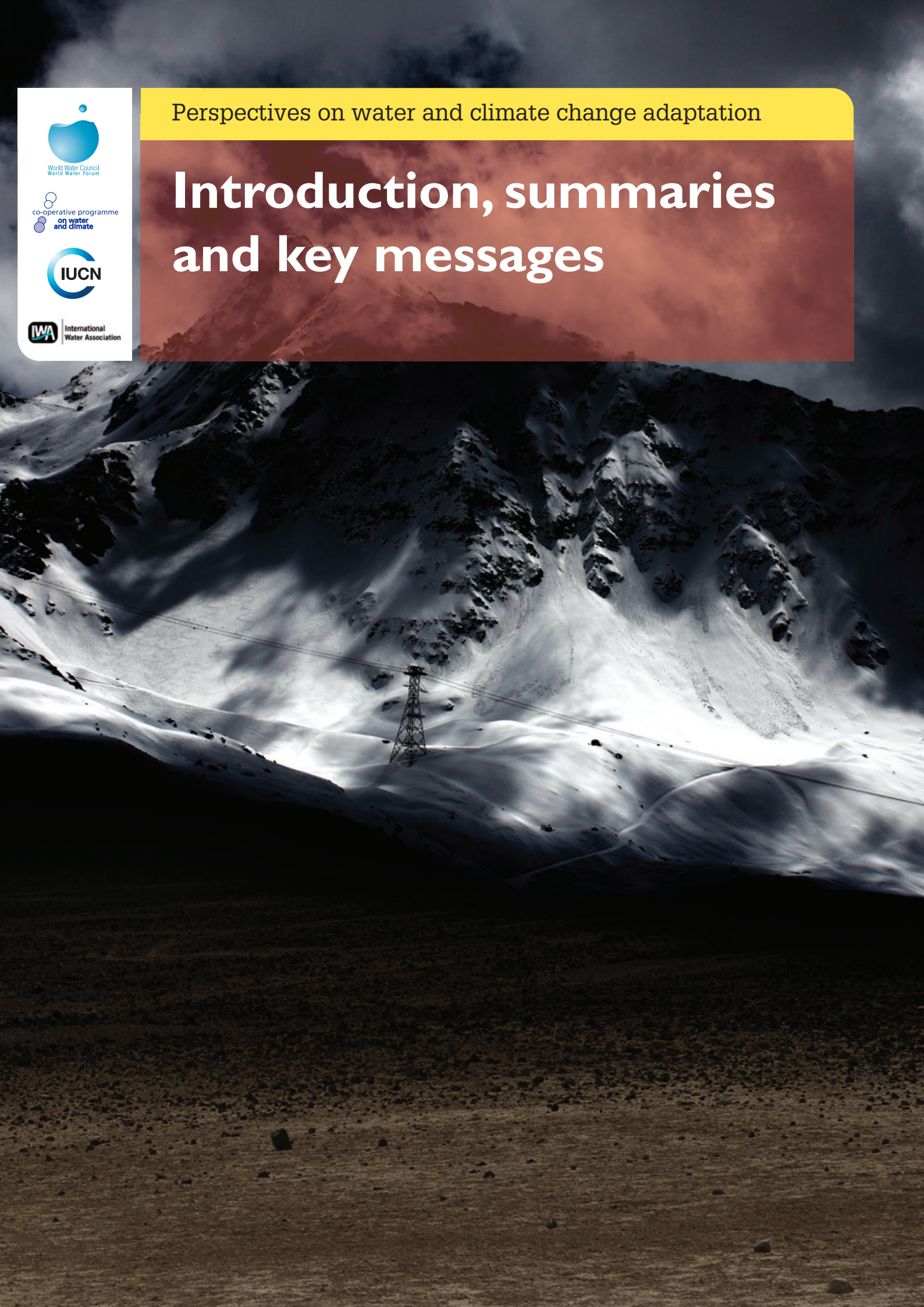
co-operative programme on water and climate

IUCN

IWA International Water Association

Perspectives on water and climate change adaptation

# Introduction, summaries and key messages



**Organizing consortium:**


**With personal contributions from:**

- Johan Kuylenstierna and Jacob Burke – FAO, UN Water
- Jos Timmerman – Rijkswaterstaat Waterdienst
- Francesca Bernardini – UNECE
- Herman van der Most – Deltares
- Margaret Pageler – ICLEI
- Larry Haas and Richard Taylor – IHA

The views expressed in these papers are the personal opinions of the author(s) and their inclusion does not imply endorsement by their employers or by the organizers of the 5th World Water Forum.

**With contributions by:**


This publication was made possible with funding from the Government of the Netherlands.

## Origin of the Series

'Climate change and adaptation' is a central topic in the 5th World Water Forum. It is the lead theme for the political and thematic processes, the topic of a High Level Panel session, and a focus in several documents and sessions of the regional processes.

To provide background and depth to the political process, thematic sessions and the regions, and to ensure that viewpoints of a variety of stakeholders are shared, dozens of experts were invited on a voluntary basis to provide their perspective on critical issues relating to climate change and water in the form of a Perspective Document. Led by a consortium comprising IWA, the Co-operative Programme on Water and Climate (CPWC), the World Water Council and IUCN, the initiative resulted in the series of papers presented here. For ease of adding future Perspectives to the series, the documents have been bundled in a folder and made available on a USB stick that accompanies this hard copy summary. The current document presents a brief introduction to the Perspective Documents and a summary in the form of abstracts and main political messages.

Taken as a whole, the Perspective Documents cover a total of sixteen issues, but the Series is not intended as a comprehensive overview of all possible perspectives related to water resources management and climate change adaptation. Inviting several institutions to write on this topic triggered a process that ultimately served the contributing organizations themselves. Many of them are now using the Perspective Documents internally to shape their strategic position within the climate change adaptation debate, and to help focus and strengthen their thinking on water-related adaptation policies, strategies, actions and objectives.

As a Series, the documents aim to define and distil the critical role of water in climate change adaptation and to lay out strategic and operational priorities for adaptation of water management and services. The Series is expected to increase the understanding among sectors and catalyze dialogue, awareness, and commitments at multiple levels and across individual interests. Furthermore, the Series will serve as a contribution to the dialogue and debate on climate change adaptation underway in preparation for the 15th Conference of the Parties under the United Nations Framework Convention on Climate Change (UNFCCC COP-15) in December 2009, and in subsequent climate change negotiations.

## Selection of Perspectives

The Series interprets climate change adaptation in the water sector in the broadest sense. Participants were invited to contribute perspectives from three categories:

**1 Hot spots**

These papers are mainly concerned with specific locations where climate change effects are felt or will be felt within the next years and where urgent action is needed within the water sector. The hotspots selected are:
- Mountains (document 1)
- Small islands (3)
- Arid regions (9)
- Deltas and coastal cities (13)

**2 Sub-sectoral perspectives**

Specific papers were prepared from a water-user perspective taking into account the impacts on the sub-sector and describing how the sub-sector can deal with the issues. The sectors selected are:
- Environment (2)
- Food (5)
- Water supply and sanitation: the urban poor (7)
- Business (8)
- Industry (10)
- Energy (12)
- Water supply and sanitation (14)

**3 Enabling mechanisms**

These documents provide an overview of enabling mechanisms that make adaptation possible. The mechanisms selected are:
- Planning (4)
- Governance (6)
- Finance (11)
- Engineering (15)

– Strategic Environmental Assessment (SEA) and Integrated Water Resources Management (IWRM) (16)

| PERSPECTIVES AND ENABLING MECHANISMS | | Financing of Adaptation | Governance and adaptation | Spatial and economic planning and adaptation | IWMR + SEA | Better engineering and adaptation | Capacity building | Information and Data collection and sharing |
|---|---|---|---|---|---|---|---|---|
| WATER-USE AND SUB-SECTOR PERSPECTIVES | Water supply and sanitation: Water Utilities | 0 | + | ++ | 0 | ++ | ++ | + |
| | Water supply and sanitation: the urban poor | 0 | ++ | 0 | +++ | 0 | +++ | +++ |
| | Water and Food | +++ | + | ++ | 0 | 0 | +++ | +++ |
| | Water and Energy | ++ | ++ | ++ | ++ | ++ | ++ | + |
| | Water and Nature | + | +++ | ++ | +++ | + | ++ | ++ |
| | Water and Business | + | ++ | + | 0 | 0 | +++ | +++ |
| GEOGRAPHICAL HOT SPOTS | Arid Regions | +++ | +++ | +++ | + | +++ | ++ | +++ |
| | Small Islands | ++ | ++ | ++ | ++ | ++ | +++ | +++ |
| | Glacial melt / high mountain areas | 0 | +++ | 0 | ++ | + | +++ | ++ |
| | Coastal Mega Cities | + | + | + | + | + | + | + |
| | Deltas | 0 | 0 | + | + | + | + | + |

| | |
|---|---|
| 0 | not applicable / not mentioned |
| + | mentioned as an enabling mechanism |
| ++ | mentioned as an important enabling mechanism |
| +++ | mentioned as being an essential enabling mechanism |

## Climate Change and Water

As recognized by the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2007, observational evidence from all continents and most oceans shows that many natural systems, uponwhich the hydrological cycle and thus water availability, water quality, and water services depend, are being affected by anthropogenic climate changes.

