## Sustainability profile of the Water Management industry

- Achievements
  - During the last decade water became firmly established on the international political agenda.
  - Significant progress has been made in providing water supply and sanitation services to developing communities in many regions.
  - Wide-ranging innovative technologies and strategies were developed in the water field.
- Unfinished business
  - Serving the unserved.
  - Converting the concepts of integrated water resources management into practice.
  - Turning the tide of water-related diseases and environmental degradation.
- Future challenges and possible commitments
  - Developing practical procedures and strategies for sustainable water management.
  - Meeting the water-related needs of mushrooming urban environments in developing countries.
  - Dealing effectively with the problems of internationally shared water resources.


For further information contact:

International Water Association (IWA)
Alliance House
12 Caxton Street
London SW1H 0QS
United Kingdom
Tel: +44 20 7654 5500
Fax: +44 20 7654 5555
E-mail: water@IWAhq.org.uk
Web site: http://www.IW.Ahq.org.uk

United Nations Environment Programme
Division of Technology, Industry and Economics
39-43 Quai André Citroën
75739 Paris Cedex 15
France
Tel: +33 1 44 37 14 50
Fax: +33 1 44 37 14 74
E-mail: wssd@unep.fr
Web site: http://www.uneptie.org/wssd/


Accounting

Advertising

Aluminium

Automotive

Aviation

Chemicals

Coal

Construction

Consulting Engineering

Electricity

Fertilizer

Finance and Insurance

Food and Drink

Information and Communications Technology

Iron and Steel

Oil and Gas

Railways

Refrigeration

Road Transport

Tourism

Waste Management

- Water Management

*Industry as a partner for sustainable development*

# Water Management

International Water Association (IWA)

*Developed through a multi-stakeholder process facilitated by:* UNEP

*Industry as a partner for sustainable development*

# Water Management



First published in the United Kingdom in 2002.



ISBN: 92-807-2195-0

## A report prepared by:

International Water Association
Alliance House
12 Caxton Street
London SW1H 0QS
United Kingdom

Tel: +44 (0) 20 7654 5500
Fax: +44 (0) 20 7654 5555
E-mail: water@IWAhq.org.uk
Web site: http://www.IW.Ahq.org.uk


## Production

**Design by Beacon Creative**
+44 (0) 1825 768811
**Printed by The Beacon Press** using their *pure***print**® environmental print technology that is both water and alcohol free. No film processing chemicals were used and 90% of the cleaning solvent was recycled.

The electricity was generated from renewable resources and vegetable based inks were used.
Registered to the environment management system ISO14001 (Certificate No. E.9586) and EMAS the Eco Management and Audit Scheme (registration no. UK-S-00011), and the printer holds FSC Chain of Custody certificate number SGS COC 0620. Over 85% of any waste associated with this product will be recycled.

## Disclaimer

In a multi-stakeholder consultation facilitated by the United Nations Environment Programme, a number of groups (including representatives from non-governmental organisations, labour unions, research institutes and national governments) provided comments on a preliminary draft of this report prepared by the International Water Association (IWA). The report was then revised, benefiting from stakeholder perspectives and input. The views expressed in the report remain those of the authors, and do not necessarily reflect the views of the United Nations Environment Programme or the individuals and organisations that participated in the consultation.

# Purpose and scope of the report

Water is a horizontal issue. Although only Chapter 18, of the 40 chapters in Agenda 21, deals specifically with freshwater, the management of freshwater inter-links with issues discussed in all of the remaining 39 chapters. It exemplifies, better than any other topic, the interdependency of many of the topics.

There is no 'water industry' with clear production and user segments.

Freshwater:

- becomes available through the dynamic hydrological cycle;
- sustains biotic and abiotic functions of all ecosystems;
- is subject to abstraction, treatment and use by humans for domestic, agricultural, industrial and recreational purposes;
- is vulnerable to pollution that degrades its quality and availability for use.

A survey by the Scientific Committee on Problems of the Environment (SCOPE), during 2000, involving 200 scientists in 50 countries, identified freshwater scarcity and pollution together as the major environmental issue that requires attention during the 21st century.

Against this background, it is understandable why Chapter 18 concluded that the sustainable management of water resources must be achieved through an integrated or holistic approach, namely integrated water resources management (IWRM). This concept has been reaffirmed at numerous subsequent international events and is now universally accepted. For this reason, this water sector report too follows a holistic approach, reflecting the pervasive nature of water as a unifying theme of environment and development. Thus, its format is different from that of other industry sector reports for the World Summit on Sustainable Development.

The report intends to present politicians and policy-makers with an overview of the freshwater scene in its totality. Only an understanding of the broader picture will enable water-related decisions to align with the principles of IWRM. The report proceeds to deal with the nature of IWRM, critically appraises the obstacles to IWRM, and presents some proposals for facilitating the implementation of IWRM.



# Contents


5 **Foreword**
9 **Acknowledgements**
11 **Part 1:** Executive summary

15 **Part 2:** Review of the water sector
15 2.1 Global water situation
15 2.2 Population growth
15 2.3 Water supply coverage
16 2.4 Sanitation coverage
17 2.5 Urbanisation
17 2.6 Industrial use
18 2.7 Agriculture
19 2.8 Aquaculture
20 2.9 Water pollution
20 2.10 Groundwater
21 2.11 Ecosystem degradation
23 2.12 Desertification
23 2.13 Hydropower
23 2.14 Dams
24 2.15 Climate change
25 2.16 Shared water resources
26 2.17 Technology and new sources of fresh water supply
26 Desalination of seawater
26 Water reuse
27 Artificial rainfall enhancement
27 2.18 Poverty
27 2.19 Privatisation
28 2.20 Targets and investment requirements

