

The United Nations World Water Development Report 3 Water in a Changing World

Coordinated by the World Water Assessment Programme, the *United Nations World Water Development Report 3: Water in a Changing World* is a joint effort of the 26 United Nations agencies and entities that make up UN-Water, working in partnership with governments, international organizations, non-governmental organizations and other stakeholders.

The United Nations' flagship report on water, the WWDR offers a comprehensive review of the state of the world's freshwater resources and provides decision-makers with the tools to implement sustainable use of our water. The WWDR3 represents a mechanism for monitoring changes in the resource and its management and tracking progress towards achieving international development targets. Published every three years since 2003, it offers best practices as well as in-depth theoretical analyses to help stimulate ideas and actions for better stewardship in the water sector.

Water in a Changing World has benefitted from the involvement of a Technical Advisory Committee composed of members from academia, research institutions, non-governmental organizations, and public and professional organizations. To strengthen the scientific basis and potential for implementation of its recommendations, interdisciplinary expert groups were also created for a number of topics, including 'Indicators, Monitoring and Databases', 'Business, Trade, Finance and Involvement of the Private Sector', 'Policy Relevance', 'Scenarios', 'Climate Change and Water', 'Legal Issues' and 'Storage'. An accompanying case studies volume, *Facing the Challenges*, examines the state of water resources and national mechanisms for coping with change in 23 countries and numerous small island developing states.



This series of side publications also accompany the WWDR3, providing more focused, in-depth information and scientific background knowledge, and a closer look at some less conventional water sectors. These publications include:

Scientific Side Papers

This series provides scientific information on subjects covered in the WWDR and serves as bridge between the WWDR3's contents and scientific, peer-reviewed publications.

Sector and Topic-Specific 'Insight' Reports

The reports and documents in this series will provide more in-depth information on water-related sectors, issues and topics in a stand-alone manner. Examples of the subjects of this series include Integrated Water Resources Management, transboundary issues and technology, among others.

Dialogue Series

Sectors and topics to which water is cross-cutting or important will be covered in this series of side publications. Some examples of subjects discussed in this collection of reports include climate change, security, biodiversity, poverty alleviation and land use.

Published by the United Nations Educational,
Scientific and Cultural Organization,
7 place de Fontenoy, 75352 Paris
07 SP, France

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ISBN 978-92-3-104114-3

Cover graphics by Peter Grundy,
www.grundini.com

Cover design and typesetting by Pica Publishing,
publish@picapublish.com

Printed by Savas Printing, <http://savasmatic.com.tr>

Printed in Turkey

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Integrated Water Resources Management (IWRM) in Action

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Jointly prepared by DHI Water Policy and UNEP-DHI Centre for Water and Environment

Introduction

This paper sets out to explore some of the practical aspects of the implementation of Integrated Water Resources Management (IWRM). The presentation has the following flow:

1. The relevance of IWRM for a number of key development issues
2. The key characteristics of the concept
3. The global status of IWRM
4. Practical implementation – the challenges
5. Practical implementation – case studies showing successful applications to problematic management scenarios
6. How IWRM programmes are being linked with the Millennium Development Goals (MDGs) and adaptation to climate change by the setting of achievement milestones

1. Linking to key development issues

A number of factors – or drivers – put pressure on water resources and affect the options and requirements for water management. These are mainly socio-economic drivers but they also include less controllable factors such as climate change.

Population growth is a very important driver, creating demands for more water and producing additional wastewater and pollution. It is estimated that the world's population will increase by about three billion people by 2050 – that's an increase of almost 50 per cent. The vast majority of this growth will take place in developing countries, with all the challenges that carries in terms of investment needs for water supply and wastewater treatment. In urban areas, the situation is compounded by the expected continued migration from rural to urban areas, which increases the current level of difficulty in securing and protecting water resources, especially for the urban poor. Also, other migrants (for example environmental refugees, who sometimes move because of water problems) may contribute to an unsustainable pressure on water resources in order to survive in their new destinations, be they urban or rural.

The strong and sustained economic growth in many developing or middle-income countries with large populations (such as Brazil, China and India) has itself contributed to increased pressure on water resources. One of the changes in lifestyle typically associated with increased wealth is an increased

Table 1

Key development issues	Examples of how IWRM links to the key development issue	Examples of the adoption of IWRM as a factor in addressing development issues
Adapting to climate change	Assists appropriate planning of water use, conservation, and the protection of surface-water and ground-water with better resilience and/or larger safety margins	The Intergovernmental Panel on Climate Change (IPCC) emphasizes the goal of achieving 'sustainable' water resources management through IWRM. Land and water governance are seen as important components. The adoption of management measures that are robust to uncertainty is essential. IWRM is useful in this respect because it is based on the concepts of flexibility and adaptability.
Mitigating disaster risks (e.g. floods and droughts)	Assists disaster preparedness	The World Meteorological Organization (WMO) adopted an Integrated Flood Management (IFM) approach within the framework of IWRM and formed the Associate Programme on Flood Management (APFM) in November 2000. The Global Water Partnership helped to establish the APFM and is a close partner.
Securing food production	Assists the efficient production of food crops in irrigated agriculture	The African ministers round-table discussion on sustainable food security was held in parallel with the 32nd United Nations Food and Agriculture Organization (FAO) Conference in December 2003 in Rome. The round-table group agreed that all African countries should improve efficiency in irrigated agriculture for food production by adopting an integrated approach to water management.
Reducing health risks	Reduces health risks in particular through the management of water quality	The UNECE ¹ Water Convention's Protocol on Water and Health came into force in 2007. The protocol requires countries to set health targets and establish measures for improved water management in order to reach targets. Progress towards IWRM has been chosen as an indicator for improved water management.
Sustaining a healthy aquatic environment	Supports the maintenance of environmental flows and ecological reserves	Under its 2007 water policy and strategy, the UNEP ² freshwater programme promotes and assists ecosystem management to be an integral part of national and regional IWRM reform processes. Allocation of minimum flows for ecosystems (environmental flow) is strongly promoted by the IUCN ³ and can be considered as a component of the IWRM framework.
Collaboration in the management of freshwater and coastal water	Advances the management of freshwater and the coastal zone as a continuum	Integrated Coastal Area and River Basin Management (ICARM) links IWRM and coastal zone management. ICARM is endorsed by the Global Environmental Facility (GEF) as a basic concept for the GEF International Waters project portfolio. Similarly, the mainstreaming of coastal zone protective actions in national IWRM processes is a strategy adopted by the member countries of the Global Programme of Action for the Protection of the Marine Environment (GPA).
Ensuring sustainable water infrastructure	Assists in giving a cross-sectoral view of water development and a multipurpose infrastructure	Lack of appropriate and integrated water resources management development plans can be very costly when it comes to investments in infrastructure. Adequate cross-sectoral co-ordination, a sound scientific knowledge base, capacity assessment, water allocation mechanisms, environmental regulations, etc. are key to preventing investment failures or sub-optimal economic and financial cost recovery. This is acknowledged by the World Commission on Dams which provides twenty-six guiding principles. A subset of these principles reflects key areas of the IWRM concept. Moreover, the Bank-Netherlands Water Partnership Program (BNWPP) aims at supporting countries in IWRM prior to or in parallel with larger hydraulic infrastructural development.
Collaboration in the management of land and water	Advances the management of land and water by considering their mutual impacts	The Mekong River Commission (MRC) emphasizes the co-ordinated management of land and water through their adopted IWRM Strategy. This strategy is currently being followed-up through the Basin Development Plan (BDP 2) prepared collaboratively by Laos, Cambodia, Viet Nam and Thailand – where water and land are of key strategic importance for the economy.
Planning transboundary collaboration	Assists water management with the catchment as the management unit, irrespective of whether it is within national boundaries or shared between two or more countries	Heads of state and government in the Region of the Economic Community of West African States (ECOWAS) adopted the West African Regional Action Plan for IWRM. This plan endorses IWRM as a framework for the management of the region's water resources including, among others, the transboundary Niger, Volta and Senegal rivers. The adoption took place in Bamako, Mali in December 2000.
Managing the water-energy relationship	Addresses the link between water and energy	Along with the vast quantities of water that are abstracted and consumed during energy production, the massive amounts of electricity required for the conveyance, treatment and application of water in various circumstances is an issue of growing concern. This is particularly true in situations where there is growing competition for limited water resources and/or climatic changes are altering the timing and availability of water. While this is a comparatively new topic on the global agenda, it is already recognized that IWRM offers ways of making balanced management decisions.