Water is predicted to be the primary medium through which early climate change impacts will be felt by people, ecosystems and economies. As summarized by the IPCC in the 2008 «Technical Paper on Climate Change and Water», the expected impacts of climate change on water resources include the expectation of much greater hydrological variability, in the form of more floods, longer and more severe droughts, storms, glacial melt, greater evapotranspiration, and exacerbation of pollution and waterborne diseases. The functions and operations of existing water infrastructure will be affected.

Observational records and climate projections provide abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems. While global climate change induced changes in hydrology have yet to be observed with current data, they are anticipated (IPCC, 2007; IPCC, 2008).

Areas in which runoff is projected to decline are likely to face a reduction in the value of the services provided by water resources. The beneficial impacts of increased annual runoff in other areas are, in some cases, likely to be tempered by negative effects of increased precipitation variability and seasonal runoff shifts on water supply, water quality and flood risks (IPCC, 2007). Globally, the negative impacts of future climate change on freshwater systems are expected to outweigh the benefits.

The future effects of climate change on the water resources of the world will depend on trends in both climatic and non-climatic factors. Evaluating these impacts is challenging because water availability, quality and streamflow are sensitive to changes in temperature and precipitation. Other important factors include increased demand for water caused by population growth, urbanization, changes in the economy, development of new technologies, changes in watershed characteristics including degradation and water management decisions.

> »Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.«
>
> — IPCC's 4th Assessment Report

## Adapting to Climate Change in the Water Sector

Climate change impacts on freshwater resources affect sustainable development and jeopardize economic development, poverty reduction, child mortality, production and availability of food, as well as the health of people and ecosystems, thereby limiting capacity to achieve the Millennium Development Goals. Mitigation will take too long to achieve results, therefore, adaptation to climate change is indispensable and urgent. Additionally, as recognized by various scientific panels, preparing for adaptation now is more cost-effective than waiting until impacts of climate change are irreversible. Adaptation is a continuous process and not a one-off exercise; it requires continuous updating and long-term thinking. Currently, short-term thinking is still too dominant.

The Perspectives Documents presented here are intended to provoke dialogue and debate over the strategic and operational responses needed to adapt to climate change impacts on water resources and water services. They demonstrate that rarely, if ever, will a single response be sufficient. Rather, these multiple perspectives highlight the importance of identifying and constructing portfolios of responses, portfolios of responses, which use coordinated and strategic approaches that can address the priority needs of different 'hot-spots' and of the multiple sectors affected by climate change impacts on water. The integrated thinking needed for effective and flexible adaptation to climate change impacts on water will emerge from dialogue on these perspectives.

The consortium has performed an interim analysis of all Perspective Documents and has synthesized the initial results in a working paper – presenting an introduction to and summaries of the Perspective

Documents and key messages resembling each of the 16 perspectives – which will be presented and discussed during the 5th World Water Forum in Istanbul. The discussions in Istanbul are expected to provide feedback and come up with sug• gestions for further development of the working paper as well as the Perspective Documents. It is expected that after the Forum all docu• ments will be revised and peer-reviewed before publication.

# 1 Impact of Climate Change on Water Resources and Livelihoods in the Greater Himalayas


## Abstract

The greater Himalayan region – 'the roof of the world' – contains the most extensive and rugged high altitude areas on Earth, and the largest areas covered by glaciers and permafrost outside the polar regions. The water resources from this area drain through ten of the largest rivers in Asia, in the basins of which more than 1.3 billion people find their livelihoods. The region and its water resources play an important role in global atmospheric circulation, biodiversity, rainfed and irrigated agriculture, potential hydropower, as well as in the production of commodities exported to markets worldwide. The water resources of this region are currently facing threats from a multitude of driving forces. Global warming is severely impacting the amount of snow and ice and resultant downstream water availability in both the short and long term. The warming in the greater Himalayas has been much greater than the global average of 0.74 degrees Celsius of the last 100 years. In Nepal, for example, the annual average temperature has increased by 0.6 degrees Celsius per decade. Up to 50% of the average annual flows are contributed by snow and glacial melting. Changes in precipitation are ambiguous with both increasing and decreasing trends in different parts of the region. Most studies have excluded the Himalayan region because of its extreme and complex topography and the lack of adequate rain gauge data. The most serious changes are probably those related to the frequency and magnitude of extreme weather events, such as high intense rainfalls leading to flash floods, landslides and debris flows. Currently, there is a severe knowledge gap on the short and long-term implications of the impact of climate change on water and water induced hazards such as floods, flash floods and droughts in the Himalayas, and their downstream river basins. There is an urgent need to close this knowledge gap through the establishment of monitoring schemes for detection of changes in snow, ice, and water; downscaling of climate models; utilisation of hydrological models for prediction of future water availability; and development of basin wide scenarios which also take water demand and socioeconomic development into account. Climate change induced hazards such as floods, landslides, and droughts will impose significant stresses on the livelihoods of mountain people and downstream populations. Society will have to improve its adaptation strategies, and structural inequalities that make adaptation by poor people more difficult will need to be levelled. It is important to strengthen local knowledge, innovations, and practices within social and ecological systems, as well as strengthening the functioning of institutions relevant for adaptation. Sound science together with credible, salient, legitimate knowledge is important to support development and implementation of sound policies. Policy is a formula for the strategic use of power in the application of knowledge. The question is, who has the power and who has the knowledge: scientific knowledge or local knowledge, or a combination of the two?


## Key messages

### 1 Reduce scientific uncertainty

A severe knowledge gap precludes a clear understanding of the impact of climate change on the availability of water resources in the Himalayan region, both in terms of time and space, and of changes in the frequency and magnitude of water-induced hazards. Appreciable changes in the volume and/or timing of river flows are likely, but great uncertainty exists regarding the rate, and even the direction, of these changes. There is an urgent need to close this knowledge gap in order to provide policy and decision makers with knowledge upon which to base well informed decisions for water resources management and disaster risk reduction.

### 2 Reduce risk from floods and flash floods

Water induced disasters such as riverine floods and flash floods are the main natural disasters in the Himalayas and downstream river basins. Water induced disasters account for more than 70% of all economic losses and more than half of the casualties. Reducing the risks from these disasters is fundamental for poverty alleviation and sustainable development. Sharing of hydrometeorological informa-

tion in a regional transboundary upstream-downstream context is crucial for the establishment of efficient early warning systems and for disaster preparedness.

### 3 Support community-led adaptation

Local communities in developing countries are the first to experience the adverse effects of climate change. Poor and marginalised groups such as the Himalayan mountain population and downstream flood plain inhabitants are particularly vulnerable. One approach to reducing vulnerability and strengthening local level adaptation is 'bottom-up' community-led processes built on local knowledge, innovations, and practices. The focus should be on empowering communities to base adaptations to a changing climate and environment on their own decision-making processes, and on participatory technology development with support from outsiders.

### 4 Regional cooperation for sustainable and prosperous water management

Climate change poses a real threat to the Himalayan region and its large rivers, and to the inhabitants of these river basins. The regional and overarching nature of the challenges that lie ahead, require that the countries of the greater Himalayan region seek common solutions to their common problems. Regional cooperation must be advanced in order to address the ecological, socioeconomic, and cultural implications of climate change in the Himalayas. The international community, including donors, decision-makers, and the private and public sectors, should be involved in regional cooperation ventures. This is of particular importance in the quest to achieve sustainable and efficient management of transboundary rivers.

### 5 Payment for Ecosystem Services (PES)

The mountains of the greater Himalayas provide abundant services to the downstream population in terms of water for household purposes, agriculture, hydropower, tourism, spiritual values, and transport. Upstream land and water managers shoulder the heavy responsibility of ensuring reliable provision of good quality water downstream. PES schemes can be developed at different scales, from local to national to regional; and involve local communities, governments, and the private sector. To date, opportunities to establish PES schemes in the Himalayas to ensure safe provision of good quality water remain largely unexplored. However, land and water managers, as well as policy and decision makers, should be encouraged to look for win-win solutions in this context.

## 2 Environment as infrastructure: Resilience to climate change impacts on water through investments in nature

### 1 Environment as infrastructure

People and the economy are more vulnerable to impacts of climate change such as floods, drought, storms and sea-level rise where watersheds and coasts are degraded. The environment provides critical 'natural infrastructure' for climate change adaptation. Strategies for investment in infrastructure platforms to reduce vulnerability will need to include maintenance and restoration of critical natural infrastructure - watersheds, wetlands, rivers and coasts.

### 2 Resilience safeguards the MDGs

Healthy ecosystems provide vital services that build social and economic resilience needed to cope with climate change. Well-managed floodplains reduce the vulnerability of cities downstream, intact mangroves buffer coasts against storms and healthy forests and wetlands reduce disaster risk. Integrating environment in development builds resilience needed to climate-proof the MDGs.

### 3 Empowerment is adaptation

Knowledge and information, skills and participation in decision-making create capacity to adapt. Effective adaptation strategies will build adaptive capacity by

empowering people. Knowledge, capacities and adaptive, participative water governance make communities and societies more resilient and better able to cope with impacts of climate change on water and uncertainties of future events.