29 **Part 3:** Integrated water resources management
29 3.1 IWRM history and definition
31 3.2 Principles and elements of IWRM
32 3.3 Progress in the development of IWRM
32 3.4 Obstacles to the implementation of IWRM
32 Fragmentation of institutional responsibilities
32 Workplace approaches
33 The potential complexity of the IWRM concept
33 Need for reference projects
34 Lack of adequate skills, expertise and awareness
35 Lack of adequate and reliable data
36 Gaps in available knowledge and technology

37 **Part 4:** Proposals for facilitating the implementation of IWRM
37 4.1 A phased and simplified approach to IWRM
37 4.2 Virtual centres of excellence
38 Water related resource economics
38 Water requirements to maintain aquatic ecosystems
38 Industrial by-product recovery
39 Life cycle assessment in the water sector
39 Waste minimisation clubs

39 4.3 Integrated urban water management (IUWM)
40 4.4 Co-ordinating the activities of international agencies
41 4.5 Launching structured south-south initiatives
41 4.6 Demonstrating sites for dry and low-water-use sanitation systems
42 4.7 The role of professional water associations

44 **Annexe 1:** Targets, costs and investment requirements
48 **Annexe 2:** Principles of effective IWRM
51 **Annexe 3:** Marseille Statement
54 **Annexe 4:** Abbreviations and acronyms



# Foreword

The global water cycle sustains all life on earth. Mankind has used water to its advantage and life has proliferated. The changes brought by the use of water have been at once beneficial and harmful. Wise use of water can be achieved through a balanced and sustainable development of systems that minimise negative impacts on the water cycle. This continuing goal has not been realised in many human activities, at least as measured by today's standards.

The universally accepted goal of improving the sustainability of development – a journey, not a destination – can only be achieved through a rational and carefully managed use of the available resources. A compromise must be reached between protecting ecological integrity and facilitating economic prosperity that supports a reasonable quality of life for all citizens of the planet.

The priority for improving sustainability in water management moved into prominence during the last decade of the 20th century, when it became apparent that many arid and semi-arid regions of the world are subject to conditions of accelerating environmental degradation and acute water shortages. These conditions have been rapidly precipitated by environmental mismanagement and population pressures, and continue to worsen.

Beginning in about 1990, the seriousness and common nature of many water crises became globally recognised. A series of international events took place, each of which progressively emphasised problems facing the water sector and a number of basic approaches to cope with these problems were identified. The first three of these events (see box 1) were the Global Consultation on Safe Water and Sanitation for the 1990s, New Delhi, 1990; the International Conference on Water and the Environment, Dublin 1992; and the United Nations Conference on Environment and Development, Rio de Janeiro, 1992. The major output of the latter event was Agenda 21, of which Chapter 18 dealt specifically with water issues. The global debate on sustainability gained formal currency through the adoption, by most nations, of the Agenda 21 protocol.

The World Summit on Sustainable Development, Johannesburg, September 2002, will review progress achieved in the implementation of the Agenda 21 principles. The sustainable management of freshwater resources will be just one of many critical issues to be covered.

For the water sector, two major events de facto served as preparatory meetings for the Johannesburg Summit. These were the Second World Water Forum and Ministerial Conference in The Hague, March 2000, organised by the World Water Council, and the International Conference on Freshwater, presented by the German government in Bonn, December 2001.

The Second World Water Forum was one of the most diverse and potentially most influential water-related meetings of recent times that further served to move water up the political agenda. A World Water Vision was presented at the Forum, as well as a set of messages for a 'water secure world' (see box 2). In parallel, the Global Water Partnership (GWP) developed a Framework for Action aimed at 'moving from vision to action'. The framework is progressively being refined and updated and will constitute an important input to the Johannesburg event.

**Box 1: Significant water events in the period 1990 to 1992**

| Event | Guiding principles |
|---|---|
| Global Consultation on Safe Water and Sanitation for the 1990s, New Delhi, 1990 | The New Delhi Statement formalised the need to provide, on a sustainable basis, access to safe water in sufficient quantities and proper sanitation for all, emphasising the 'some for all rather than more for some' approach. Four guiding principles were postulated:<br>• protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid wastes,<br>• institutional reforms promoting an integrated approach.<br>• community management of services,<br>• sound financial practices. |
| International Conference on Water and the Environment, Dublin 1992 | Four guiding principles were formulated:<br>• freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment;<br>• water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels;<br>• women play a central part in the provision, management and safeguarding of water;<br>• water has an economic value in all its competing uses and should be recognised as an economic good. |
| United Nations Conference on Environment and Development, Rio de Janeiro, 1992 | Agenda 21 emerged from this conference, with chapter 18 dealing with water issues. Chapter 18 was entitled: 'Protection of the quality and supply of freshwater resources: Application of integrated approaches to the development, management and use of water resources'. Seven programme areas were proposed for the freshwater sector:<br>• integrated water resources development and management,<br>• water resources assessment.<br>• protection of water resources, water quality and aquatic ecosystems,<br>• drinking-water supply and sanitation,<br>• water and sustainable urban development,<br>• water for sustainable food production and rural development,<br>• impacts of climate change on water resources. |

The outputs from the Second World Water Forum provided a significant contribution to the mainstream United Nations (UN) process, and the need to act was included in the UN General Assembly Millennium Declaration of September 2000. The declaration draws attention to the importance of water and water-related activities in supporting development and eradicating poverty. It reinforces water-related targets by resolving to halve, by the year 2015, the proportion of people who are unable to reach, or to afford safe drinking water.

In addition to the Vision 21 and Framework for Action documentation, there were over 20 regional Vision and Framework for Action reports available at the forum, as well as a Vision for Water for Food and Rural Development and Water and Nature – Vision and Framework for Action (IUCN Report).

**Box 2: The Second World Water Forum, The Hague, 2000**

The World Water Vision which was presented at the forum, defined three primary objectives: (1) to empower people and communities to decide how to use water, (2) to get more crops and jobs per drop, and (3) to manage use to conserve freshwater and terrestrial ecosystems. It deemed five actions critical to the achievement of the objectives:

- involving all stakeholders in integrated management,
- moving to full-cost pricing,
- increasing public funding for research and innovation,
- co-operating to manage international basins,
- massively increasing investments in water.