1 UNECE – The United Nations Economic Commission for Europe

2 UNEP – The United Nations Environment Programme

3 IUCN – International Union for Conservation of Nature

demand for meat, which has a much larger virtual water content¹ than vegetarian food. The general trend towards consumerism that's associated with increased wealth is likely to lead to a larger water footprint per capita because of the virtual water content of most commodities.

Another economic driver, the globalization of trading goods and services, provides opportunities but also adds to the pressure on water resources. Water-stressed countries can reduce their stress by importing water-intensive goods and services, but very often, this issue is not addressed. The relocation of production and employment to cheaper areas is often driven solely by economic considerations. But it shifts the issues of increased water consumption and water pollution to more vulnerable areas that may be eager to satisfy demands for jobs and economic development. Such shifts often take place without proper consideration for water resources issues.

As indicated, many development issues are dependent on water resources. This applies, in particular to the way in which water resources are managed. In addition to the links mentioned above, water management, in its many different dimensions, is also crucial for the achievement of the Millennium Development Goals (MDGs). (For more detail on this, see Annex 2).

Water management that follows the principles of IWRM has been recognized and adopted by key players in a very wide cross-section of sectors. IWRM has for instance been adopted for its importance in relation to the efficient production of food crops in irrigated agriculture, for its assistance in reducing water-related health risks, and its important role in reducing the risks of floods and droughts.

Table 1 gives prominent examples of how IWRM links to key development issues and assists in addressing them. Examples are also given of institutions and agencies that have adopted the IWRM approach to addressing water issues. Using common sense and clear language

2. Using common sense and clear language

IWRM is an empirical concept which was built up from the on-the-ground experience of practitioners. Although many parts of the concept have been around for several decades – in fact since the first global water conference in Mar del Plata in 1977 – it was not until after Agenda 21 and the World Summit on Sustainable Development (WSSD) in 1992 in Rio that the concept was made the object of extensive discussions as to what it means in practice. The concept has been adopted widely by water managers, decision-makers and politicians around the world.

1 Virtual water refers to the total volume of freshwater that is used to produce a particular good or service. Similarly, the water footprint of an individual, business or nation is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual, business or nation.

The emergence of the concept is one of the results of a search for a new water management paradigm. Faced with increasing water scarcity, pollution, climate change, and fractioned and isolated sectoral water management practices, the water community contributed useful principles and noted which links they saw as essential for more efficient and sustainable water resources management. These links and principles were placed in a societal framework together with the goals of economic efficiency, social equity and the sustainability of ecosystems. In preparation for the Rio Summit, the four Dublin Principles were agreed upon by nearly 500 government-designated experts from 100 countries who assembled at the International Conference on Water and the Environment in Dublin in January 1992.

Box 1 Key principles in IWRM – The Dublin Principles

- Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment
- Water development and management should be based on a participatory approach involving users, planners and policy makers at all levels
- Women play a central part in the provision, management and safeguarding of water
- Water has an economic value in all its competing uses and should be recognized as an economic good

The International Conference on Water and the Environment, January 1992, Dublin

Later the same year, these principles helped to inspire Chapter 18 of Agenda 21, which was agreed at government level. For decision-makers and practitioners alike, these principles have provided a simple, understandable and very useful guidance for water resources management and development over the last 17 years. The Global Water Partnership's² definition of IWRM is widely accepted and is also used for the purposes of this presentation. It states:

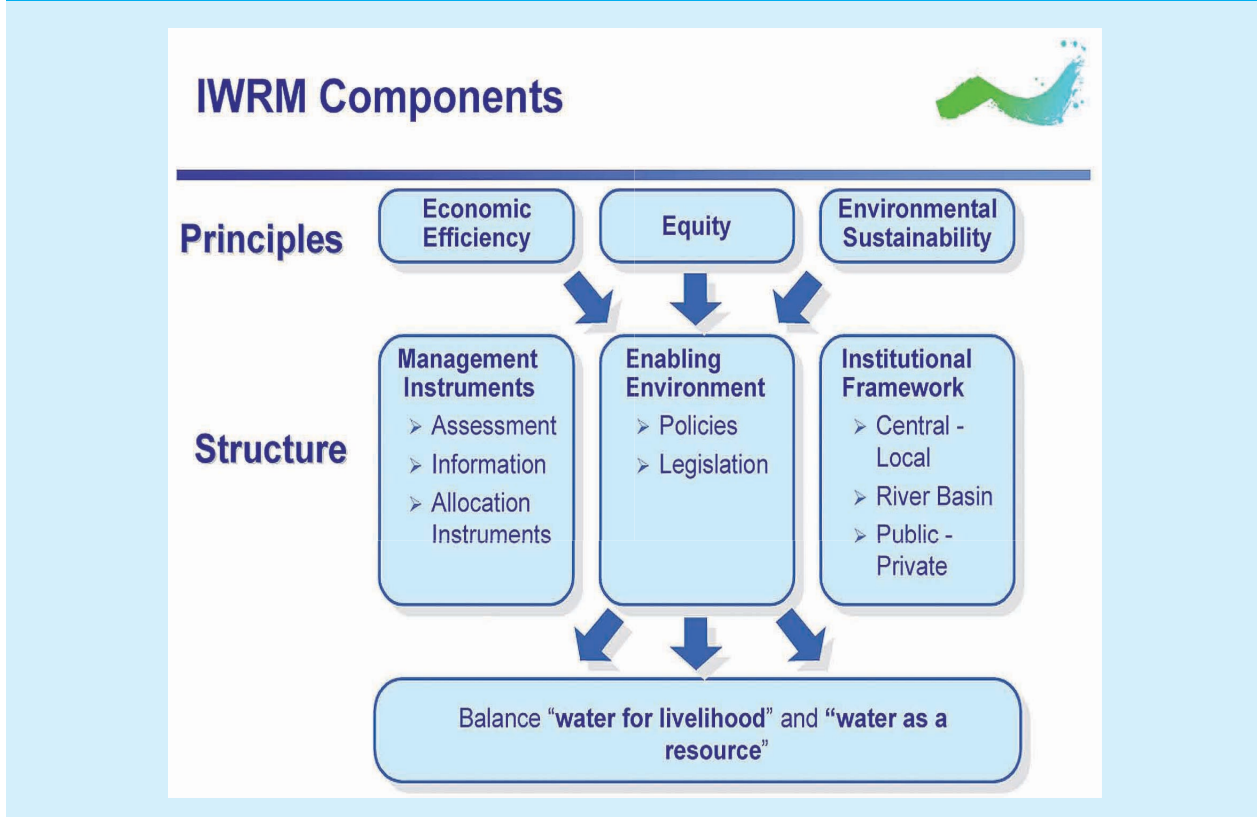
'IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.'

Implementing an IWRM process is a question of getting the 'three pillars' right (see Figure 1):

1. moving towards an enabling environment of appropriate policies, strategies and legislation

2 The Global Water Partnership (GWP) was founded in 1996 with reference to these principles, and has since developed mechanisms for sharing good practices via a global network of organizations in currently fourteen sub-regions and seventy countries that are committed to sustainable water resources management via IWRM.

Figure 1 The three pillars of IWRM: an enabling environment, an institutional framework and management instruments



for sustainable water resources development and management

2. putting in place the institutional framework through which the policies, strategies and legislation can be implemented
3. setting up the management instruments required by these institutions to do their job

IWRM is thus not a scientific theory that needs to be proved or disproved by scholars. Rather it is a set of common-sense suggestions as to what makes up important management aspects. IWRM has proved to be a flexible approach to water management that can adapt to diverse local and national contexts. It requires policy-makers to make judgments about which set of suggestions, reform measures, management tools, and institutional arrangements are most appropriate in a particular cultural, social, political, economic or environmental context.