**4 Institutions fit for uncertainty**

In an adapting world, water and natural resource governance that builds flexible, adaptive and coordinated institutions strengthen abilities to cope with unavoidable uncertainty. Development of adaptive institutions accompanies investment in natural infrastructure, as natural infrastructure investments are not top down, they are system based. They deliver water storage, flood control and coastal defence, while building self-organisation and learning that are characteristics of resilience needed to deal with uncertain future events.

**5 Put all the infrastructure options on the table**

Policymakers must consider the full range of infrastructure options - whether engineered or natural. They need to determine which are most cost-effective in terms of short-term benefits and long-term resilience and build portfolios of measures for climate change adaptation. Adaptation portfolios need to encompass local actions, development of engineered infrastructure where appropriate and investments in natural infrastructure.

## 3 Adapting to climate change in water resources and water services in Caribbean and Pacific small island countries

### Summary

Given the extreme vulnerability of Small Island Developing States to climatic change and variability, over the past decade the Pacific and Caribbean regions have been working together to promote adaptation to this challenge in the area of land and water management. In this paper, SOPAC, together with input from CEHI, seeks to:

1 provide examples of 'no regrets' approaches, applied in small island countries to cope with current climate variability and adapt to future climate change, at different levels from communities to local administrations, and national governments.
2 demonstrate the need for a sound knowledge base, monitoring and information systems and a better understanding of the relation between water resources, water and health, and climatic extremes.
3 discuss the need for integrated approaches such as integrated water resources management and drinking water safety planning, and how these concepts can mainstream climate adaptation and should be linked to disaster risk reduction and disaster management.
4 influence policy and decision-makers of small island countries, and mobilize increased efforts in the broader development financial discussions for adaptation in the water sector.

In general the perspective document aims to provide further guidance to the efforts in SIDS regions in coping and adaptation related to water resources management and provision of water services. It addresses the general water and climate issues in small island countries, the coping and adaptation strategies adopted by SIDS, the advances made in implementation and the need to mainstream climate adaptation into water resources management and disaster risk reduction, and the political will and need for additional financing to the water and sanitation sector. They noted some key findings from the IPCC and other scientists in terms of SIDS and climate change, such as the variety of impacts to SIDS and the vulnerability of freshwater supplies to both sea level rise and extreme weather events. The paper concludes by underscoring the need for political will and coordinated donor interventions to help SIDS better mainstream adaptation to climate change.

SOPAC will make use of the Perspective Document to advocate political messages to Pacific Island Leaders for the 2nd Asia Pacific Water Summit to be held in Singapore in 2010, as well as to country counterparts and partners involved in regional and

national consultations on water supply and sanitation, water resources management, climate adaptation and disaster management within the Pacific region.

CEHI will promote the water and climate change agenda through this Perspective Document amongst the Caribbean Community (CARICOM), in its role as the principal CARICOM technical institution responsible for water resources management. It will present this document in meetings of CARICOM Ministers, such as Council for Trade and Economic Development (Environment). The Caribbean Community Centre for Climate Change (CCCCC) has developed a regional draft strategy for climate change, and CEHI plans to present this paper to the task force for consideration and potential integration. The perspective document will also be used to promote public awareness of this issue and to seek donor funding and collaboration.

Additional 5th World Water Forum contributions are covering other aspects for SIDS in water resources management and water supply and sanitation e.g. under the Asia Pacific regional contributions and PECC Guidelines for small islands, territories and isolated areas which will both be presented at Istanbul.

### Key messages

- Due to SIDS high level of vulnerability to the negative impacts of climate change and variability, they should adopt a 'no regrets' approach to land and water management, fully integrating their watershed and coastal areas management in terms of policies, legislation, land-use planning, infrastructure, development, public health, etc.
- Significant investment in a sound knowledge base, monitoring and information systems and a better understanding of the relation between water resources, water and health, and climatic extremes is essential for the challenges facing SIDS.
- Funding for adaptation in the water sector should be mainstreamed into broader development finance discussions and linked to integrated approaches such as IWRM and drinking water safety planning.

## 4 Better water resources management – Greater resilience today, more effective adaptation tomorrow

### Summary

Achieving and sustaining water security – broadly defined as harnessing water's productive potential and limiting its destructive potential – provides a focus for adaptation strategies and a framework for action. For countries that have not achieved water security, climate change will make it harder. For those who have enjoyed water security, it may prove hard to sustain. All are likely to need to channel additional resources to water resource management.

A water secure world will need better information and stronger institutions, as well as investment in infrastructure – natural and man-made, small and large scale – to store and transport water. It will require balancing equity, environmental and economic priorities; and 'soft' (institutional and capacity) as well as 'hard' (infrastructure) responses. It will require actions and innovations at all levels: in projects, communities, nations, river basins and globally. Integrated water resources management offers an approach to manage these dynamics, and a thread that runs up and down these levels of engagement.

The remaining gaps include, but are not limited to, the region-specific dimensions of the challenge and the practical interventions that are possible at different levels. The background paper will address some of these gaps.

### Key messages

- Water is the primary medium through which climate change impacts will be felt by people, ecosystems and economies.
- The core goal of adaptation should be to achieve and sustain water security: ensuring the ability to harness water's social and productive forces and control water's destructive forces

- Sound water management will be key to successful adaptation strategies – in the same way that energy policy is recognized to be key to mitigation.
- Trade-offs that have to be made between different water uses and users will become more acute with climate change, and both action and inaction to cope with hydrological variability will incur economic, social and environmental sustainability costs. IWRM offers an approach to make these trade-offs.
- 'Hard' infrastructure investments, in particular to provide additional storage, will be essential in many places to complement 'soft' institutional interventions. Balancing both types of intervention will be fundamental to the 'art of adaptation'.

## 5 The Water Variable: Producing enough food in a climate insecure world

### Summary

This paper serves as an input for the thematic, regional and political processes of the 5th World Water Forum and focuses on the challenges related to water, climate change and food security. Recent publications related to the anticipated impacts of climate change on water and agriculture are comprehensive, but a global analysis of specific impacts remains limited. The paper summarizes recent food production and food security trends and provides an overview of how climate change, through impacts on global hydrology, could impact food production, and consequently food security, in some key farming systems. However, as climate change is but one of many drivers of agriculture, the contextualization of climate change impacts is necessary in order to identify appropriate adaptation measures. The paper highlights some drivers and presents possible responses, emphasizing areas of political action.

### Key messages

Over the last century, global food production has managed to match population growth and despite a three-fold global population increase since the turn of the 1900s, global production is still just enough to sustain six and a half billion people. The fact that more than 900 million people in developing countries remain undernourished can be attributed to lack of access to food rather than lack of global capacity to produce enough food.

Even if global food stocks are falling and recent agricultural growth has been very sluggish, the global capacity to produce (and waste) food has not been cited as a direct cause of malnutrition, but a combination of limited food stocks and volatile energy costs clearly helped to increase consumer prices during 2008. The recent volatility in food commodity prices is a salutary warning that the globe's food supply systems are not infinitely elastic. Apart from known trends in demand, disruptions to food supply through adverse weather or the unintended consequences of biofuel policies illustrate how sensitive both subsistence and intensive farming systems can be to external shocks. Regions already struggling with complex food-related challenges (marginal areas, subsistence farming, poverty, management challenges, etc.) will clearly also be more sensitive to climate change. Some key recommendations from the paper are:

**1 Future investments in land and water will have to be much more flexible and responsive to climate opportunities**

Such investments in hardware (infrastructure) or software (human capacity), are critical adaptation measures given the current levels of uncertainty about the future. If adequately implemented on a 'no regrets' basis, they have the potential to make society better prepared for and less vulnerable to future climate change – allowing for a 'smarter' spread of the production risk.

**2 Access to information relevant to licy and management is a strategic issue**

Having access to relevant information for policy-making and for the development of management responses will be a fundamental prerequisite to build capacity to cope with and adapt to changes. Scientific

data and state of the art knowledge needs to be translated into policy and management information that could be of direct relevance to decision-making at various levels. The issue of scale will be fundamentally important and knowledge transfer and capacity building need to increasingly focus on the user's level.

**3 An increased focus on adaptation and mitigation strategies will need to go both deep and wide**

The integration of climate change-related challenges with other drivers is essential, otherwise there is a risk that investments are made in vain or even become counterproductive. Land use changes, large-scale water diversions, economic development, changes in consumption and production patterns (agriculture, industry), changes in population and population dynamics, etc. will impact on water resources availability and quality, and agriculture. The better understanding of linkages forms the foundation for wider policy intervention necessary to address the climate change – water – agriculture interface and thus the basis for relevant adaptation and mitigation strategies as well as for building overall resilience.

**4 Resilience building in all food production systems, and in particular the most vulnerable farming systems, will need to be emphasized in policy and management initiatives**

Moving from 'coping with impacts' to 'managing risks' to 'invest in adaptation' to 'building long-term resilience' is essential in order to better prepare for future climate change impacts. Ultimately, achieving improved resilience towards global changes, including climate change, needs to underpin more or less all planning and decision-making. This will also imply focusing more on how the potential positive impacts of climate change can be further harnessed.