The World Water Council which organised the Second World Water Forum, formulated the following 'messages for a water secure world':

- a holistic, systemic approach relying on integrated water resources management must replace the current fragmentation in managing water;
- participatory institutional mechanisms must be put in place to involve all sectors of society in decision-making;
- fresh water must be recognised as a scarce commodity and managed accordingly;
- full cost pricing of water services with targeted subsidies for the poor;
- fresh water must be recognised as a basic need, with adequate access ensured for the poor;
- incentives for resource mobilisation and technology change are needed;
- institutional, technological and financial innovation is needed;
- private investment and community action;
- political will is needed – going beyond Dublin and Rio;
- governments are key actors – as enablers and regulators;
- behavioural change is needed by all – no more business as usual.

The second preparatory event for the water sector discussions at the Johannesburg Summit, was the International Conference on Freshwater, presented by the German government in Bonn, December 2001. The recommendations emerging from the conference are listed in box 3.

### Box 3: Recommendations for action: International Conference on Freshwater, Bonn, 3 to 7 December 2001

Actions in the field of governance:

- secure equitable access to water for all people,
- ensure that water infrastructure and services deliver to poor people,
- promote gender equity,
- appropriately allocate water among competing demands,
- share benefits,
- promote participatory sharing of benefits from large projects,
- improve water management,
- improve water quality and ecosystems,
- manage risks to cope with variability and climate change,
- encourage more efficient service provision,
- manage water at the lowest appropriate level,
- combat corruption effectively.

Actions in the field of mobilising financial resources:

- ensure significant increase in all types of funding,
- strengthen public funding capabilities,
- improve economic efficiency to sustain operations and investment,
- make water attractive for private investment,
- increase development assistance to water.

Actions in the field of capacity building and sharing knowledge:

- focus education and training on water wisdom,
- focus research and information management on problem solving,
- make water institutions more effective,
- share knowledge and innovative technologies.

Other notable reports that became available since 1999 are the following:

- *Vision 21: A shared vision for water supply, sanitation and hygiene* (Water Supply and Sanitation Collaborative Council, July 1999).
- Addressing the water crisis – *Healthier and more productive lives for poor people* (Department for International Development, Great Britain, March 2000).
- *Water: A key resource for sustainable development* (UN Economic and Social Council, March 2001).

In view of the extensive consultations on which the various documents were based, this report draws heavily on the data and the mainstream insights presented there. In addition, the report presents new insights and practical proposals for facilitating the implementation of integrated water resources management (IWRM).



# Acknowledgements

Inputs and comments to this report by the following persons are gratefully acknowledged:

Roger Aertgeerts
European Centre for Environment and Health, World Health Organization

Denis Ballay
International Water Association

Jay Bhagwan
Water Research Commission, South Africa

Timothy Downs
International Water Association

Winston Gereluk
Public Services International

Jerry Gilbert
International Water Association

Richard Holland
World Wide Fund for Nature

Tony Milburn
International Water Association

Michael Rouse
International Water Association

Laszlo Somlyody
International Water Association

Meike van Ginneken
Global Water Partnership

A special word of thanks is due to Isabella Marras and Hari Srinivas, UNEP IETC, for respectively co-ordinating report inputs from UNEP sources, and for chairing the special meeting held in Paris on 3 October 2001, to discuss the first draft of the report; and to Piet Odendaal, International Water Association who was the compiler and editor of the report:

# **Part 1:** Executive summary

Water is a horizontal issue that permeates all human activities. As such, there is no 'water industry' with clear production and user segments. Hence, it is understandable that Agenda 21 (chapter 18) – emerging from the Earth Summit in Rio de Janeiro in 1992 – postulated that the sustainable management of water resources must be achieved through an integrated or holistic approach, namely integrated water resources management (IWRM). The IWRM concept has been reinforced at various subsequent events, and is now widely accepted.

This report aligns itself with the IWRM approach, and following a review of the present freshwater scene, it proceeds to deal with the nature of IWRM, critically appraises the obstacles to IWRM, and finally presents some proposals for facilitating the implementation of IWRM.

## Overview of the freshwater scene

### Drivers of water crises

The main driver for water crises is population growth, particularly in developing countries. Rapid urbanisation is one of the consequences of sustained population growth, and it is estimated that over the next 25 years 95% of population growth in developing countries will occur in urban areas, posing severe challenges for water services and pollution control.

Climate change is expected to become a major driver for water crises. Although specific predictions on a regional level are not yet possible, scientists agree that the climate will change globally, leading to a global rise in temperatures and sea levels, with resultant droughts and floods.

**Sources of supply**

More than 1,500 million people rely on groundwater for potable use. Serious over-abstraction occurs in many regions, and many aquifers are seriously polluted. Measures are urgently needed to protect these sources.

Today there are at least 45,000 large dams, but rate of construction declined since the 1970s. Environmental impact of dams raised major opposition to the construction of further large dams, and has raised ongoing debate.

Two well-proven alternative sources of water supply are the desalination of seawater and water reuse. Research on rainfall enhancement, conducted over several decades around the world, yielded very promising results during the last decade.

**Water supply and sanitation coverage**

Three to four million people die annually of waterborne diseases, indicating the urgency to make adequate water supply and sanitation services available to all. Worldwide, the provision of new water services is outpacing population growth, but 1.3 billion people still lack safe drinking water. In spite of substantial progress in the provision of sanitation services, about 2.8 billion people have no adequate sanitation. Where waterborne sewerage systems are available in poor cities, sewage is often untreated or inadequately treated, and sewers poorly maintained.