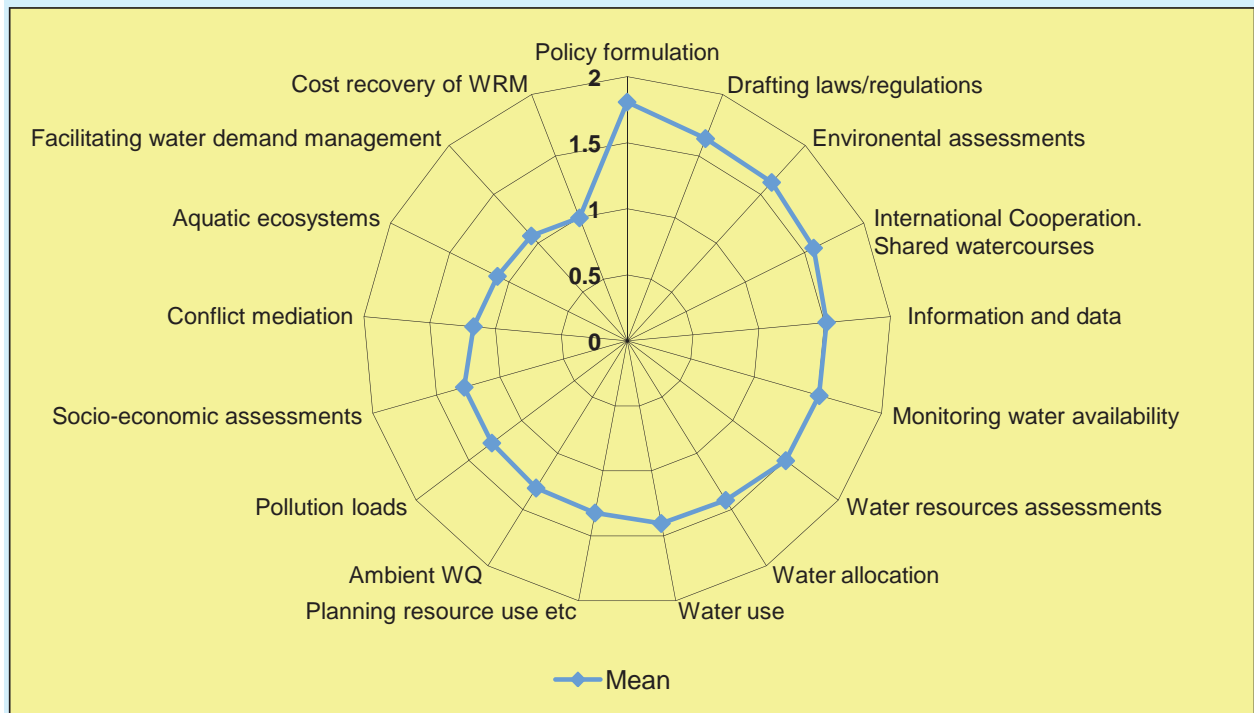
One of the great strengths of IWRM is that it has given the water community a common language that's applicable over a wide range of levels from the local to the national and regional. This allows knowledge and lessons-learned to be exchanged across borders, across regions and at a local level, and makes it possible for decision-makers and managers to agree on and monitor policies and targets for the improvement of water resources management.

3. Changing ways of thinking

IWRM processes are now established or being established in many parts of the world. At the 4th World Water Forum in Mexico (2006), it was reported that out of ninety-five countries examined, 74 per cent either had IWRM strategies in place or had initiated a process for the formulation of such strategies. The table in Annex 1 gives a non-exhaustive list of forty-two countries that have adopted and explicitly used the term IWRM in their official documents dealing with water resources management. While it is obvious that the existence of such documents alone is not proof that IWRM is working in these countries, it is indisputable that such documents are essential for helping to create and support an enabling environment for water reforms.

An attempt to establish a more detailed picture of the extent to which IWRM has been adopted by government institutions was made by the United Nations Environment Programme Collaborating Centre for Water and Environment (UCC-Water) through a survey completed in 2007 with the support of the UNEP IWRM 2005 Programme. The survey covered fifty-eight countries in Africa, Central Asia, South-East Asia, Latin America and the Caribbean. The respondents were typically senior government officials. One of the indicators used was the institutional capacity for maintaining

Figure 2 The institutional capacity for carrying out various IWRM-inspired functions



The ratings that the respondents were asked to give were: 0 = function not established, 1 = function has many gaps in quality and coverage, 2 = function has some gaps in quality and coverage, 3 = function operates at realistic goal levels.

various functions basic to IWRM, for instance policy formulation, water allocation and water demand management. The result is shown in Figure 2.

From the figure it appears that countries have the best-developed capacities – highest scores – in terms of the formulation of policies, the drafting of laws and co-operation on shared watercourses. Recovery of for the cost of water resources management and the capacity for water demand management were among the areas that scored lowest.

The results of the survey showed an expected pattern. From experience it is known that countries and governments that start from scratch to reform their water sector, focus on the preparation of policies, laws and regulations (the enabling environment) first. New policies and laws pave the way for new institutions, set institutional roles, and develop the capacities for taking on these roles. With institutions in place, the new management instruments and capabilities needed to perform IWRM can be developed.

Another important indicator of progress towards IWRM is the number of countries that have water laws that include certain characteristic IWRM principles. For the same fifty-eight countries, the results are shown in Figure 3, overleaf.

Figure 3 shows some interesting results. The highest scoring indicator is ‘participation of stakeholders’ – the second Dublin principle. The second-most

frequent principle is ‘user pays,’ while ‘river basin management’ comes in third. These results, as well as other survey results, illustrate that many countries acknowledge the usefulness of IWRM principles and associated management approaches as guidelines in the advancement of their water resources management.

Since 2002, the UN organizations dealing with water (UN-Water) have co-ordinated and monitored the global progress towards IWRM and Water Efficiency Plans³. At the CSD-16 in 2008, UN-Water reported on the latest status of IWRM planning work⁴.

5. Monitoring progress

The previous sections show that monitoring the level of adoption and use of IWRM is a challenge in itself. Many methodological issues emerge along with issues of definitions of indicators. But

3 Article 26 of the Plan of Implementation adopted at the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002 called for countries to develop Integrated Water Resources Management and Water Efficiency Plans by 2005.

4 UN-Water (2008). *Status Report on Integrated Water Resources Management and Water Efficiency Plans*. Prepared for the 16th session of the Commission on Sustainable Development (CSD) in May 2008. This status reporting is based on surveys made by the United Nations Department of Economic and Social Affairs (UN-DESA) in 2007, by UCC-Water itself also in 2007, by the Global Water Partnership (GWP) in 2006, and by the African Development Bank (AfDB) in 2007.

monitoring is necessary for measuring progress and making sure that a process stays on track. A possible framework is shown below and further explanations are given in Annex 3.

6. Challenges in the practical application

When applied, the concept of IWRM has many challenges. Some of these challenges relate to integration and the extent to which integration can be achieved, because water resources are used by many sectors and many institutions are engaged in water management. Ideally, all aspects should be considered and integrated – or at least harmonized. In order to arrive at that situation, co-ordination is one of the first steps that must be taken. However, needs, funding, resources, human capacity, institutional barriers and many other factors are attributes of the real world as opposed to a theoretical management universe. These factors set the operational limits and determine how far integration can be taken. The decision-maker/manager has to decide on priorities and make sure that the important aspects are included in any assessment, management plan or water resources development process.

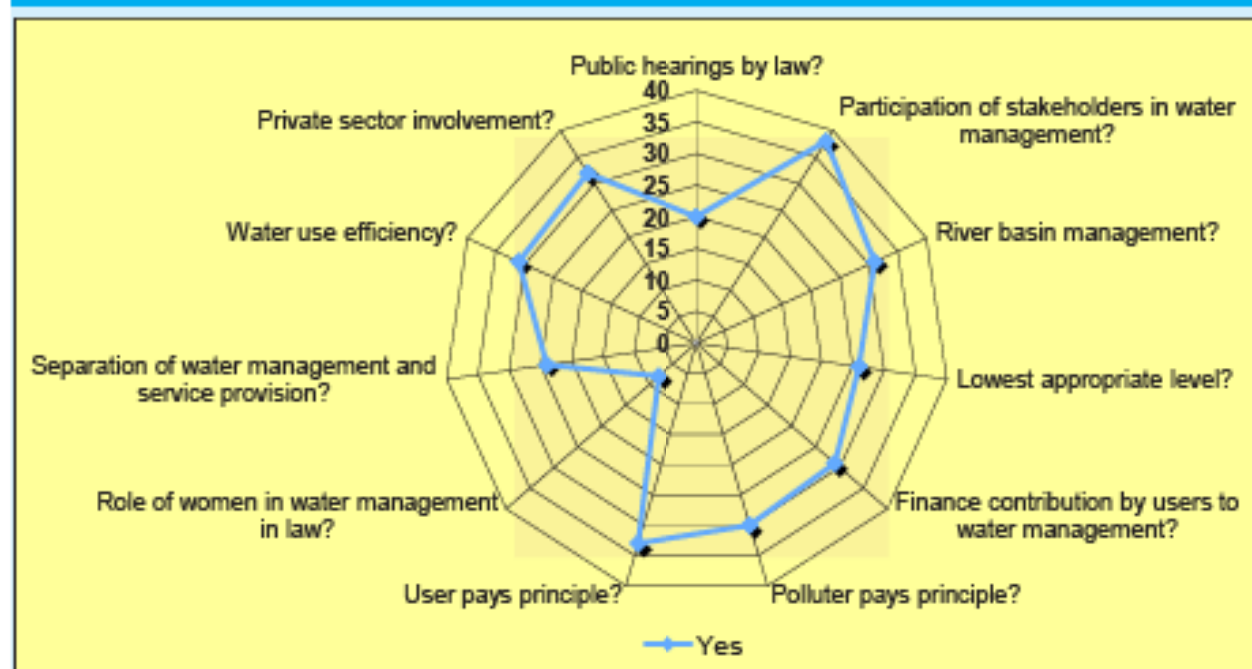
Aspects of particular importance would be upstream-downstream issues. Good examples here are the Colorado River and the Rio Grande where, because of drainage from agricultural land, salinity has increased almost tenfold in recent years and

production losses run to billions of US dollars, not taking into account the decline in ecosystem functions. Other examples are the Syr Darya and Amu Darya river basins in Central Asia, where there is competition for water from large-scale cotton growing, farming, and domestic use in downstream areas and power generation in upstream areas. Water management decisions in the basins are not always dictated by IWRM principles, as is demonstrated by the decline of the Aral Sea and its ecological status at the downstream end of the basins.