**5 The policy agenda has to move beyond the sectors**

The policy agenda has to move beyond the sectors and focus also on macro-economic policies (notably those influencing social structures, market conditions and international trade), infrastructure development and spatial planning.
Such initiatives will have a greater impact on demand for agricultural production and the capacity to adapt to change. It will also be essential to foster 'joined-up' decision-making to obtain appropriately scaled responses to climate change.

## 6 Adapting to climate change in transboundary water management

### Summary

A large part of the world's freshwater resources is contained in river basins and groundwater systems that are shared by two or more countries. As climate change is expected to raise the number of extreme situations of flooding and drought, both in frequency and in duration, transboundary management of these water resources becomes more essential to reduce the impact of these extremes.

Transboundary water management is, in essence, more complex than national and sub-national water management because the water management regime (the principles, rules and procedures that steer water management) usually differ more between countries then within countries. Transboundary water management therefore requires coordination over different political, legal and institutional settings as well as over different information management approaches and financial arrangements. Joint bodies are usually instrumental in achieving such coordination. Next to that, riparian countries should look for commonalities in the water management problems they face and should look for solutions which are mutually beneficial.

The UNECE Convention of the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) provides a common legal basis for countries to cooperate. The Water Convention is based on equality and reciprocity between countries. Its provisions offer the basis upon which countries can build their activities. The

implementation programme under the Water Convention also offers a range of guidelines for practical implementation as well as good practices. Under the Water Convention, the Protocol on Water and Health is established which endeavors to protect human health and well-being through improvements in water management, and through implementation of processes to prevent, control and reduce water-related disease. The Protocol on Water and Health is an important tool to address climate change impacts, in particular the impacts water resources and water services, such as water supply and sanitation which affect human health.

In view of the expected impacts of climate change on water management, a Guidance on Water and Climate Adaptation is developed, to be finalised by the end of 2009. The objective of the Guidance is to support cooperation and decision-making in transboundary basins on a range of relevant or emerging issues as a result of climate change. For this purpose, the Guidance addresses adaptation to possible impacts of climate change on flood and drought occurrences, water quality and health related aspects as well as practical ways to cope with the transboundary impacts through, inter alia, integrated management of surface and groundwater for flood and drought mitigation and response, including benefits of floods to increase water availability and to improve the ecological status of waters. The Guidance illustrates steps and adaptation measures that are needed to develop a climate-proof water strategy, starting from the transboundary context. It focuses on the additional new challenges for water management deriving from climate change: what are the impacts of climate change on water management planning and how should this planning be modified to adapt to climate change.

The Guidance addresses the central elements of transboundary regimes: policy setting, legal setting, institutional setting, information management, and financing systems and provides recommendations to deal with them. The Guidance also distinguishes 5 different types of measures to adapt water management to climate change that together form the so-called safety chain: prevention measures, measures to improve resilience, preparation measures, response measures, and recovery measures.

The Guidance aims at developing mutual understanding, between and within countries as well as between scientists and decision-makers. This understanding is best built through intensive cooperation. Moreover, by jointly working towards climate adaptation, riparian countries can achieve cost-effectiveness because measures can be implemented where they are most effective, irrespective of the national boundaries. The Guidance provides a structured approach towards developing such measures.

Nevertheless, in all the work towards adaptation to climate change, the major challenge for politicians is to have the vision of how to put the ideas into practice, as well as the courage to withstand criticism and to share power with other actors.

The perspective document provides a background and rationale for application of the guidance document and will as such be used to further strengthen transboundary water management cooperation under climate change and to promote the use of the Guidance on Water and Climate Adaptation once fully developed.

## Key messages

- Collaborative governance in water management should be strengthened, joining government, society and science as well as joining countries to ensure that measures will be effective and sustainable.
- A paradigm shift is needed from water supply management, wherein water resources are managed to satisfy water needs, to water demand management, in which water use is adapted to the availability of water.
- Non-structural adaptation measures such as legal and policy agreements to encourage water-efficient use, should be employed.
  Adaptation to climate change should be accepted as a long-term, continuous exercise.
- Financial arrangements should be developed which reflect the value of the service provided by water and acknowledge that water-related ecosystems are an essential element of adaptation.

## 7 Local government perspective on adapting water management to climate change

### Summary

With over half the world's population now living in cities, it is essential to engage local political leaders in responding to climate challenges. Mayors and local elected officials are most likely to be motivated by specific threatened climate impacts. As those impacts alter the hydrologic cycle, city leaders will be forced to develop better water management strategies, with or without the support of their national governments. This paper selects five areas of vulnerability – infrastructure deficits, inundation risks, water scarcity and increased competition, and pollution risks – and provides brief case studies of city adaptation responses under a variety of circumstances showing that, while the challenge is global, local leadership can make a difference.

Recognizing the broad range of differences among cities – different political authorities, institutional and financial capacities, as well as likely climate change impacts and local vulnerabilities – this paper nevertheless identifies important commonalities in the local adaptation planning process. Cities that have developed climate adaptation plans for water management use a common process:

- first identifying the range of specific climate impacts;
- then assessing local vulnerability;
- coordinating city agencies for cross-sectoral analysis and action;
- engaging citizens and stakeholders;
- considering and enacting adaptation strategies beginning with "no-regrets" actions;
- then mainstreaming climate resilience into infrastructure investment, building regulations, and disaster preparedness.

Thus, while outcomes will be city-specific, there is much to be shared. The Istanbul Urban Water Consensus commits city leaders to this adaptation planning process, and ICLEI's climate-resilience campaign incorporates the same planning elements. The adaptation planning process at local level must be appropriately funded, especially in regions undergoing water-services decentralization.

The paper highlights the importance of local land management and building regulations, where action (or inaction) can greatly exacerbate water risks or, in the best case, can create long-term adaptive solutions. The Adaptation Agenda must promote stronger linkages between land and building authorities and forward-thinking water professionals at the city level, and begin to build political will for new directions.

### Key messages

**1 Political will**

Climate change is a powerful motivator for overdue water management improvements at local level.

**2 Invest in the process**

For cities, a first level of essential investment will be in local vulnerability assessments, adaptation planning, civic engagement and social marketing, and training in probabilistic or adaptive decision-making. The process must be appropriately funded.

**3 Process commonalities**

Cities that have developed climate adaptation plans for water management use a common process: first identifying the range of specific climate impacts, then assessing local vulnerability, coordinating city agencies, engaging citizens and stakeholders, and considering and enacting adaptation strategies. Thus, while outcomes will be city-specific, there is much to be shared.

**4 Cross-sectoral involvement**

For cities, much of climate change adaptation and resilience is about land –how the land is used, developed and regulated. Politically, engaging the water sector alone will not be sufficient to meet this challenge.

**5 Mainstreaming adaptation**

As cities build and rebuild, climate resilience must be 'mainstreamed' into infrastructure, investments, building regulations, environmental management and disaster preparedness.

## 8 Water, Energy and Climate Change — A contribution from the business community

### Summary

Recently, there has been increased understanding of the links between water, energy and climate change. Research and knowledge have expanded and discussion has progressed within technical circles. Some places in the world have successfully integrated both water and energy into planning, from investment to institutional decision-making. For example, in December 2008, the US Environmental Protection Agency announced an inter-agency agreement between the offices of Air and Water to collaborate on energy and climate efforts for water utilities. Nevertheless, there is still a significant gap in communications addressing the linkages at a global scale. In particular, currently only a limited number of publications, scenarios and perspectives about energy and climate change also address water issues.

Today's financial crisis presents an opportunity for us to revisit the way we manage risk. We need to learn to consider critical issues such as water, energy, climate change, food, land, development and ecosystem services together.

This paper was initially developed for the 5th World Water Forum in Istanbul, Turkey (March 2009). Members of the World Business Council for Sustainable Development (WBCSD) have come together for this important event to provide a business contribution to this critical debate.

### Key messages

1 Provide reliable climate change risk data, models and analysis tools.
2 Integrate water and energy efficiency in measurement tools and policy.
3 Ensure institutional capacities can deliver common management practices, education and awareness-raising.
4 Integrate and value ecosystem services into transboundary decision-making.
5 Encourage best practice through innovation, appropriate solutions and community engagement.

## 9 Vulnerability of arid and semi-arid regions to climate change

### Summary

Climate change impacts will add to already difficult water management challenges in the arid and semi-arid regions. Climate change will impact several sectors of the economy and will have worldwide ramifications. The changes in other parts of the world will impact the economy of arid and semi-arid regions too. Many countries in these regions depend on river flows originating in tropical or temperate regions. The overall water stress will increase.

There are several key policy challenges that have to be confronted for successfully adapting to climate change with respect to water. The first challenge concerns information and data collection and sharing. The adaptation strategy is another challenge, varying from one country to another based on the projected impact of climate change. There are multiple stakeholders in a region. The institutional capacity should be strong enough to undertake adaptive measures. One of the greatest policy challenges will be the financing of climate change adaptive measures. With imperfect information about the magnitude of climate change impact, the allocation of financial resources to constructing expensive infrastructures will be a great challenge for developing countries.