**Industrial and agricultural water use**

Due to substantial technological improvement, industry in developed nations has made considerable progress to reduce water intake and waste discharge. Much of the progress is due to more stringent regulations, but escalating water costs, market considerations, pressure groups, and social responsibility, also contributed. A drive for application of cleaner production, life cycle analysis and eco-efficiency is rapidly gaining momentum

In 1996, 18.4% of the world's electricity came from hydropower. At present, it is the only

energy source that is both renewable and economically viable

Globally, irrigation accounts for nearly 70% of water use. Although it may have wide-ranging environmental impacts, it does play a vital role in food supply, presently producing about 50% of all food. To keep pace with population growth, it will have to expand by 20% to 30% in area by 2025. However, various factors are limiting the rate of increase, particularly competition from other water users. Irrigation farming is, therefore, under increasing pressure to increase the value of crop yields per unit of water consumed.

World aquaculture more than doubled from 1984 to 1994, and now provides 25% of all fish consumed directly by humans.

**Socio-economic and political issues**

More than a quarter of the developing world's people live in poverty, of which a lack of access to safe drinking water is a major component. It is generally accepted that poverty is the major contributor to environmental degradation

Privatisation of water services is advocated on the rationale that it introduces competition which stimulates improved performance. Opposing views hold that there are various problems associated with the privatisation of water services, such as domination of the market by a few multinational enterprises and higher prices to water users.

Some 269 rivers and numerous aquifers are shared by two or more nations and constitute potential sources of conflict. Water cannot be efficiently managed in the basis of political boundaries, and international agencies should aim at facilitating international agreements to manage shared water resources on a catchment basis.

Indicative targets for global water security and investment requirements were generated by the World Water Council, the GWP, and the Water Supply and Sanitation Collaborative Council (WSSCC). To find the additional investments will require political will and commitment.

**Environmental issues**

Much of the economic progress in developed and transitional economies has been made at the cost of environmental degradation, including desertification. The internalisation of environmental costs merits increasing attention, but is hampered by an inadequate understanding of the value that ecosystems provide. Certain countries now have legislation for the allocation of water for environmental purposes.

Water pollution diminishes water usability, and increases the cost of water treatment, the spread of waterborne diseases, and destruction of aquatic ecosystems. The wide application of wastewater management technology is hampered by lack of funding, capacity and political will. There is growing support for implementation of the 'polluter pays' principle.

## Integrated Water Resources Management

The Integrated Water Resources Management (IWRM) concept became formally established in global thinking in the period 1990 to 1992 and, since then, IWRM principles have been elaborated upon and refined by several international meetings. However, despite universal acceptance of the IWRM concept, its implementation has not been fully achieved in either developed or developing countries. One main obstacle is insufficient funding, particularly in developing countries, but there are other obstacles as well:

- fragmentation of institutional responsibilities,
- insufficient attention to workplace approaches,
- perceived complexity of the IWRM concept,
- a lack of reference projects,
- lack of skills, expertise and awareness,
- lack of adequate and reliable data,
- gaps in available knowledge and technology.

It is encouraging that in the case of most of these 'obstacles', positive initiatives have been launched by one or more of the international agencies to improve the situation.

## Proposals for facilitating the implementation of IWRM

1) A phased and simplified approach to IWRM. This means steering away from urging immediate grand-plan IWRM strategies. It involves an adaptive management approach, based on incremental gains, an initial focus on key issues of importance to all stakeholders, and responding to changes in information, understanding and circumstances. It does not imply that the vision of comprehensive IWRM be abandoned, rather that a step-wise approach towards the ultimate goal be used. The GWP in concert with resource planning agencies, is well positioned to propagate this approach

2) Virtual centres of excellence. There are areas of knowledge and technology – supportive of IWRM – where it is necessary to accelerate research. This can be facilitated through the establishment of a 'virtual centre of excellence' (VCEs), each comprising a collaborative network of nodes, across the globe, working on complementary topics. UNEP could act as the co-ordinating/facilitating agency. Examples of topics particularly pertinent to IWRM that could be accelerated through VCEs, are discussed in the report.

3) Integrated urban water management. There is a growing conviction that integrated urban water management (IUWM) should be pursued as a core component of IWRM. Cities are dominant features in the catchments where they occur, and success in IUWM will contribute to the theory and practice of IWRM. IUWM must inter alia endeavour to optimise the interfacing of urban water concerns with relevant activities beyond the urban boundaries, such as rural water supply, down-stream use, and agriculture. IUWM already comprises a sub-programme of UNESCO's International Hydrological Programme, and is strongly supported by the International Water Association (IWA) and the International Council for Local Environmental Initiatives (ICLEI).

4) Co-ordinating activities of international agencies. International agencies provide essential support-services. However the lack of coordination between agencies, serves to create a 'confusion barrier' between programme outputs and those that can benefit from them. To set up co-ordinating structures will take time. An initial measure, that can go a long way towards eliminating confusion and promote the use of agency outputs, would be the setting up of a database of water-related agency activities, on a single Web site

5) Structured south-south initiatives. Traditionally, the transfer of information and technology to developing countries mainly occurred in north to south mode, which to some extent is a 'top-down' approach. More emphasis needs to be placed on south-south initiatives, as many developing countries have similar circumstances. GWP launched an initiative in this regard, while IWA has taken a strategic decision to collaborate with others in the launching of south-south initiatives. This will involve the bringing together of those with successful home-grown technologies and strategies, with those that could potentially benefit from them.

6) Demonstration sites for dry and low-water-use sanitation systems. In the context of growing water shortages and rapid urbanisation, the sustainability of the western model of water-based sanitation is seriously questioned. There is a need to develop and demonstrate acceptable and environment-friendly dry or low-water-use sanitation systems. Ongoing initiatives are scattered and institutions that are interested to explore the application of such sanitation systems find it difficult to logistically access demonstration units on a comparative basis. The use of these systems can be promoted by setting up judiciously located demonstration sites across the globe. This initiative could be launched on a pilot-scale by the Water Supply and Sanitation Collaborative Council.