Co-operation across international boundaries is another important aspect of IWRM. This is exemplified by the Mekong River Commission, through which the four Lower Mekong riparian countries – Laos, Cambodia, Viet Nam and Thailand – strive to co-ordinate the development of the basin. An IWRM strategy is to guide in the preparation of a basin development plan.

From a water entry point it would be desirable if sectors such as land, energy and agriculture were open, flexible and willing to be integrated in the way that suits the water sector best. But water does not rule the world and integration works both ways. The water sector needs to consider the requirements and priorities of other sectors too, i.e. water needs to be mainstreamed in the national economy. Water resources management is performed by many interested parties with different objectives and long histories – parties who do not change their habits overnight.

Figure 3 An illustration of the inclusion of IWRM principles in respondents' water laws



The scale shows the number of water laws where the item has been included.

7. Implementation takes time and trade-offs are required

Like any other reform, IWRM is a process that could take several decades before it reaches the point where water resources management is taking place according to the most important principles. In France, the process was started with the establishment of basin agencies in 1968. Other important milestones were a revised water law in 1992, which was brought in line with the EU's Water Framework Directive in 2003. In Spain, the maturing of the process has lasted close to eighty years. The monitoring of progress towards IWRM in developing countries that have a weak institutional capacity for change shows a rather slow progress towards IWRM, as would be expected. There are many other factors limiting the speed of the process in developing countries. In these countries, the water sector is predominantly informal, especially in the rural areas where it is based to a large degree on self-supply and local, informal water institutions. Regulatory influence is minimal and laws, prices and policies often fail to function. In contrast, the water sector in developed countries is more formalized and to a large degree the behaviour of the sector is under direct regulatory influence. The chance of success for IWRM at the national level goes hand-in-hand with the development of national governance structures and an approach towards a more formal water sector. At the local level, IWRM principles still guide water resources management but initiatives and actions are taken by the communities of their own accord. The IWRM process takes a long time, but that does not mean that its principles and goals do not need to be pursued in a world of increasing scarcity and competition for water.

Likewise, the implementation of IWRM requires tough trade-offs between sometimes conflicting objectives. Changing a water law typically involves changing an indirect power balance in relation to water between different interest groups. Changing water allocations in order to achieve a better overall societal use of water will, typically, yield both winners and losers – some users will get more and others will get less. In some countries, for example the large 'irrigation countries' of Asia, large water users are influential but represent an inefficient use of water. In such cases, the implementation of IWRM may require delicate, time-consuming and difficult negotiations and trade-offs, as well as a change of mindset for farmers.

8. Top-down and bottom-up processes go hand in hand

The level of centralized influence on the management of a water resource has shown to some degree to be dictated by how scarce it is, either as a result of lack of water itself or as a result of poor water quality. If you have a resource that is of good quality and is plentiful in terms of the demands made on it, it may seem not to matter how you deal

Box 2 A framework for the development of indicators for monitoring IWRM

A framework for the development of indicators for monitoring the IWRM process and its outcomes can be structured at four different levels, or orders, with each order measuring progress at the various stages of the IWRM planning cycle:

- **1st order:** Measuring to what extent the basic conditions for IWRM have been established ('the paperwork has been done')
- **2nd order:** Measuring to what extent IWRM reform processes have taken effect ('institutions and stakeholders have changed water management behaviour')
- **3rd order:** Measuring to what extent key water issues have been addressed ('changes have taken place in nature and society')
- **4th order:** Measuring the sustainability of economic, environmental and equitable uses of water ('changes and developmental effects are sustainable')

Modified after Stephen B. Olsen¹

1 Olsen, Stephen B. 2003. Framework and indicators for assessing progress in coastal management initiatives. *Ocean and Coastal Management*, Vol.46, Amsterdam, Elsevier Science, pp 47–361

with it. In economic terms, you could say that it has little or no value. As scarcity sets in, competition increases and the resource will increase in value. Society needs to regulate the use of the resource and make sure that water is not wasted on low-value uses, but is used in the most beneficial way. Until that happens, local initiatives and local ownership are essential in the majority of cases where water demands are relatively small. Large-scale use will continue to be regulated centrally.

Regardless of the degree to which water resources management is centralized, involving water users and interest groups remains important for the commitment to and outcome of IWRM. For cross-sectoral and multi-stakeholder dialogues at national, basin, and local level, it is important to have active NGOs or other civil society organizations through which dialogues can take place. This is important for overall water management results and many governments encourage and support such dialogues as part of establishing an appropriate enabling environment for IWRM.

As the progression above alludes, bottom-up water resources management processes can thrive in situations where there is an abundant supply of water to meet demand. When the squeeze is on, however, IWRM – with its consolidation of an enabling environment and institutional roles – will have to be applied. The institutional roles will describe the

sharing of authority and responsibility between local levels, basin levels and a centralized level.

In 2000, South Africa had come to a stage in water scarcity (and inequality in access) where water reallocation became necessary. The response was a compulsory licensing process initiated on the basis of the National Water Act of 1998. Existing water rights were revoked and had to be applied for again if needed. Water licences were made time-bound and at the same time, the links between land ownership and water licences were severed.

9. The practical application of IWRM principles as examples of good practices

Whatever the rhetoric that surrounds it, IWRM should be judged by its usefulness. The following cases all serve to demonstrate the benefits accruing on the ground when actions are inspired and guided by IWRM thinking and principles. Whether or not IWRM has brought about changes that would have appeared anyway as a result of the co-operation of dynamic professionals and politicians with vision and common sense will never be known. A comparison of the 'with IWRM' and 'without IWRM' situation can, at best, be speculative. The very least that IWRM does, is to remind the practitioner about a number of good – and generally accepted – principles, that assist with taking on water-sector reforms, and give common mechanisms for exchange on best practices for specific management solutions.

Malaysia: local level IWRM actions made winners of both lakeside communities and the environment

There was a conflict of needs between two sectors using the water bodies in Kelana Jaya Municipal Park in Malaysia. The two sectors were urban wastewater (including stormwater and solid waste) and the environment (including wetlands, flora and fauna). The sectors had not been considered in an integrated manner so stakeholders were losing opportunities and risking health. They eventually got together with local authorities to identify remedial IWRM actions. From these actions, improvements were made in water quality, fisheries and health. Both lakeside communities and the environment came out as winners when the conflicts were resolved. See also Annex 4.

USA: a conflict between pollution in a source watershed and the water supply for New York City was resolved in a partnership at state level resulting in huge economic benefits

This case is from the USA and relates to a conflict between the polluting activities of a watershed and an urban water supply. New York City's water supply (nine million consumers) from the source watershed was experiencing a deterioration in quality. The city was faced with a choice of investing \$6

Box 3 Management issues at increasing levels of water scarcity – the turn of the water screw

When dealing with water, the crucial scarcity may not be the scarcity of the natural resource itself, but rather the scarcity of the social resources needed to adapt to water scarcity. The significance of this message is made clear by considering how water managers can deal with increasing scarcity over time.

- At the first turn of the water screw, the remedy is to get more water. This goal is predominantly accomplished by water storage and transfer.
- At the second turn of the water screw, the effort is redirected towards efficiency measures, predominantly end-use efficiency. The goal here is to get more benefit per drop.
- The last turn of the water screw is the reallocation of water rights. This requires profound changes in national policies because achieving allocation efficiency could mean the withdrawal of water rights from irrigation schemes that generate a low-value-per-unit of water. The food needed by growing populations will then need to be imported and paid for by the industry and services sector. This will require large-scale social restructuring, which risks tension and conflict within countries and between sectors and population groups with different stakes in the new socio-economic environment.