Many countries and regions in the world are already taking actions that will help them manage the challenges of climate change. The approach that each has followed is specific to the context of the region or the country. The main emphasis is on improving information, strengthening institutions and devising strategies for reducing the negative impact on vulnerable population groups.

A rational framework consisting of assessment, bargaining, codification, delegation, engineering and feedback - that can be summarized as the ABCDEF – was traditionally used in water-scarce regions to develop and manage their water resources productively and sustainably. The framework requires appreciating the human, financial, natural and technological aspects of water management, through systematic engagement of stakeholders in learning about water management, and recognizing that any change (to allocations, technology, laws, etc.) has implications for other aspects of the system. Assessment requires much information. The current knowledge stock on climate change requires constant and systematic updating. Cooperation between various institutions spread across the world and cross-sectoral knowledge is necessary for this purpose.

Since it is difficult to predict the magnitude of climate change, this approach will provide flexibility, and develop coping strategies against an array of climate change scenarios. To simplify information complexity of organizing such a huge task, the adaptation strategy could begin by undertaking a bottom up vulnerability assessment of the existing system. Thus, instead of analyzing complex climate change models, the local water management institution could analyze information it already possesses, and assess the type of quantity and quality changes which will present the greatest threat to its current functioning. Based on this knowledge, the institution could plan several initiatives that will lessen the impact of climate change whenever it occurs.

### Key messages

1 The water situation in many of the countries in the MENA region is fragile. Climate change threatens to disturb this fragile situation because demand, especially for agriculture, will increase and supply will be at best more erratic. Adaptation to climate change will be required to cope with the new situation.
2 Information is indispensible for improving knowledge about expected climate changes within the country/region/basin and to persuade politicians, decision-makers and the public at large to support and accept adaptive actions.
3 Information technologies including remote sensing are powerful tools to improve information and understanding of current and potential future scenarios.
4 Rational frameworks such as ABCDEF (Assessment, Bargaining, Codification, Delegation, Engineering and Feedback) proposed by AWC in its endeavor to address adaptation to climate change in the Arab region systematically explore adaptive measures.
5 Joint work between scientists, institutions and countries would create a common knowledge base at the basin/regional level and open opportunities for cooperation.

## 10 Climate change and the water industry – practical responses and actions

### Summary

This paper outlines the key vulnerabilities of the water industry to climate change and the most important adaptation strategies, responses and actions. It has been prepared by the IWA Specialist Group on Climate Change (CCSG), on behalf of the IWA. The vulnerability of the water industry in terms of water security and water quality to the impacts of climate change is firmly established. Water professionals and utilities acknowledge that climate change is unequivocal, and shares an increasing concern of the need to take action now to mitigate and adapt. The impacts will exacerbate increasing human pressures on water systems, and decision-makers and managers need to address the challenges in an inte-

grated fashion. Impacts will be felt differently in different geographical regions. Here, climate change impacts are described according to different climatic conditions: a) Low lying countries and river deltas which are more prone to flooding and under threat of sea level rise; b) Mountainous regions, which will be affected by retreating glaciers and snowmelt; and c) Arid and semi-arid areas that will be impacted by less rain and increased evaporation. A primary challenge for the industry will be to enhance the capacity to cope with impacts on, for example, groundwater, surface water quality, flow seasonability, urban flooding, potable water supply, waste water treatment, ecosystems, social and economic activity, etc. Adaptive management, flexible approaches, diverse portfolios of water sources and management strategies and an ability to move quickly to make and implement decisions will be imperative. Continuous monitoring and evaluation will be essential to underpin the knowledge of decision-makers. Adaptation strategies for drinking water supply should address both the demand and supply side. With increasing frequency of extreme events, recommended interventions include early warning systems, improved physical defense for existing facilities and careful site selection for new facilities. The paper lists specific strategies for the different climatic regions. In regions affected by melting snowpack, measures need to address a broad spectrum of interventions to address uncertainty and make staged investments that enhance system capacity. In low lying countries it is also important to reduce the vulnerability to flooding, where careful urban planning is required and future developments must take into account the safe provision of vital water services under future climate scenarios. In drying climates a proactive approach is needed to avoid sourcing reactive emergency supplies. Furthermore, it is of vital importance to diversify resources and building capacity especially in low- and middle-income countries. This paper also includes aspects of mitigation since it is linked to adaptation. Pursued climate change mitigation options should demonstrate co-benefits that facilitate climate change adaptation, such as constructed wetlands as well as reducing non-renewable water. Finally, the paper includes a section on recommendations for actions for governments, the water industry at large and individual utilities.

### Key messages

- Take adequate steps to model climate change.
- Monitor and evaluate unfolding climate and its impacts.
- Develop nimble, adaptive management strategies.
- Ensure that all personnel employed in the field of water are adequately educated and trained.
- Establish and provide access to data monitoring and observational networks and support needs driven climate research that is developed with the involvement of the water sector.
- Pursue climate change mitigation options that demonstrate co-benefits with climate change adaptation.
- Adaptation in the water sector should be part of the discussion in multilateral talks for the successor to the Kyoto Protocol and a focal point for the Adaptation Fund that is being created.

## 11 Climate Change Adaptation in the Water Sector: Financial Issues

### Summary

The present document discusses the economic and financial issues of adaptation to climate change. The (inter)national adaptation funding instruments presently available were inventoried and analyzed. The analysis clearly showed that projected needs cannot be met with these instruments alone, while an overarching harmonized strategic financial framework, without which the benefits for the global environmental environment will remain suboptimal, is still lacking. The document therefore describes what other options for financing could be developed.

Key messages

**1 Additional financial resources needed**

While it is a nation's responsibility to finance their national water management programmes, climate change may add additional challenges within the overall development and sustainability agenda, resulting in the need of additional external financial resources for developing countries to implement adaptation measures.

**2 New adaptation funding instruments needed**

While recognising that several promising financial initiatives are being launched on adaptation (and mitigation), it is clear that additional needs cannot be met with the present (inter)national adaptation funding instruments alone.

**3 Other financial financing sources needed**

It will therefore be crucial to consider tapping into other international and multilateral (environmental) financing sources, as well as other domestic public and private sources. Private funding sources may also cover a portion of the costs, and public resources are expected to play a dominant role in all sectors.

**4 Climate change is not just an environmental issue**

Climate change affects through the medium water all sectors: social and development issues, but also economic and environmental sustainability. Climate change is not limited to environmental impacts only. Similarly, adaptation funds should also not be limited to environmental agendas; investments at the national level should therefore be optimised and move from stand-alone projects to sector-wide and programmatic interventions.

**5 Overarching financial architecture needed**

Because of its multi-sectoral nature, there is a need for an international, overarching financial architecture for the current and yet to be developed bi- and multilateral and international climate adaptation funds. It is of the utmost essence that the COP-15 participants agree on an overarching financial architecture and as well as on (multiple) financing sources, and issues such as but not limited to priorities, and criteria for disbursement and eligibility.

## 12 Climate adaptation – Aligning water and energy development perspectives

Summary

The water and energy sectors are intrinsically linked: one resource is needed to produce, transport and provide the other and climate change is affecting the supply and quality of both. Contrary to common debate, climate change will not only result in water scarcity, but there is also the challenge to manage changing hydrological input (greater variability and intensity of precipitation). While past efforts have concentrated on mitigating climate change, future efforts need to provide measures for adaptation.

This paper argues that while there is no single prescription, progress in climate adaptation at the water-energy interface hinges on addressing multiple imperatives. Therefore, in the first part of this paper, the multiple interlinkages between the water and energy sectors are revealed. Water-energy linkages encompass conventional, traditional and emergent energy forms, where each energy system or technology has a unique water footprint (e.g. fresh water impoundment and regulation for hydropower, water to grow bio-fuel crops, water for steam and cooling at geothermal, fossil-fuel and nuclear schemes, wind and other emerging renewables relying on hydro storage, and groundwater for traditional biomass energy). Furthermore, it is shown that numerous options exist for fuel switching and financing to adapt traditional water and energy systems to climate change.

The second part of this paper identifies five key issues to guide policy-makers. To address climate change it is important to take action now.

In the third part of this paper, it is shown that beyond these concerns, global society must: curb the current appetite for narrow, ideological policy prescriptions (especially those limiting developing country access to international finance and shared learning); reverse maladaptive policies in land use and catchment management; and seek to optimise hydrological services of ecosystems and integrate national adaptation strategies for the water and energy sectors, already called for under the UNFCCC – but driving them with coalition approaches to overcome lack of progress to date.

The energy sector is uniquely central in framing local to global strategies for mitigation and adaptation. Synergies need to be captured at all levels if political calls for a 60% reduction, or more, in global GHG emission by 2050 have any chance of success, and to make genuine progress in adaptation in many developing countries. There is ample room for optimism. Water security, energy security and environment security concerns are already linked in policy and planning in many countries and regions. But it is necessary to start implementing what is already on the table, with 'least regret' strategies that have been adopted in the climate dialogue process.

### Key messages

1 Reconcile demand and supply to provide climate 'headroom' by relieving pressure on natural resources systems already under stress.