7) Utilising the expertise of professional water associations. An invaluable water-related resource that has never been fully utilised by the international agencies, is the pool of expertise and goodwill, comprised by members of water-related international professional associations. Collectively, these associations can play a brokerage role between the formation and implementation of policies. Professional associations are well positioned to assist in the generation and transfer of knowledge and technology, and to provide scientific support in policy formation. A mechanism to involve professional associations would be through memoranda of understanding between specific agencies and associations.



# **Part 2:** Review of the water sector

## 2.1 Global water situation

Of the global water resources, a large fraction is tied up in the ice of the arctic regions, or present in areas where human demands are small. Rainfall and river run off occur in peaks during very short periods, and are not available for human use, unless stored in aquifers, reservoirs or small storage facilities. In the past 100 years the world population tripled, but water use for human purposes multiplied six-fold principally for irrigation of crops. Today perhaps half of all available freshwater is being used by humanity – double what it was a mere 35 years ago. Therefore, in many regions of the world, competition for available resources is intense, and in the case of shared resources, disputes are prevalent and even hold potential for serious conflict.

In the next two decades it is estimated that water use by humans will increase by 40%, and that 17% more water will be needed to produce food for growing populations in developing countries. Water-short areas have developed drought planning and new techniques for reallocation of water during times of shortage. Short and long-term impacts of water shortage can frequently be addressed, but established institutions and practices based on plentiful supplies are barriers to more efficient use including the reallocation of water to meet newly appreciated goals, including environmental sustainability. It should furthermore be noted that the pollution of freshwater resources contributes to water shortages.

What makes sustainability both a powerful idea and an illusive goal is that it has forced us to think about the inter-generational equity of resource management and allocation. Since supplying water and sanitation to our current generation of global citizens falls significantly short of their needs, adding into the equation future human generational needs and biodiversity conservation, reveals the enormous challenges we face. IWRM squarely faces up to this challenge.

## 2.2 Population growth

According to the United States Census Bureau, the world's population tripled in the 20th century, reaching six billion at the turn of the century. In a report *World Population at a Glance: 1998 and Beyond,* the Bureau estimated that global population will be eight billion by 2026 and 9.3 billion by 2050. The greatest increases are – and will continue to be – in developing countries where water supplies, arable land and other natural resources are already under growing pressure.

In response to concerns about the interrelated effects of population growth and environmental pressures, UNEP and the UN Population Fund (UNFPA) signed an agreement in 1999 aimed at improving cooperation on topics related to sustainable development. The agreement addresses the relationship between human well-being and environmental quality, stating 'population and environmental issues are interdependent and must be resolved as such.'

Water Vision 21 points out that there is a high correlation between countries with the greatest water shortage, the poorest economies, and the highest population growth rate. Water stress is a major conspirator in the poverty trap and a prime link in the vicious cycle of underdevelopment, public health risk and ecological deterioration.

## 2.3 Water supply coverage

An important initiative that bolstered water supply and sanitation coverage was the International Drinking Water Supply and

Sanitation Decade (1981 to 1990). It resulted from the Mar del Plata Action Plan adopted by the UN Water Conference in 1977, the event where IWRM as a participatory approach was emphasised. The target of the decade was to provide safe drinking water and sanitation to under-served urban and rural areas by 1990. This investment drive and follow-up actions by national governments, supported through international organisations, ended in 2000 with access to safe and affordable drinking water for 78% of the world's population. However the actual number of unserved remains more or less unchanged

Notable are the following:

- access to water is acknowledged as a basic right in the Convention on the Rights of the Child;
- worldwide the provision of new water services is outpacing population growth;
- despite substantial achievements over the past two decades, the sobering fact is that 1.3 billion of the earth's citizens still lack safe drinking water;
- in many larger cities of Asia and Latin America, the total water produced by utilities is very high, from 200 to 600 litres per person a day, but up to 70% is lost to leakage. Service is often undependable, and water quality often unreliable;
- coverage levels in rural areas and during the 1990s have risen and are not far behind those in urban areas.

## 2.4 Sanitation coverage

The International Drinking Water Supply and Sanitation Decade and follow-up initiatives also achieved substantial progress in the provision of sanitation services. Some 600 million people gained access to sanitation services, increasing coverage to 52%. However, it is clear that far fewer people have adequate sanitation than safe water and that the global provision of sanitation is not keeping up with population growth. In rural areas, coverage actually declined during the early-1990s and in urban areas, coverage remains below 60%. These figures translate to the fact that about 2.8 billion of the world's people have no adequate sanitation.

Experience shows that clean water alone leads only to minor health improvements in the absence of personal hygiene and adequate sanitation. The implication is that to derive the maximum benefit of installed water supply services, there must be a joint focus on raising hygiene awareness and sanitation. Most practitioners indeed now include safe water provision as an integral part of holistic environmental sanitation, not separate from it. Many people do not understand the link between poor hygiene, sanitation and disease, because this link has still not been sufficiently well explained to people through education and awareness programmes. Consequently, they demand water as a priority, not sanitation or hygiene promotion

The importance of water-related health improvement is clearly evidenced by WHO statistics (1996), which indicate that three to four million people die annually of waterborne diarrhoeal diseases alone (including amoebic and bacillary dysentery). These figures include more than 2 million children who die of diarrhoea. Other sources provide an even higher estimate. Vision 21 points out: *'The most important point is that it costs more not to provide basic services than to provide them. As far back as 1970, water-related diseases cost an estimated $125 billion per year in direct medical costs and lost work time, plus the colossal social costs of lost education, family disruption, health care and shortened life expectancy. A major water-related disease outbreak can cost far more in medical care and lost productivity than the universal provision of safe water and sanitation.'*

Against this background, it is clear that, much needs to be done to place sanitation much higher up on the international agenda. It must be developed in parallel with water supply in order to gain public health benefits and avoid water resource degradation. In this context it was most unfortunate that the UN General Assembly Millennium Declaration of September2000, although it drew strong attention to drinking water supply, made no reference to sanitation.