Source: Snellen & Schrevel

billion in new filtration and treatment facilities or a \$1.6 billion clean-up of the causes of the pollution. In partnership mode, the water supply company assisted the upstream farmers to implement good farming practices, bought land for protection, and rehabilitated existing wastewater treatment plants. As a result of the water quality improvements, the city avoided the need for costly filtration methods, the population of the watersheds enjoys an improved environment and the city made a total saving of \$4.4 billion. See also Annex 4.

China: IWRM actions at provincial level substantially improved the aquatic environment and the water-use efficiency in an area with over forty million inhabitants

A provincial-level IWRM process took place in Liaoning Province in China. Untreated industrial and urban wastewater was polluting the streams to a level where they were no longer supporting the river's ecological processes. As part of a new institutional framework, the EU-Liaoning Water Resource Planning Project Office was established. This office had the responsibility of developing and implementing an IWRM plan. Pollution loads were reduced by 60 per cent and the quality of the water in the river improved considerably. Deforestation practices were halted, drinking water within the basin was safeguarded, and

ecosystems along several river stretches were restored. See also Annex 4.

Mexico: national level irrigation reforms were taken following IWRM principles, decision-making and responsibilities were decentralized, and efficiency was greatly increased.

Reforms were driven by external governance factors including membership of the North American Free Trade agreement (NAFTA), which forces efficiency improvements in irrigated agriculture in order to facilitate competition with US and Canadian agro-products. This coincided with a period of rapid economic and social change in Mexico and major political upheaval in the traditional governing party. To date, the outcome of decentralizing responsibilities (water-user organizations) has been positive with water fees paid by users up from 18 per cent of operations and maintenance costs (in 1988) to 80 per cent today. Water distribution efficiency rose from 8 per cent to 65 per cent and there has been a general reduction in operations and maintenance costs because of better use of equipment and a reduction in personnel of more than 50 per cent. See also Annex 4.

Chile: a continuous interaction between growth strategies and water issues

Over the last 20 years, Chile has successfully incorporated water issues into its strategies for sustainable growth – offering valuable lessons to all policy-makers involved in national development planning, not just those responsible for water. In Chile, water has been a key ingredient in fuelling exports and economic growth, and the country's decision-makers have also made provisions that protect the environment and provide affordable water for the poor. Through implementation of IWRM principles, water has successfully been applied as a strategic input to the national economy and transferred from low-value to high-value uses. As a result, Chile provides an example of progress towards the three E's of IWRM: 'economic efficiency,' 'social equity' and 'environmental sustainability.' See also Annex 4.

The Fergana Valley: IWRM actions at international level in Central Asia improved water accessibility and irrigation efficiency.

The Fergana Valley was once the most fertile valley in Central Asia. With a population of approximately ten million, it is now subject to high soil salinization and its crops are no longer sufficient to feed its population. State boundaries between Uzbekistan, Kyrgistan and Tajikistan make transboundary management problematic. IWRM principles emphasizing capacity building, higher efficiency and equity were applied in a partnership mode. Bottom-up IWRM approaches increased yields and water productivity by up to 30 per cent. See also Annex 4.

10. IWRM roadmapping towards the MDGs and beyond

As outlined in this paper, the principles of IWRM have been widely adopted by countries and concrete examples of how they can be applied in practical water management have been demonstrated in many places. However, if the water resources management reforms are to support the achievement of the MDGs and adaptation to climate change, the implementation of water policy changes must be linked to efforts to achieve the MDGs and proceed at a pace that's in-keeping with the MDGs' 2015 deadline. It has, therefore, been suggested that national IWRM plans and strategies should have associated programmes of implementation with timeframes and milestones, i.e. a 'roadmap.'

Based on the Copenhagen Initiative on Water and Development⁵, UN-Water, in conjunction with the Global Water Partnership launched the initiative, 'Roadmapping for Advancing Integrated Water Resources Management (IWRM) Processes' at CSD 16 in March 2008.

The initiative recommends that nationally-owned roadmaps for improving water management through IWRM could include a set of milestones to help countries translate their IWRM plans into specific actions and interventions on the ground, as well as to monitor the impact of actions taken or interventions made. Such roadmaps could be developed around outcomes to be achieved by implementing water policy changes aimed at the achievement of the MDGs and the adaptation to climate change.

It is recognized that countries are at different stages of their water development and that management and for institutional and policy changes to be effective, some countries will need substantial capacity building and time. The timeline of individual national processes will, therefore, vary widely according to existing plans and points of departure. Moreover, the details in planning and implementation must reflect local water issues and management conditions.

Thus, it is envisaged that each country would make its interpretation and design its own roadmap for improving water management. In doing so, countries are likely to monitor their plans to implement IWRM and the MDG-related water resource management priorities that they have identified by keeping a watching brief on three key inter-related processes:

- the extent to which key enabling conditions for the implementation of these priorities have been addressed

⁵ The Copenhagen Initiative is an outcome of the International Conference on Managing Water Resources Towards 2015, which was hosted by the Danish Government in co-operation with UN-Water and the Global Water Partnership and held in Copenhagen on 13 April 2007. The Conference Summary can be found at www.ucc-water.org

- the progress of specific IWRM change processes
- the extent to which improved water management through IWRM has successfully contributed to the achievement of the MDGs

In this way, the roadmaps would also serve as monitoring instruments, inspiration and guidance for countries and development partners striving to improve water resources management for development. On the assumption that water management policy changes should be directly related to the milestones for the achievement of the MDGs, roadmaps could have MDG-linked indicators that could be monitored every three years – 2009, 2012 and 2015.

In addition to the need for each country to develop its unique implementation plan or roadmap, it is emphasized that regular reporting and discussion at regional and global levels can play an important role in encouraging and supporting such processes and addressing the barriers to progress. In 2008, country reports to the Commission on Sustainable Development (CSD) focused on progress in establishing plans to implement IWRM and in addressing their identified MDG-related water resource management priorities. Beyond 2008, countries are

encouraged to monitor on a continuing basis and in an integrated (process and outcome) way, on all three key inter-related processes outlined above.

To facilitate meaningful discussion and comparison, the initiative recommends that such monitoring may be carried out within a structured framework under which, every three years, a specific set of indicators or theme is chosen. The themes suggested by UN-Water and GWP are:

- 2009: Focus principally on reviewing the extent to which key enabling conditions for the implementation of national IWRM priorities have been addressed. Note progress on specific IWRM change processes and the realization of the water-related MDGs
- 2012: Focus principally on reviewing the progress of specific IWRM change processes. Note progress on enabling conditions and the realization of the water-related MDGs
- 2015: Focus principally on assessing the extent to which improving water management through IWRM has successfully contributed to the implementation of the MDGs. Note progress on enabling conditions and on specific IWRM change processes

Annex 1: Examples of countries that have adopted IWRM as a key concept

Roadmaps, strategies, policies, laws, plans, etc. with explicit reference to IWRM

The table below provides examples of forty countries that have found IWRM a useful framework for the management of water resources and have included it as a pivotal concept. In these countries, the concept has been included in key government documents that guide and regulate the use, conservation and protection of a nation's water resources and IWRM is being implemented at local level. The table is not exhaustive.