2 Recognize that electricity will play a dominant role in low-carbon energy systems.

3 Facilitate adaptation to climate change by action to 'climate-proof' water, energy and ecosystem services.

4 Better understand the water footprint of energy systems and reconcile the role of water storage within water, environment and energy security frameworks.

5 Build appropriate capacity with knowledge-sharing, technology, industry and finance to move adaptation from policy to practice.

## 13 Adaptation to climate change: another challenge in the sustainable development of deltas

### Summary


**Economic and environmental hot spots, but under stress**

Deltas are generally located at strategic locations close to seas and inland waterways. Deltas also provide some of the world's most fertile lands for food production. Attracted by these potentials, large numbers of people live in deltas. The rivers that flow through the deltas are an important source of fresh water and nutrients that create environmental conditions for a unique flora and fauna. Delta and estuarine ecosystems are therefore valuable and among the most productive ecosystems on earth.

The characteristics, which make deltas attractive areas to live and work, are under stress. Available space is under pressure, vulnerability to flooding is increasing and fresh water resources are threatened. Population growth, economic development and climate change will cause additional stress on deltas unless appropriate measures are taken. In addition to these drivers there are a number of societal trends such as decentralization and privatization which affect the organization and outcome of planning of delta development. These trends in society require a selective enhancement of governance, reflecting the regional scale, integrated nature and long-term perspective of delta development.

**Two perspectives on development of deltas**

Basically there are two different ways to respond to the drivers and trends. The first perspective is driven by the (liberal) economic perspective: privatization

and decentralization play a key role in this perspective. The potential conflicts from this focus are generally solved through further development of infrastructure. The long-term sustainability, however, is not guaranteed. Changing environmental conditions will require a regular upgrading of the infrastructure, as infrastructure does not adapt naturally.

The second, environmental perspective, is driven by global concerns on climate change and environmental degradation. It reflects a growing awareness that nature poses limits to development. Natural processes should be utilized as much as possible to adapt to changing environmental conditions. The environmental perspective aims to make better use of the inherent adaptive capacities of nature.

The first perspective is visible in most deltas of the world. The second perspective is, as yet, less visible, but is gaining momentum. The main challenge therefore is to combine elements of both perspectives into a strategy which is both economically viable and ecologically sound.

**The way forward: a delta vision supported by innovations**

To promote sustainable development of deltas a clear and shared vision has to be developed on how to best respond to the various drivers of change (including climate change) as well as on how to play along with the various trends in society. Next the delta vision should be elaborated into a policy or delta programme through a Strategic Environmental Assessment. Such a programme should comprise a sensible combination of different kind of responses: restoration of natural systems, adaptation of land and water use, development of infrastructure, as well as measures to strengthen the governance structure. The perspectives of these responses are elaborated in this document.

Sustainable development of deltas requires innovations in the knowledge of natural systems behavior as well as in the approach to planning and design (e.g. moving from an engineering approach to an 'integral approach'). Good governance should also promote that proper conditions are created for the actual implementation of delta visions through development and adaptation projects. Sustainable development of deltas is an increasingly complex field which requires the contribution and cooperation of many parties. Although there is no general recipe on how to best deal with many delta issues, it is important to learn from experiences elsewhere. To this end, exchange of knowledge and experiences should be stimulated.

## Key messages

This text presents a preliminary top 5 of issues, challenges in the development and management of deltas. For each topic a short description is given of status and trends. That description is succeeded by a required management response, which might be understood as political take-home messages or could be further elaborated into such messages.

**1 Improving resilience of delta areas**

- [*status and trends:*] Accumulation of people and wealth in low lying coastal areas will increase the vulnerability with respect to future climate change (which could lead to higher flood risks, higher frequencies of droughts and salinity intrusion).
- [*response:*] Societies should become better prepared to these hazards, preferably by making them more resilient. This requires a combination of appropriate technology and community participation. Resilience can be improved by: preparedness, coping strategies and adaptation to changing conditions.

**2 Freshwater resources threatened**

- [*status and trends*]: Many deltas in the world currently face water shortages (Nile, Godavari, Yellow River, Rhine). Climate change induced changes in rainfall patterns in the main catchment areas could result in more frequent and prolonged periods of low river discharges. This will have profound repercussions on the delta agriculture, as well as on delta and coastal ecosystems.
- [*response*]: Establishment of environmental flow requirements for deltas is needed. Implementation requires involvement of river basin agencies (upstream – downstream coordination!)

**3 Ageing infrastructure**

- [*status and trends:*] Many deltas have irrigation and drainage systems developed in the late 19th and early 20th century (Nile, Godavari, Red River). Many of these require an upgrade or major revision to improve their effectiveness. Other deltas have inadequate flood protection schemes or schemes that will require major upgrading within the next 20 or 30 years (Rhine delta, Mississippi Delta, Red River Delta). Hence, countries will now or in the near future face a decision whether or not to invest a large amount of public funds to improve their delta infrastructure.
- [*response:*] How are these countries going to finance these investments? Public private partnerships could provide a solution in those cases where farmers, industries and harbour companies directly benefit from these infrastructure investments. But for protection schemes against floods and storm surges other options could be more appropriate, such as financing mechanisms through water boards.

**4 Coastal erosion management**

- [*status and trends:*] Many deltas face a sediment shortage (Nile, Mississippi, Rhine...). This (in combination with sea level rise will) cause coastal erosion problems. Solutions should preferably include a restoration of the sediment balance. If is not feasible, sand nourishments are preferred over hard engineering structures. Also other 'building with nature' options should be looked into, tested and where possibly implemented (e.g. mangrove restoration, artificial reefs).
- [*response:*] This is primarily a task for coastal management agencies, who should work closely together with local stakeholders and the private sectors, to find socially acceptable and financially efficient solutions.

**5 Biodiversity protection**

- [*status and trends:*] Worldwide biodiversity in deltas is under very high pressure, because of a high population density, concentration of industrial, harbour and mining activities and as receptor of pollutants from upstream. Deltas often form major stepping stones for migratory bird species (e.g. Nile, Rhine, Yellow River), and their coastal and estuarine ecosystems provide key functions for fisheries and other biological resources.
- [*response:*] Delta management must take effective action to protect nature areas, both from local habitat destruction and from external disturbance and adverse inputs (pollutants). This requires adhering to the national and international obligations (WFD, Habitat Directive, Ramsar Convention, Biodiversity Convention) and should be effectuated at the local level through cooperation and involvement of all stakeholders.

## 14 Climate change and WASH services delivery – Is improved WASH governance the key to effective mitigation and adaptation?

### Summary

There is general agreement that climate change poses a threat to sustainable, equitable and efficient WASH service provision if not immediately then at some time in the future. Although climate change predictions aim to quantify the severity of this threat in space and time, there are high levels of uncertainty in these predictions particularly at the spatial scales at which most WASH decisions are made. As a consequence, it is argued in the paper that climate change should be viewed as just one of many potential causes of risk, uncertainty and vulnerability that should be considered during WASH governance processes. It is noted that other sources of risk, uncertainty and vulnerability (e.g. population increase, urbanisation, increasing competition for safe water, poverty, macro-economic downturns etc) are the fundamental causes of the unacceptable levels of WASH service provision in many parts of the world. It is argued that the most effective way of mitigating or adapting to climate change is by ensuring that governance take explicit account of risk, uncertainty and vulnerability by adopting prin-

ciples of adaptive management and by using tools such as scenario building as an integral part of decision-making processes. Or put another way, uncertainty in the WASH sector has now become so pronounced as to render futile, if not counterproductive, planning processes that are based on probabilities and extrapolation of current trends. Unique forecasts of factors influencing water WASH supply and demand should no longer be relied upon. Whilst the paper recommends that improvements in WASH governance is the key to improved long-term service provision worldwide. It is recognised that this will not be achieved without strengthening of capacity particularly at the intermediate and local levels. Finally, it is recommended that the WASH sector become more actively engaged in climate change research programmes and fora of all types. Not least because, this will ensure that recommendations from these programmes: 1) View climate change within the context of other challenges facing the sector and 2) Take better account of the knowledge and experience from earlier and ongoing attempts to develop, adapt and upscale innovative approaches to WASH service provision. A good first step will be to form a WASH sector thematic group that has the primary role of exchanging views on climate change and seeking opportunities for constructive dialogue between the WASH sector and research and policy groups that are directly involved in climate change initiatives

## Conclusions and recommendations

The current state of 'climate change and water' knowledge can be summarised simplistically as follows:

- Precipitation will increase in high latitudes and parts of the tropics, and decrease in some subtropical and lower mid-latitude regions.
- Annual average river runoff and water availability are projected to increase in high latitudes and in some wet tropical areas, and decrease over some dry regions at mid-latitudes and in the dry tropics.
- Increased precipitation and variability intensity will increase the risks of flooding and drought in many areas.
- Water supplies stored in glaciers and snow cover are projected to decline as will dry-season river flows based on snow melt.
- Higher water temperatures and changes in extremes, including floods and droughts, are projected to affect water quality and exacerbate many forms of water pollution.
- Global mean sea level has been rising.
- Climate change challenges the traditional assumption that past hydrological experience provides a good guide to future conditions.