To give a boost to the drive for sanitation, more than eight organisations have combined their efforts in the Sanitation Connection. The Sanitation Connection will make up-to-date knowledge available online about technologies, institutions and financing possibilities for sanitation systems (http://www.sanicon.net).

Note should also be taken of the fact that where there are waterborne sewerage systems in cities of developing countries, the problem is often that the sewage is inadequately treated, or not treated at all, before discharge to the land and water environment. This leads to the degradation of downstream water quality, which limits further use and degrades ecosystems.

The maintenance of sewers too, is in many cases inadequate, allowing raw sewage to enter residential areas through broken or blocked sewers. Where urban infrastructure is old and in decay, the risk of cross-contamination between broken sewers and leaky supply distribution lines is of major concern. The mixing of stormwater drainage with wastewater drainage is a serious problem in areas subject to episodic rain events because drains overflow and cause pollution surges.

## 2.5 Urbanisation

Rapid urbanisation poses severe challenges for water supply and sanitation services. According to Vision 21, 95% of population growth in developing countries, over the next 25 years, will occur in urban areas. By 2025, urban population will have doubled in size to over four billion people (more than 60% of world population, compared with the present 45%).



The number of big cities with over one million people will almost triple to well over 500. By 2015, one person in five will live in a big city, compared to one person in nine now.

In the developing world by far the fastest rate of urban growth is taking place in slums and squatter settlements situated on waste ground, flood planes or unstable hillsides. By the middle of the century, villages will cease to exist in many countries, and poverty will largely have been transferred to urban areas. The projected growth of cities is especially significant in drier countries where it is likely to contribute to urban/rural conflicts over water use, as well as impacting ecosystems in source areas from which water is drawn (often hundreds of kilometres away).

Fortunately, the last decade has seen a remarkable expansion in expertise and technology to manage water systems. Opportunities now exist for greater liaison between municipal systems in developed countries and those in developing countries with low capacity and high need. This should be the focus of a major international effort. It should be noted that in addition to discrete priority needs, like pollution abatement, empirical evidence strongly advocates the integrated management of urban systems in the wider watershed context.

## 2.6 Industrial use

Worldwide, industries use about twice as much water as households and, in addition, can release harmful pollutants to the multi-phase environment (water, soil, air, biota), such as heavy metals and toxic chemicals. In rich countries, large factories, that can afford the appointment of staff dedicated to water management and pollution control, have, in many cases, made considerable progress to reduce water intake and waste release, through cleaner technologies, water recycling and proper pre-treatment of final effluents. Much of the progress can undoubtedly be

ascribed to more stringent regulations by controlling authorities, but the escalating cost of water, environmental pressure groups, marketing considerations, and a sense of social responsibility, have also become drivers of increasing importance for developed nations. Lessons can be drawn for developing countries about the strategic role of societal capacity – community, industrial, agricultural and regulatory – in managing natural resources. This experience further upholds the shared roles and responsibilities of water stakeholders in any country, city or village, acknowledged by IWRM.

In order to meet the evolving consumer demands in developed country markets, a growing number of companies in developing countries are obtaining certification of environmental management systems under the ISO 14000 criteria of the International Organisation for Standardisation (ISO).

Much work has been done on:

- savings in freshwater intake through water recycling and closed loop systems;
- reduced pollution load discharges, through clean housekeeping and improved effluent treatment technology;
- minimising the use of toxic chemicals;
- new technologies for treatment and recycling of industrial waters;
- dry cooling in power generation.

Much still remains to be done in transitional and developing nations to strengthen their capacity to carry out IWRM-type initiatives, and equitable, mutually-beneficial partnerships with developed countries to do this are to be encouraged.

The drive for cleaner production in industry is rapidly gaining global momentum. Cleaner production protocols follow a holistic, life cycle, materials balance approach whereby all activities in production are optimised in order to minimise environmental risk. Cleaner production is being promoted by UNEP, and in collaboration with the UN Industrial Development Organisation (UNIDO), by the year 2000, 19 national cleaner production centres had been established.

At that time, the International Declaration on Cleaner Production had been signed by 223 industries and governments. Implementation of a project for promoting cleaner production investment in developing countries, is operated under a trust fund from the Government of Norway.

The World Business Council for Sustainable Development (WBCSD) developed Eco-efficiency, a management approach that allows companies to improve their environmental performance while meeting the demands of the market.

UNEP, together with the UN Office of the High Commissioner for Human Rights, UNDP and the ILO, are core agencies in the UN Secretary General Kofi Anan's 'Global Compact'. It calls on business worldwide to promote nine basic principles in relation to human rights, labour standards and environmental protection. The environmental principles require businesses to:

- support a precautionary approach to environmental challenges,
- undertake initiatives to promote greater environmental responsibility,
- encourage the development and diffusion of environmentally friendly technologies.

## 2.7 Agriculture

With its land and water requirements, agriculture has a greater impact on natural resources than any other activity. Globally, withdrawals for irrigation comprise nearly 70% of the total withdrawn for human use, with 20% going to industry and 10% to residential use. Direct environmental impacts of agricultural activities include soil degradation and soil erosion, diversion of water resources, damage to or loss of land and aquatic ecosystems, and pollution by agricultural chemicals and wastes. Poor irrigation management causes about 10% to 15% of all farmland to be affected by salinisation, driving the expansion of irrigated agriculture onto new land. Addressing this issue head-on with an IWRM approach should enable more production on the same land area with less water used.

Subsidisation of agricultural inputs such as water, electricity, fertilizers, and pesticides, has often led to their inefficient and environmentally damaging use. Government policies still generally exempt farmers from the 'polluter pays' principle, allowing them to avoid internalising the full cost of damage from pesticides, water resource degradation and other agricultural impacts. Removing subsidies to these environmental externalities will encourage innovation in agricultural best management practices (BMPs) and irrigation technologies that currently lack market incentives.