Country	Evidence of the continued adoption and explicit use of IWRM
Algeria	National Plan for Water – Ministry of Water Resources (2003) National Water Law – Government of Algeria (2005) Action Plan for the implementation of an IWRM Framework – Ministry of Water Resources (draft 2006–2007)
Angola	IWRM and Water Efficiency Roadmap – Ministry of Water and Energy (draft 2007)
Argentina	IWRM Roadmap – Sub-secretariat of Water Resources (2007)
Armenia	Water Code – Government of Armenia (2002) National Water Policy – Government of Armenia (2005) National Water Programme – Government of Armenia (draft 2007)
Botswana	IWRM Strategy and Action Plan – Ministry of Minerals, Energy and Water Resources (2006)
Brazil	National Water Policy (Law No. 9433) – Government of Brazil (1997) National Water Resources Plan – Ministry of Environment (SRH/MMA), National Water Council (CNRH) and National Water Agency (ANA) (2007)
Burkina Faso	Decree No. 2003–220: Action Plan for IWRM in Burkina Faso (PAGIRE) – Ministry of Agriculture, Hydraulics and Fishing Resources (2003) Burkina Faso Water Vision - Ministry of Agriculture, Hydraulics and Fishing Resources (2000) Water Law No.002-2001 – Government of Burkina Faso (2001)
Cambodia	Integrated Water Resources Management (IWRM 2005) and Roadmaps in Cambodia – Department of Water Resources Management and Conservation (2006) Water Law – Royal Government of Cambodia (Sept 2006)
China	China Water Law – Government of China 2002
Colombia	National Development Plan 2006–2010 – National Planning Department (2006)
Costa Rica	National Strategy for Integrated Water Resources Management – Government of Costa Rica (2006) National IWRM Action Plan – Government of Costa Rica (2006) National Water Law (No. 14585) – Government of Costa Rica (draft 2006)
Ivory Coast	IWRM Roadmap 2007-2015 – Ministry of Environment, Water and Forestry (2007)
Egypt	National Water Resources Plan – Ministry of Water Resources and Irrigation (2004)
Eritrea	Integrated Water Resources Management and Water Efficiency Plan (IWRM/WE) – Ministry of Land Water and Environment (draft 2007)
Ghana	IWRM Component Support programme (2004–008) – Water Resources Commission (2004) Water Resources Policy – Water Resources Commission (draft 2007)
Grenada	Simultaneous preparation of IWRM Roadmap and National Water Policy – Water Policy Steering Committee (April 2007)
Honduras	IWRM Action Plan – Honduran Water Platform (2006)
Indonesia	National Water Law No.7/2004 – Government of Indonesia (2004) IWRM Roadmap – Directorate General Water Resources of Ministry of Public Works (2006)
India	National IWRM Committee – Government of India 1999 National Water Policy – Government of India 2002
Kazakhstan	IWRM National Roadmap including proposed project outlines – speed-up of the IWRM 2005 objectives implementation in Central Asia – Government of Kazakhstan (2006)
Kenya	Water Act 2002 – Government of Kenya (2002) National Water Policy on Water Resources Management and Development (Sessional Paper No.1 of 1999) – Ministry of Water and Irrigation Integrated Water Resources Management and Water Efficiency Plan for Kenya – Ministry of Water and Irrigation (draft 2007)
Kyrgyzstan	IWRM National Roadmap including proposed project outlines – speed-up of the IWRM 2005 objectives implementation in Central Asia – Government of Kyrgyzstan (2006)
Lao PDR	Policy on Water and Water Resources – Government of Lao PDR (draft 2000) The Law on Water and Water Resources – Government of Lao PDR (1996) IWRM National Roadmap – Water Resources Co-ordination Committee Secretariat (2006)

Annex 1: (cont)

Country	Evidence of the continued adoption and explicit use of IWRM
Lesotho	Roadmap to completing integrated water resources management and water efficiency planning in Lesotho – Ministry of Natural Resources, Water Commission (April 2007)
Liberia	Liberia IWRM Roadmap – Ministry of Lands, Mines and Energy (draft 2007) National Water Policy – Ministry of Lands, Mines and Energy (draft 2007)
Malawi	National Water Policy – Ministry of Irrigation and Water Development (2005) Water Resources Act No. 15 of 1969 with later amendments. Government of Malawi Integrated Water Resources Management/Water Efficiency (IWRM/WE) Plan for Malawi – Ministry of Irrigation and Water Development (draft 2007)
Malaysia	9th Malaysia Plan – Economic Planning Unit – Prime Minister’s Department (2006) National Study for the Effective Implementation of IWRM in Malaysia – Ministry of Natural Resources and Environment (2006) Our Vision for Water in the 21st Century – Ministry of Natural Resources and Environment (2000)
Mauritania	IWRM Action Plan – National Council for Water (2007) National Development Policy for Water & Energy – Ministries of Water, Energy and Environment (1998) National Water Act (Article 3) – Government of Mauritania (2005)
Morocco	Master Plans of Integrated Water Resources Development for River Basins – Ministry of Land, Water and Environment (2001) National Water Plan – Ministry of Land, Water and Environment (2006) Decree no 2–05–1594 – Development and Revision of Master Plans and National Plans for Integrated Water Resources Management – Government of Morocco
Mozambique	National Water Resource Strategy – Department of Water Affairs and Forestry (2004) IWRM Plan – National Directorate of Water Affairs (draft 2007)
Namibia	National Water Policy White Paper – Government of Namibia (2000) Water Resources Management Act – Government of Namibia (2004) Integrated Water Resources Management Strategy and Action Plan – Ministry of Agriculture, Water and Rural Development (2006)
Nicaragua	General Law on National Waters – Government of Nicaragua (2007) Environmental Action Plan – Ministry of Environment (1994) IWRM Action Plan – Ministry of Environment (1996)
Philippines	Medium Term Philippine Development Plan (2004-2010) – Government of Philippines (2004) Clean Water Act – Government of Philippines (2004) Integrated Water Resources Management (IWRM) Plan Framework – National Water Resources Board (2007)
Swaziland	Water Policy – Ministry of Natural Resources and Energy (draft 2007) IWRM and Water Efficiency Plan – Water Resources Branch (draft 2007) Water Act (2003) – Government of Swaziland
Tajikistan	IWRM National Roadmap Including Proposed Project Outlines: Speed-up of the IWRM 2005 Objectives Implementation in Central Asia – Government of Tajikistan (2006)
Tanzania	National Water Sector Development Programme 2006–2025 – Ministry of Water (2006) IWRM Strategy and Action Plan – Ministry of Water (2004) National Water Policy – Ministry of Water (2002) National Water Law based on revised Water Act No. 42 of 1974 – Government of Tanzania (draft 2007)
Thailand	National Water Law/Code – Government. of Thailand (draft 2007) National Water Policy – Ministry of Natural Resources and Environment (2000) IWRM National Roadmap – Department of Water Resources (2007)
Togo	National Water Policy – Directorate of Water and Sewerage (draft 2007) National Water Law – Directorate of Water and Sewerage (draft 2007) IWRM Roadmap – Directorate of Water and Sewerage (draft 2007)
Turkmenistan	IWRM National Roadmap including proposed project outlines – speed-up of the IWRM 2005 objectives implementation in Central Asia – Government of Turkmenistan (2006)
Uganda	A National Water Policy – Ministry of Water, Lands and Environment (1999) National Water Action Plan – Water Resources Management Department (1994) Water Resources Management Reform Strategy – Water Resources Management Department (2005) National Water Quality Management Strategy – Ministry of Water and Environment (2006)
Uzbekistan	IWRM National Roadmap Including Proposed Project Outlines – speed-up of the IWRM 2005 objectives implementation in Central Asia – Government of Uzbekistan (2006)
Zambia	IWRM and Water Efficiency Plan – Ministry of Energy and Water Development (2006) The Revised National Water Policy – Ministry of Energy and Water Development (2007) Water Resources Management Bill – Ministry of Energy and Water Development (draft 2007) National Development Plan – Ministry of Energy and Water Development (2007)

Annex 2: Water and the Millennium Development Goals (MDGs)

Millennium Development Goal	Contribution of improved water resources management and access to water supply and sanitation
<p>Poverty To halve the proportion of the world's people whose income is less than a dollar a day</p>	<p>Water is a factor of production in agriculture, industry and other economic activities Investments in water infrastructure and services is a catalyst for local and regional development Reduced vulnerability to water-related hazards reduces risks in investments and production Reduced ecosystem degradation makes the livelihoods of the poor more secure Improved health increases productivity and reduces the burden on those who care for the sick</p>
<p>Hunger To halve the proportion of the world's people who suffer from hunger</p>	<p>Water is a direct input to irrigation for expanded grain production Reliable water is needed for subsistence agriculture, homes, gardens, livestock and tree crops Water is needed for the sustainable production of fish, tree crops, and other foods gathered in common property resources (also affects poverty when such goods are sold for income) Cheaper food prices mean less urban hunger Healthy people are better able to absorb the nutrients in food than those suffering from water-related diseases, particularly worms</p>
<p>Primary Education To ensure that children everywhere complete a full course of primary schooling</p>	<p>Improved school attendance as a result of improved health and reduced water-carrying burdens, especially for girls Having separate sanitation facilities for girls and boys in schools increases girls' school attendance</p>
<p>Gender Equality To ensure girls and boys have equal access to primary and secondary education</p>	<p>Community-based organizations for water management improve the social capital of women Reduced health and care-giving burdens brought about by improved water services give women more time for productive endeavours, adult education, empowerment activities and leisure Water sources and sanitation facilities closer to home put women and girls at less risk of sexual harassment and assault while gathering water and searching for privacy Higher rates of child survival are a precursor to the demographic transition toward lower fertility rates; having fewer children reduces women's reproductive responsibilities</p>
<p>Child Mortality To reduce by two-thirds the death rate for children under five</p>	<p>Improved quantities and quality of domestic water and sanitation reduce main morbidity and mortality in young children Improved nutrition and food security reduces susceptibility to disease</p>
<p>Maternal Mortality To reduce by three-quarters the rate of maternal mortality</p>	<p>Improved health and reduced labour burdens from water carrying reduce mortality risks Improved health and nutrition reduce susceptibility to anaemia and other conditions that affect maternal mortality Sufficient quantities of clean water for washing pre- and post-birth cut down on life-threatening infections Higher rates of child survival are a precursor to the demographic transition toward lower fertility rates, and fewer pregnancies per woman reduce maternal mortality</p>
<p>Major Disease To halve, halt and begin to reverse the spread of HIV, malaria, other major diseases</p>	<p>Better water management reduces mosquito habitats Better water management reduces the incidence of a range of other water-borne diseases Improved health and nutrition reduce susceptibility to and the severity of HIV/AIDS and other major diseases</p>
<p>Environmental sustainability To stop the unsustainable exploitation of natural resources and to halve the proportion of people who are unable to reach or afford safe drinking water</p>	<p>Improved water management, including pollution control and water conservation, is a key factor in maintaining ecosystem integrity The development of integrated management within river basins creates situations where sustainable ecosystem management is possible and upstream-downstream effects are mitigated Biodiversity conservation and combating desertification are furthered by sound water management</p>