There is a high-level of uncertainty in climate change predictions that increases at the scales at which WASH decisions are generally made. It is recommended, therefore that the WASH focus its attention on improving WASH governance and, more specifically, methods, approaches and tools that help decision-making approaches take explicit account of risk and uncertainty.

Solutions to climate change tend to be the same as those that are being advocated for tackling more immediate WASH challenges. However, there are solutions that are being advocated with a particular evangelical vigour in the climate change literature that have already been shown to have limited scope for tackling WASH challenges and/or to have significant negative tradeoffs when implemented at scale. It is recommended that WASH professionals become more involved in climate change research so that a more rigorous vetting of 'solutions' takes place.

Finally, it is recommended that a climate change thematic network be established within the WASH sector for better exchange of views on climate change and to promote a more active engagement of the sector in climate change research programmes, workshops and policy fora.

## Key messages

**The WASH sector should become more actively engaged in climate change research programmes and fora of all types** to ensure that their recommendations:

1 view climate change within the broader context of other challenges facing the WASH sector; and
2 take better account of knowledge and experience from earlier and ongoing attempts to develop,

adapt and upscale innovative approaches to WASH service provision.

Climate change should be considered one of many potential sources of risk, uncertainty and vulnerability that merit attention during WASH governance processes. In practical terms, this can be achieved if the WASH sector adopts principles of adaptive management and uses scenario building as an integral component of WASH planning processes.

## 15 Adapting to climate change in water resources and water services

Management, by definition, includes the planning and implementation of adaptive measures as well as anticipatory ones. Water resources managers have historically been at the forefront of adapting to considerable natural climate variability, shifts in population and resultant demands, as well as profound changes in social preferences for economic, environmental and recreational uses of water. Hence, there is adequate justification in assuming that the potentially serious range of direct hydrologic runoff effects of climate change, expressed normally as an increase in the magnitude and frequency of floods and droughts that are forecasted by the new family of Intergovernmental Panel on Climate Change (IPCC)-generated scenarios and General Circulation Model (GCM) results, is not expected to result in a commensurate level of adverse water resources or management consequences, even in the semi-arid areas of the globe. In other words, there is not a direct linear correlation between the highly uncertain hydrologic response sensitivity, as suggested by the GCMs, and assessments of water sector vulnerability. Preparing for and ameliorating future climate change vulnerability is very much dependent on the current state and capacity of water management, as it will serve as the platform for effective adaptation to future anticipated changes.

A 'proactive adaptive management' response is advocated as a starting point for most water management aspects associated with existing water-based infrastructure, such as irrigated agriculture and developed floodplains and urban areas. The 'operating agencies', i.e. those responsible for investing in, managing and operating water infrastructure need to take the lead in promoting adaptation, in conjunction with the science agencies of their respective countries. Irrigated agriculture uses the largest amount of water resources – nearly 80% worldwide, and densely populated urban floodplains are currently the most vulnerable to contemporary flooding. Fortunately both are inherently activities that can be upgraded incrementally, through the introduction of adaptive management techniques over time, as new information and technologies become available, and as resources allow. Irrigated agriculture is essentially built as a series of modular components that are amenable to proactive, incremental adaptation to changes in technological advances – both in biotechnology and irrigation techniques, as well as improved management techniques. The same is true for water and wastewater treatment systems; they are modular in nature and can be incrementally adapted to changes in technology and demand. Floodplain development has been the subject of numerous technical advances, land use and flood plain management regulations, insurance initiatives and legislation governing the wise and sustainable use of floodplains.

However, because of the long design lives of new, large-scale water infrastructure projects that are being planned and designed today, such as multi-purpose dams and levee systems that protect urban infrastructure, urban water and wastewater distribution systems (pipelines and tunnels, sewerage systems) - these require different approaches that are more problematic, for they are not amenable to an incremental 'adaptive management' strategy . New hydraulic infrastructure inherently must deal with large uncertainties related to future climate changes, and would require a 'paradigm shift' in the way this infrastructure is planned, designed and justified according to traditional economic decision criteria. Furthermore, this is where Integrated Water Resources Management (IWRM) is needed to provide the 'enabling environment' for developing acceptable, stakeholder-driven robust solutions. In addition, a concerted and collaborative applied research effort is needed to revise the fundamental evaluation principles that have guided water resources planning and management for the past 50 years, focusing on how the highly uncertain GCM information is used

in a rigorous evaluation and decision-making process.

### Key messages

1 In the irrigation and urban flood management sectors incremental adaptive management of existing infrastructure to contemporary climate change signals (increased variability, frequency and magnitude of floods and droughts) would address many emerging hazard related problems, and set the stage for dealing with design of new infrastructure needed to address longer term problems.

2 Capacity, technology and capability for incremental adaptive management exist in irrigation and urban food protection, the two sectors that are most hazard-prone and where consequences are greatest. These sectors are best suited to incremental adaptation to climate uncertainty because they are inherently based on modular components that can be incrementally adjusted as new technologies, policies and information emerge.

3 Flood/drought preparedness, warning and response planning are the essential core of adaptive management and are leading edge practice in any climate adaptation response effort. They provide the extra dimensions of needed resiliency and robustness for the operation of existing water infrastructure without requiring any new innovative technologies or IWRM.

4 Design of new, long-life infrastructure, such as dams, large urban flood protection structures, pipelines and tunnels, requires more specific and certain information from the climate modelling community. IWRM, especially the enabling institutional framework and comprehensive management at a river basin scale, would be a helpful complement in planning new infrastructure under climate uncertainty.

5 Designing new large infrastructure under climate uncertainty requires a new project planning and evaluation paradigm, especially with respect to economic justification procedures, which are influenced by discount rates and procedures that implicitly discount future low probability/high consequence events, such as large floods and droughts.

## 16 Integrated Water Resources Management and Strategic Environmental Assessment - Joining forces for Climate Proofing

### Summary

The international community is concerned about the consequences of climate, especially for particularly vulnerable groups in developing countries. A high priority should be given to increasing the capacity to adapt to climate change in ways that are synergistic with wider societal goals of sustainable development. The challenge is to have adaptation integrated in overall planning, and to define guiding principles for this integration.

There is general agreement that the supply of and demand for water resources will be substantially affected by climate change. Changes in climate will be amplified in the water environment. In other words, water is in the eye of the climate management storm. Improving the way we use and manage our water today will make it easier to address the challenges of tomorrow.

Integrated Water Resources Management (IWRM) and Strategic Environmental Assessment (SEA) are two mechanisms, available to support the integration of climate change adaptation in overall (water resources) planning. In this paper, strengths and weaknesses of these are discussed and their complementary nature with respect to climate change adaptation is highlighted.

Integrated Water Resources Management (IWRM) has been the accepted management paradigm for efficient, equitable and sustainable management of water resource since the early 1990s. IWRM is a process, which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner,

without compromising the sustainability of vital ecosystems.

The strength of IWRM is its well-developed and highly structured approach, capable to cope with the multi-functionality of water, based on quantified data. Its weakness is a lack of formal procedural requirements to implement IWRM and consequently, weakly implemented process aspects, such as public participation. A further disadvantage is that other sectors are unaware of the principles of IWRM.

Strategic Environmental Assessment (SEA) is a family of tools that identifies and addresses the environmental consequences and stakeholder concerns in the development of policies, plans, programmes and other high level initiatives. The definition of environment depends on the scope of the SEA, and ranges from biophysical environment only, to all encompassing including biophysical, social, economic and institutional environments. SEA aims at better strategies, ranging from legislation and countrywide development policies to more concrete sector and spatial plans. SEA assists in identifying, assessing and comparing the different ways in which a policy, plan or programme can achieve its objectives.

The strength of SEA is that in many countries it is a legally embedded tool, with clearly demarcated roles and responsibilities. Furthermore, there is a strong common understanding of what good SEA practice is. Transparency and stakeholder participation are core values, supported by an increasing evidence base of good practices. The weakness of SEA lies in the contents. SEA in itself has relatively little content, but provides the procedural umbrella under which a variety of tools have to be used.

Analysis of both instruments reveals that they share many characteristics: integration of environmental and social considerations into multi-sectoral decisions; participatory approaches; monitoring and evaluation of outcomes; broadening perspectives beyond immediate sectoral issues; and emphasis on the product as well as the process.

A further look at strengths and weaknesses reveals major differences of complementary nature, summarised in four messages.

## Key messages

1 SEA is a (more and more) legally established vehicle to convey the messages of IWRM.

2 SEA is better geared toward the practical implementation (process) of the principles it shares with IWRM: stakeholder participation and informed, transparent decision-making.

3 IWRM is best equipped to deal with the scientific dimension of climate change adaptation. It provides comprehensive and integrated understanding of water sector issues to inform – through SEA - decision making.

4 Climate change adaptation is not only a responsibility for the water sector but is a responsibility for various sectors linked to water (tourism, agriculture, energy, etc.). As a sector-neutral, broadly applied instrument, SEA can insert IWRM principles beyond water sector boundaries, easier than IWRM does.