Despite these negative indicators, irrigation is playing, and will have to play, a vital role in feeding the world's population that is expected to increase from the present six billion, to nine billion in 2050. At present, irrigated land produces about one-third of all agricultural products and 50% of all food. The amount of irrigated land has nearly tripled since 1950, being closely tied to the dramatic rise in food production during the same period.

It is estimated that for irrigated agriculture to keep pace with population growth, it will have to expand by 20% to 30% in area by 2025. However, the rate of increase is declining because of increased costs and competition from other water users. Coupled to a slow-down in dam building and irrigation investments, and falling groundwater tables, the expansion of irrigated areas may be limited to 5% to 10%, an absolute ecological incentive to improve production efficiency.

Irrigation farming is, therefore, coming under increasing pressure to step up the value of crop yields per unit of water consumed. This can be done through improved cultivation practices and irrigation scheduling, the re-allocation of water to higher-value crops, and improving the nutritional yield of crop cultivars.

The high withdrawals of water for irrigation are largely driven by food security objectives. Food security hinges on water security, and both control vulnerability to famine in underdeveloped regions. Food security does not mean that each country needs to grow all the food required nationally. However, although the value of 'virtual water' (water imported in food grown elsewhere) is increasingly recognised, there is a deep-seated national inclination to opt for self-sufficiency.

In impoverished nations, subsistence agriculture is the norm, with vulnerable food surpluses as the most valuable local trading goods. Prolonged droughts precipitate famine, and such regions still exhibit the most acute manifestations of water stress. IWRM must be adapted to local needs and priorities and, like any management model, must be driven by them, and be strategic in its design and implementation.

## 2.8 Aquaculture

According to UNEP (1999), world aquaculture more than doubled from 1984 to 1994, and now provides 25% of all fish consumed directly by humans. Asia is the leading aquaculture region, and China alone produces almost 60% of global production. Growth prospects are constrained by environmental factors. Fish farming requires both land and water, and these resources are already under pressure in many areas. Aquaculture operations have caused environmental impacts, including water pollution, loss of mangrove swamps and other habitats in Africa and south-east Asia, erosion, exacerbated flooding, and salt intrusion into freshwater supplies.

The other side of the coin is the threat that water pollution from other sources poses for aquaculture and the impacts on this important local economic activity. Community-driven 'sustainable aquaculture' initiatives are becoming more attractive, though the degree to which they are sustainable needs careful assessment using the kinds of socio-ecological multi-criteria used in IWRM.

## 2.9 Water pollution

Rapidly growing cities, burgeoning industries, mining, soil erosion, animal feedlots, and the increasing use of chemicals in agriculture, are progressively degrading water quality in many rivers, lakes, and aquifers. This impairs water usability, escalates water treatment costs, facilitates the spread of waterborne diseases, and damages or even destroys aquatic ecosystems. Bad land management practices, such as overgrazing and injudicious deforestation, cause serious land degradation and soil erosion, with associated siltation of rivers and dams. The effects of pollution are much more severe in water-stressed countries, where there is little or no dilution capacity available

Many rivers running through urban centres are dead or dying through discharge of untreated or poorly treated effluents. Half the rivers and lakes in Europe and North America are seriously polluted, though their position has improved in the past 30 years. In central and eastern Europe, decades of neglect have left surface waters from the Baltic to the Balkans heavily polluted. This situation is mirrored in rapidly developing transitional countries like Mexico and Malaysia where industrialisation outstrips the capacity to treat wastes, and ecological concerns are of low priority compared to economic growth.

As greater investments are made in controlling pollution, mainly from industrial and urban 'point sources', attention is turning to non-point or diffuse sources. Their control is primarily an institutional and cultural problem, and secondarily an economic problem. Absolute standards can achieve benefits but rarely result in the efficient reduction of pollution. The elimination of all evidence of pollution is not a reasonable goal, but significant reductions can be achieved particularly through the use of new technologies that emphasise control of pollutants at source, whether point or non-point.

There is wide support for the implementation of the 'polluter pays' principle in combating water pollution. But this must be done in ways appropriate to each region and its economy. In the Philippines, for instance, an environmental users' fee system was initiated in 1998 for industries discharging into the Laguna de Bay. This took the form of a pollution charge system, intended to raise revenue for lake management and rehabilitation.

In practice, environmental risk management needs to be a combination of command and control regulation, and market-driven incentive schemes, suited to local conditions, priorities and capacities. Where capacities are weak, strategic strengthening needs to be done to support an acceptable level of risk abatement and control for both priority human health risks and ecotoxicological risk.

## 2.10 Groundwater

It is estimated that as much as 10% of global annual water consumption may come from depleting groundwater resources. Such over-abstraction – the water is effectively 'mined' – leads to falling water tables (in some areas up to several metres a year), increased pumping costs, land subsidence, intrusion of salt water into coastal aquifers, and ecological damage such as the drying of wetlands.

New techniques and institutional mechanisms are urgently needed to protect natural recharge areas from deforestation and erosion, actively enhance groundwater recharge and to protect the quality of precious aquifer reserves. Such strategies will include restricted access and providing incentives to users to limit or stop over-pumping. Setting withdrawal rates at or below recharge rates is one of the most unequivocal and important criteria for sustainable water resources management, though the estimation of recharge and water balance is not a trivial exercise. This issue highlights the role of hydrologists, hydrogeologists and hydrogeochemists in IWRM.

Groundwater, the preferred source of drinking water for most people in the world (more than 1,500 million people rely on groundwater for potable use), is also being polluted, particularly through industrial activities, poor sanitation practices, and agricultural chemicals and fertilisers. Aquifer pollution is also insidious and may take many years or even decades to manifest. Once pollution has occurred, clean-up is at best costly and at worst impossible with existing technologies.