Annex 3: Global IWRM indicators based on milestones towards achieving the MDGs

The first set of indicators (focus for 2009): Putting enabling conditions in place

Here, the focus should be on ensuring that enabling conditions are in place, and that change processes have been initiated in accordance with a politically supported and approved legal framework and with the allocation of appropriate financing sources for management functions. To illustrate the way in which countries might monitor progress in these areas, here are some possible examples of process indicators that could be used:

Make the following changes to ensure an enabling environment:

- Revise and amend policies and laws
- Mainstream water into national development policies, strategies and plans
- Allocate appropriate and sustainable funding in national budgets

Make the following changes to ensure a robust institutional framework:

- Establish cross-sectoral co-ordination frameworks
- Change ministerial and departmental mandates
- Formally involve stakeholder groups
- Launch awareness and mobilization campaigns
- Decentralize responsibility and delegate decision-making at the river basin, provincial/local and community levels
- Develop the capacity of government staff and stakeholder groups

Make the following changes in management instruments:

- Improve information management
- Carry out assessments of water resources issues
- Develop IWRM strategies and plans
- Produce coherent water resources development and management plans that support the achievement of the MDGs
- Demand the management of user behaviour and water-use efficiency
- Introduce social change instruments for public awareness, mobilization and conflict mediation
- Develop regulatory instruments and associated enforcement frameworks
- Formulate economic instruments to encourage behavioural change

The second set of indicators (focus for 2012): Seeing the IWRM change process taking effect

Here, the focus should be on ensuring that the implementation of change processes takes place and that changes begin to take effect to influence the way in which water managers at all levels deal with water. To illustrate the ways in which countries might monitor progress in these areas, here are some possible examples of performance indicators that could be used:

Enabling environment

- New legislation and standards show that institutional capacity building is taking effect
- Water resources agencies are starting to administer according to new IWRM principles

Institutional framework

- Sector ministries are actively promoting and implementing the IWRM approach
- Water-use organizations and the private sector are increasingly co-ordinating water use in co-operation with government authorities
- Awareness and management capacity is growing measurably in government and user groups

Management instruments

- Monitoring and research programs are documenting the impacts and causes of major water issues
- Transparent, coherent and consensus-based planning and strategy-making is taking effect in all sectors
- Social, economic and regulatory instruments are changing inappropriate water allocations and uses
- Water conflicts across the sectors are mediated through the participation of appropriate stakeholder groups

**The third set of indicators (focus for 2015):
Mitigating key water constraints related to
the achievement of the MDGs**

Here, the focus should be on reviewing the extent to which the required water infrastructure has been developed and water resources management issues addressed in accordance with the strategic goals and targets in water resources development and management plans – and thus in a way that supports the achievement of the MDGs. To illustrate the way in which countries might monitor progress in these areas, here are some possible examples of process and outcome indicators that could be used:

MDG 1: Poverty and Hunger

- The infrastructure to store surface water and further develop groundwater resources is put in place
- The health of aquatic ecosystems – particularly fish – is optimized and protected
- Rural poor populations are protected against flood risks

MDGs 4–6: Health

- Discharges of human waste waters are treated for bacterial contamination to prevent diarrhoea outbreaks
- Toxic emissions from industrial enterprises are controlled within international health standards
- Pesticide release to ground-water, wetlands and surface-water is controlled

MDG 7: Environmental sustainability

- Appropriate environmental flows are ensured in order to maintain wetlands, goods and services
- Safe water supply and sanitation expansion has reached or exceeded Target 10 (to halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation)
- Urban slum dwellers are protected against flooding
- Social, economic and regulatory instruments are changing inappropriate water allocations and uses
- Water conflicts across the sectors are mediated through the participation of stakeholder groups

Annex 4: Examples of good practice in IWRM

Malaysia: local level: The rehabilitation of lakes in Kelana Jaya Municipal Park⁶

Issues: Tin-mining activities created polluted ponds, reservoirs and lakes. Rapid development added wastewater, solid waste and storm water overflow to the main lake in the area used for fishing, recreation and, potentially, for a non-drinking water supply. The lake ecosystem changed completely caused by poor water quality and the loss of wetland plants and animal life.

IWRM actions: A stakeholder forum was formed with 400 Friends of Kelana Jaya Park and a 15-member steering committee. An awareness programme was introduced in three schools to target students, parents and teachers. Communities and local authorities were brought together and they identified and implemented the actions necessary for integrating urban and environment planning.

Tangible impacts: Solid waste and wastewater from storm drains were reduced by 60 per cent and the quality of discharge from an oxidation pond improved after refurbishment work was carried out. Water quality in the lake improved, with consequent benefits for fishing and lake ecosystems, and health benefits were observed in the lakeside communities.

USA: state level: New York City water officials as partners in watershed management⁷

Issues: Faced with a deteriorating quality of input water, the city of New York had the choice of building a new water supply treatment plant at a cost of \$6 billion or taking comprehensive measures to improve and protect the quality of the source water in the Croton and Catskill/Delaware watersheds. The watersheds cover an area of approximately 5,000 km² and deliver water for over nine million people in New York. Dual goals of protecting water quality and preserving the economic viability of watershed communities were set out.

IWRM Actions: Partnerships were developed between New York City; New York State; the US Environmental Protection Agency (EPA); watershed counties, towns and villages; and environmental and public interest groups. Programmes were developed to balance agriculture, urban and rural wastewater and storm drainage infrastructure, the environment, and the quality of water in the nineteen reservoirs and three controlled lakes. A watershed agricultural programme was supplemented by land acquisition,

watershed regulations, environmental and economic partnership programmes, wastewater treatment plant upgrades and protection measures at reservoirs.

Tangible impacts: More than 350 farms within the watershed are implementing best-management practices, thereby reducing pollution loads; some 280 km² of land has been acquired for protection; effective watershed regulations have been enforced; the problem of 2,000 failing septic-tank systems has been remedied; and existing wastewater treatment plants have been upgraded with tertiary treatment. There has been a reduction of more than 50 per cent in coliform bacteria, total phosphorus and several other major contaminants. As a result of the water quality improvements, the city's water supply has been exempted from filtration, the population of the watersheds enjoys a better quality environment and the city made a total saving of \$4.4 billion.

China: provincial level: Liao river basin management⁸

Issues: The province of Liaoning, with a population of over forty million, has seen rapid development resulting in water shortages and severe water pollution. In the 1980s, water-use efficiency was very low in urban and industrial areas and for irrigation. Water pollution was rampant. No fish could be found in 70 per cent of the streams and ecosystem productive functions had ceased in 60 per cent of the streams. Citizens were ignorant of water conservation issues. Urban wastewater was discharged untreated into streams and in some cases infiltrated the ground-water aquifers. Deforestation took place in the upper parts of the catchments.

IWRM Actions: An institutional framework was set up comprising the Liaoning Cleaner Water Project Office, the Liao River Basin Co-ordination Commission, and the EU-Liaoning Water Resource Planning Project Office. Together, they developed an IWRM Planning Project. Under this project, a water resources assessment was carried out, a reform of the policy for water exploitation and use was made, water prices were adjusted, a monitoring network was established, and capacity building within an IWRM framework was encouraged. In addition, the Cleaner Water Project created a wastewater infrastructure where low-production-high-pollution production was discouraged and planning was put in place to prevent and control pollution. Development of the Liao River Basin was planned and a reforestation programme was implemented.