In conclusion, there is clear scope to further elaborate the added value of bringing IWRM and SEA together when discussing the implementation of climate change adaptation.

**The authors:**

## 1 The changing Himalayas – Impact of climate change on water resources and livelihoods in the Greater Himalayas


Corresponding author:

- **Mats Eriksson**, International Centre for Integrated Mountain Development (ICIMOD), G.P.O. Box 3226, Khumaltar, Kathmandu, Nepal, Tel: +977 1 5003222, Fax: +977 1 5003299, 5003277, meriksson@icimod.org.

Co-authors:

- **Xu Jianchu**, World Agroforestry Centre, China Programme, #12 Zhongguancun Nan Dajie, CAAS Mailbox 195, Beijing 100081, PR China, Tel: +86-10-82105693, Fax: +86-10-82105694, J.C.Xu@cgiar.org.
- **Arun Bhakta Shrestha**, International Centre for Integrated Mountain Development (ICIMOD). G.P.O. Box 3226, Khumaltar, Kathmandu, Nepal, Tel: +977 1 5003222, Fax: +977 1 5003299, 5003277, abshrestha@icimod.org.
- **Ramesh Ananda Vaidya**, International Centre for Integrated Mountain Development (ICIMOD), G.P.O. Box 3226, Khumaltar, Kathmandu, Nepal, Tel: +977 1 5003222, Fax: +977 1 5003299, 5003277, rvaidya@icimod.org.
- **Santosh Nepal**, International Centre for Integrated Mountain Development (ICIMOD), G.P.O. Box 3226, Khumaltar, Kathmandu, Nepal, Tel: +977 1 5003222, Fax: +977 1 5003299, 5003277, sanepal@icimod.org.
- **Klas Sandström**, Akkadia Consulting AB, Åsögatan 140, SE-116 24 Stockholm, Sweden, Tel: +46 (0)8 7022145, klas.sandstrom@akkadia.se.


## 2 Adapting to climate change in water resources and water services in Caribbean and Pacific small island countries


Lead author:

- **Marc Overmars**, Water Adviser; SOPAC, Pacific Islands Applied Geoscience Commission, Private Mail Bag, GPO, Suva, Fiji Islands, Tel: 679 338 1377, Fax: 679 337 0040, marc@sopac.org, www.pacificwater.org.

Co-author:

- **Sasha Beth Gottlieb**, Technical Coordinator; GEF-IWCAM Project Coordination Unit, c/o Caribbean Environmental Health Institute, The Morne, P.O. Box 1111, Castries, St. Lucia, Tel: 758 452-2501, 452-1412, Fax: 758 453-2721, sgottlieb@cehi.org.lc, www.iwcam.org.


## 3 Better water resources management – Greater resilience today, more effective adaptation tomorrow


Corresponding author:

- **Claudia W. Sadoff**, Member of the Global Water Partnership Technical Committee, Lead Economist, The World Bank, South Asia Region, Address: The World Bank, PO Box 798, Kathmandu, Nepal, Fax: +977-1-422-5112, Csadoff@worldbank.org.

Co-author:

- **Mike Muller**, Member of Global Water Partnership Technical Committee, Visiting Adjunct Professor, School of Public and Development Management, University of the Witwatersrand, P O Box 366, Bruma, Johannesburg 2026, South Africa


## 4 The Water Variable: Producing enough food in a climate insecure world


- **Jacob Burke**, Senior Water Policy Officer, Food and Agriculture Organization (FAO), Land and Water Division, Viale delle Termi Caracalla 1, 00153 Rome, Italy
- **Johan Kuylenstierna**, Adjunct Professor, Stockholm University; Chief Technical Advisor, UN-Water Food and Agriculture Organization (FAO), Land and Water Division, Viale delle Termi Caracalla 100153 Rome, Italy, johan.kuylenstierna@fao.org, fax: +39 06 570 56275

## 5 Adapting to climate change in transboundary water management

- **Jos G. Timmerman**, RWS Centre for Water Management, P.O. Box 17, NL-8200 AA Lelystad, The Netherlands, jos.timmerman@rws.nl.
- **Francesca Bernardini**, Convention on the Protection and Use of Transboundary Watercourses and International Lakes, United Nations Economic Commission for Europe, Palais des Nations, 8–14 Avenue de la Paix, 1211 Geneva 10, Switzerland.

## 6 Local government perspective on adapting water management to climate change

- **Margaret Pageler**, ICLEI – Local Governments for Sustainability, www.margaretpageler.com.

## 7 Water, Energy and Climate Change — A contribution from the business community

- World Business Council for Sustainable Development (WBCSD)

## 8 Climate change and the water industry – practical responses and actions

- **Gertjan Zwolsman**, KWR, Watercycle Research Institute, P.O. Box 1072, 3430 BB, Nieuwegein, The Netherlands, gertjan.zwolsman@kwrwater.nl, fax: +31(0)30 606 11 65.
- **Davy Vanham**, University of Innsbruck, Christoph-Probst-Platz, Innrain 52, A - 6020 Innsbruck, Austria.
- **Paul Fleming**, Seattle Public Utilities, 700 5th Ave. Suite 4900, PO Box 34018, Seattle, WA 98124-4018, USA.
- **Chris Davis**, Institute for Sustainable Futures, University of Technology Sydney, P.O. Box 123, Broadway, NSW 2007, Australia.
- **Adam Lovell**, Water Services Association, Level 11, 91 York St, Sydney, NSW 2000, PO Box A812, Sydney South, NSW 1235, Australia.
- **Daniel Nolasco**, NOLASCO & Assoc. Inc., Congreso 1908 Piso 2 Dpto. D, (C1428BVB) Buenos Aires, Argentina.
- **Olivia Thorne**, University of Cambridge, The Old Schools, Trinity Lane, Cambridge CB2 1TN, UK
- **Renaat de Sutter**, Arcadis, Avenue Louise 500, 1050 Bruxelles, Belgium.
- **Bence Fülöp**, Trinity Enviro Kft., Horváth M. tér 4, 1082 Budapest, Hungary.
- **Philipp Staufer**, RWTH Aachen University, Templergraben 55, 52056 Aachen Germany
- **Åse Johannessen**, International Water Association, Bezuidenhoutseweg 60, P.O. Box 90405, 2509 LK, The Hague, The Netherlands.

## 9 Climate Change Adaptation in the Water Sector: Financial Issues

- **Marloes Bakker**, Co-operative Programme on Water and Climate (CPWC), P.O. Box 82327, 2508 EH Den Haag, The Netherlands, Tel: +31 (0)70 304 37 53, Fax: +31 (0)70 304 37 96, m.bakker@cpwc.nl.

- **Henk van Schaik**, Co-operative Programme on Water and Climate (CPWC), P.O. Box 82327, 2508 EH Den Haag, The Netherlands, Tel: +31 (0)70 304 37 52, Fax: +31 (0)70 304 37 96, h.vanschaik@cpwc.nl.

## 10 Environment as infrastructure: Resilience to climate change impacts on water through investments in nature

- **D. Mark Smith and Stefano Barchiesi**, Water Programme, International Union for Conservation of Nature (IUCN), Rue Mauverney 28, 1196 Gland, Switzerland,mark.smith@iucn.org, stefano.barchiesi@iucn.org.

## 11 Vulnerability of arid and semi-arid regions to climate change – Impacts and adaptive strategies

- The Arab Water Council

## 12 Adaptation to climate change: another challenge in the sustainable development of deltas


- **Herman van der Most**, Deltares, P.O. Box 177, 2600 MA Delft, The Netherlands, herman.vdmost@deltares.nl.

Contributions of:
- **Marcel Marchand**, Deltares
- **Tom Bucx**, Deltares
- **Tjitte Nauta**, Deltares
- **Martijn van Staveren**, Netherlands Water Partnership


## 13 Climate change and WASH services delivery: Is improved WASH governance the key to effective mitigation and adaptation?


- **Charles Batchelor**, IRC, P.O. Box 82327, 2508 EH The Hague, The Netherlands, www.irc.nl.
- **Ton Schouten**, IRC, P.O. Box 82327, 2508 EH The Hague, The Netherlands, www.irc.nl.
- **Stef Smits**, IRC, P.O. Box 82327, 2508 EH The Hague, The Netherlands, www.irc.nl.
- **Patrick Moriarty**, IRC, P.O. Box 82327, 2508 EH The Hague, The Netherlands, www.irc.nl.
- **John Butterworth**, IRC, P.O. Box 82327, 2508 EH The Hague, The Netherlands, www.irc.nl.


## 14 Adapting to climate change in water resources and water services


- **Eugene Z. Stakhiv**, Institute for Water Resources, U.S. Army Corps of Engineers, 7701 Telegraph Road, Alexandria, Virginia 22315-3868.
- **Robert A. Pietrowsky**, Institute for Water Resources, U.S. Army Corps of Engineers, 7701 Telegraph Road, Alexandria, Virginia 22315-3868.


## 15 Integrated Water Resources Management and Strategic Environmental Assessment – Joining forces for Climate Proofing


- **Roel Slootweg**, SevS natural and human environment consultants, Oegstgeest, The Netherlands, sevs@sevs.nl.