Tangible impacts: Pollution loads were reduced by 60 per cent and the quality of river water improved considerably. Upstream-downstream conflicts

6 Global Water Partnership. *ToolBox for Integrated Water Resources Management – Rehabilitation of lakes in Kelana Jaya Municipal Park (Case #173)*. www.gwptoolbox.org/index.php?option=com_case&id=116&Itemid=46 (Accessed 17 February 2009).

7 Commission on Geosciences, Environment and Research (CEGR). 2000. *Watershed Management for Potable Water Supply: Assessing the New York City Strategy*. Washington D. C., National Academies Press.

8 Lis Stedman. 2003. Liaoning's search for sustainability. *Water21*. London, IWA Publishing, pp. 20–22.

were reduced and deforestation practices halted. Drinking water within the basin was safeguarded and ecosystems along several stretches of the river were restored. Groundwater pollution was reduced and public awareness of demand management and pollution risks was raised.

Mexico: national level: irrigation reform following IWRM principles⁹

Issues: The Mexican government suffered a severe financial crisis in the 1980s. One of the results of this was that the budget for the maintenance of the national irrigation system was reduced significantly. This created a vicious cycle in the irrigation sector – rapidly deteriorating systems made farmers unwilling to pay for irrigation water, thus creating a shortage of funds. The ineffective irrigation also generated widespread salinization and drainage problems.

IWRM Actions: The financial crisis led to drastic changes in Mexico's irrigation policy. The National Development Plan (1989–1994) called for an increase in irrigation efficiency and a better use of the existing infrastructure. Under the National Program for Decentralization of Irrigation Districts, the Mexican government initiated the transfer of irrigation districts to Water User Associations (WUAs). Along with the management transfer, the government, supported by the World Bank and the Inter-American Development Bank, invested in rehabilitation and improvement to irrigation and drainage systems and in operation and maintenance equipment, which was transferred to the WUAs along with the systems. In 1992, the Mexican government issued a renewed federal National Water Law (NWL) and corresponding regulations as the main legal basis for water and irrigation management in the country. The NWL explicitly declares sustainable development as its primary objective. Furthermore, it is consistent with Mexico's efforts related to decentralization, water-user participation, the efficient use of water, the expanded participation of the private sector, and fiscal policies related to the collection of water levies for both water use and water pollution control. Political commitment to the reform process was visible through the support from the president.

Tangible impacts: Mexico began establishing WUAs in 1990. By 1997 the transfer had resulted in 400 operational WUAs of an average size of 7,600 ha. Following the transfer, there was a steady pace of better maintenance in the majority of the irrigation districts. Most irrigation systems are operated and maintained by WUAs or by farmers themselves and government subsidy has dropped to only 15 per cent of the operation and maintenance costs. Now, more than 90 per cent of farmers pay their irrigation assessment charges.

Chile: national level: a continuous interaction between growth strategies and water issues¹⁰

Issues: The strategy of exporting products for which Chile has a comparative advantage has led to a boom in the export of goods that use water in their production process. A sharp increase in water demand has followed, often in water-poor basins. This has resulted in competition for water in many areas. Export needs are now competing with in-country needs for drinking water and farming for the domestic market. And water is rising in value.

IWRM Actions: Improvements in water-use efficiency have been considerable especially in areas linked to exports. In wine production for instance, sophisticated water management systems are now in place. During the 1980s, Chile's policies on water resources were guided by the same market-oriented principles as were used to reform the country's economy. Market forces have played a major role in ensuring that water is allocated to the highest value uses – demonstrating that water is considered to be an economic good. Increased private-sector investment in sanitation has been encouraged by Chile's focus on maintaining its macro-economic equilibrium, coupled with the many safeguards that were put in place to protect foreign capital. This has boosted the development of the sewerage sector as well as the water supply sector.

Tangible impacts: Chile has managed to support growth in water-demanding industries and sectors and achieved high growth in exports. Water is allocated to high-value uses partly based on market mechanisms. By 2010, almost all the country's sewage is expected to be treated.

Fergana Valley: international level: improving water accessibility through IWRM¹¹

Issues: The Fergana Valley was once the most fertile valley in Central Asia. With approximately ten million inhabitants, it is now subject to high levels of soil salinization and the crops grown there are no longer sufficient to feed the population. State boundaries between Uzbekistan, Kyrgistan and Tajikistan make transboundary management problematic and cause constant internal and interstate disputes. More than 60 per cent of the inhabitants do not have access to safe drinking water or basic sanitation, which causes widespread water-borne diseases in the rural areas. Irrigation infrastructure is inadequate and water use is inefficient.

IWRM Actions: Improved management of water resources based on IWRM principles was initiated,

¹⁰ Sandy Williams and Sarah Carriger, Global Water Partnership – Technical Committee (TEC). 2006. Policy Brief 2 – Water and Sustainable Development: Lessons from Chile. www.gwpforum.org/gwp/library/Policybrief2Chile.pdf (Accessed 17 February 2009).

¹¹ The International Water Management Institute (IWMI) and the Scientific Information Center of the Interstate Commission for Water Coordination (SIC-ICWC). Integrated Water resources Management in Fergana Valley. http://iwrmi.icwc-aral.uz/index_en.htm (Accessed 17 February 2009).

⁹ www.en.wikipedia.org/wiki/Irrigation_in_Mexico (Accessed 17 February 2009).

emphasizing higher efficiency and more equity. IWRM capacity building within the river basin management area was put into practice, involving river commissions, provinces, municipalities, companies and WUAs. The effectiveness of bottom-up approaches was demonstrated and methods to enhance water use efficiency were put in place. The Swiss Agency for Development and Cooperation (SDC) assisted the Interstate Commission for Water Coordination of Central Asia (ICWC) in the implementation of IWRM principles.

Tangible impacts: Partnership between all the water management actors across the Fergana Valley was achieved. Safe drinking water was provided to twenty-eight villages with a total population of

80,000 people and 320 ecological sanitation toilets were constructed on a cost-sharing basis. Water-borne diseases have decreased by more than 60 per cent on average and infant mortality has been almost eradicated in all villages, despite prevailing poverty. Twenty-eight Water Committees have been created to operate and maintain the water systems efficiently and more than 30 per cent of those involved in the village committees are women. Crop yields and water productivity increased by as much as 30 per cent. Expanded and improved irrigation practices were implemented using innovative solutions for the management of the irrigation canals. There is now sustainable financing at canal, water-user association, and farm levels.

World Water Assessment Programme side publications, March 2009

During the consultation process for the third edition of the World Water Development Report, a general consensus emerged as to the need to make the forthcoming report more concise, while highlighting major future challenges associated with water availability in terms of quantity and quality.

This series of side publications has been developed to ensure that all issues and debates that might not benefit from sufficient coverage within the report would find space for publication.

The 17 side publications released on the occasion of the World Water Forum in Istanbul in March, 2009, in conjunction with *World Water Development Report 3: Water in a Changing World*, represent the first of what will become an ongoing series of scientific papers, insight reports and dialogue papers that will continue to provide more in-depth or focused information on water-related topics and issues.

Insights

IWRM Implementation in Basins, Sub-Basins and Aquifers: State of the Art Review

by *Keith Kennedy, Slobodan Simonovic, Alberto Tejada-Guibert, Miguel de França Doria and José Luis Martin for UNESCO-IHP*

Institutional Capacity Development in Transboundary Water Management

by *Ruth Vollmer, Reza Ardakanian, Matt Hare, Jan Leentvaar, Charlotte van der Schaaf and Lars Wirkus for UNW-DPC*

Global Trends in Water-Related Disasters: An Insight for Policymakers

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Governance for Sustainable Development

In a world where limited resources are increasingly stressed, good water governance is more crucial than ever for sustainable development. Ecosystems are under threat, health risks are growing as a consequence of decreasing water quality, and climate changes add to threats to the sustainability of the world's water resources and thus also to the livelihoods of our increasing populations.

DHI Water Policy, a member of the DHI Group, is assisting governments and institutions to address these problems through improved governance and Integrated Water Resources and Coastal Zone Management. This assistance is often rendered in a partnership arrangement and covers areas such as diagnostic water resources assessments and institutional analyses, policy dialogues and formulation, legislation, and overall sector reforms. Facilitation of stakeholder involvement is a key component in all these processes.

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