The Ground Water Management Team (GW-MATE) is a new initiative of the World Bank and the GWP. A core group of experienced specialists in groundwater management aims at developing operational capacity in the management of groundwater, facilitating the implementation of management systems, and evaluating global experience. Again, both developed and developing country contexts need consideration, with adaptive approaches preferred.

## 2.11 Ecosytem degradation

Excessive withdrawals of water and in-stream diversions without sufficient attention to environmental impacts, as well as indiscriminate water pollution over many decades, have caused serious degradation of aquatic ecosystems in many parts of the world, including estuaries and coastal zones. Much of the economic progress in developed and transition economies, has been made, and is being made, at the cost of severe impacts on natural ecosystems.

In many developing countries, environmental degradation is driven by rapid population growth, rapid industrialisation and poor agricultural practices. Short-term benefits from development are not measured well against more chronic social and environmental costs: Deforestation to clear land for farming or to gain foreign exchange from wood export and industrial development, is a common practice devoid of attention to negative impacts.

The internalisation of environmental costs is an issue receiving increasing attention (see box 4 on page 22). Accounting for natural capital in the assessment of national assets is a parallel strain of enlightened environmental economic thought, though its practice is fledgling.

As a result of unsustainable development and degradation of freshwater ecosystems, it is estimated that 20% of the world's freshwater species have become extinct, threatened or endangered; and half of the world's wetlands have been destroyed in the 20th century, causing major losses of biodiversity

An adequate knowledge base is essential for the effective integration of ecological/ biodiversity conservation into water resources management and into strategic environmental impact assessments. Theoretically, any 'sustainable' integrated watershed/water resources strategy must account for the use of water by non-human species, and water's primary role in vital ecosytem functions, notably nutrient cycling.

Some positive developments are the following:

- in South Africa, the United States, the United Kingdom, the Rhine countries and Australia, legislation exists for the allocation of water for conservation of the natural environment;

Reference
UNEP, (1999). Agri-food production -facts and figures Industry and Environment , Vol. 22, No.2-3, April-Sept 1999, p 4

### Box 4: Internalisation of environmental costs

In 1999, the UN Conference on Trade and Development (UNCTAD) published a report *Environmental Cost Internalisation: Case Studies from the Czech Republic, Egypt and South Africa.* The report states that the internalisation of environmental costs is often proposed as a strategy for reducing environmental degradation. This strategy is based on the theory that users of environmental resources typically do not pay the full cost of using them, and are therefore encouraged to use or degrade more natural resources than would be the case if they had to pay for hem at full value.

However, internalising costs is complicated and can be difficult to implement, in part because there is no standard system for assigning value to environmental resources that may be intangible, such as clean air or ecosystem diversity. One of the greatest difficulties is identifying and measuring a society's priorities in making choices or trade-offs between what are commonly perceived as competing interests of development and environmental conservation.

### Box 5: Water reduction by invasive plants

A serious reduction of freshwater availability by invasive plants has been identified in South Africa. Research indicates that these plants waste an estimated 7% of the country's mean annual run off. If uncontrolled, the problem will double within 15 years, constituting the fastest growing 'water demand activity' in the country. Continuous physical clearing involves great cost, and increasing attention will have to be paid to biological control methods. Although relevant research has only been undertaken in South Africa, observations indicate that the problem is prevalent in the whole of Southern Africa. It might be prudent to conduct at least pilot studies in other low rainfall regions,

- there have been restoration successes such as the showcase returns of salmon to the Thames and Rhine Rivers;
- the EU has introduced standards and laws that have led to significantly healthier rivers.

Notable is the launch of the IUCN Water and Nature Initiative, involving more than 50 organisations. The main goal is the mainstreaming of an ecosystem approach into catchment policies, planning and management.

In final analysis, the degradation of the aquatic environment can only be effectively countered through improved recognition of the intrinsic and utility value of these systems and an understanding of the quantitative and qualitative water requirements of ecosystems.

In this context, there are huge gaps in our knowledge base. At the same time, a lack of knowledge should not be used as an excuse not to act today. It is almost universally the case that priority issues of water quality and/or quantity can be addressed with existing science and technology. The socio-political and cultural obstacles are more difficult to resolve, for example making multi-stakeholder consultation and participation work.

Another form of ecological disturbance that has serious impact on the conservation of water resources is that of invasive plants. This problem has recently been identified in South Africa (see box 5).



## 2.12 Desertification

Desertification results from a combination of unfavourable climatic conditions and poor land/water management practices in arid regions. The conceptual discussion of the phenomenon evolved during the 1980s and a consolidated document was discussed and approved during the UN Conference on Environment and Development, Rio de Janeiro, 1992.

During the conference, the General Assembly concurred with a request by several countries with desertification problems, for the negotiation of an international convention on this theme. This came to fruition in June 1994 in the UN Convention to Combat Desertification. It is ratified by 155 countries and has been in effect since December 1996. The success of such international policies requires thoughtful evaluation and the incorporation of lessons learned to effect ongoing improvements.

## 2.13 Hydropower

According to the E7 Observer (2000), hydropower constitutes a large share of the energy market in all major regions of the world, and nearly half the countries in the world have hydro projects under construction. In 1996, 18.4% of the world's electricity came from hydropower. At present it is the only large-scale energy source that is both renewable and economically viable, and is the largest contributor to the reduction of greenhouse gases from power generation.

The main drawback of hydropower is that reservoirs flood land area, altering the environment, existing habitats, flow regimes downstream, and the composition of fish populations. Although the total fish biomass usually increases, river fish populations tend to diminish in favour of lake-dwelling species. Dams can also hinder fish migration

A report published by the International Energy Agency in 2000 summarises the results of five years (1995 to 2000) of hydropower studies, conducted by six member countries. It recommends best practices based on a rigorous study of lessons drawn from environmental practitioners who worked on assessing and managing the environmental impacts of hydropower

The *E7 Observer* (2000) points out that according to popular perception, large hydroprojects have a greater environmental impact than small projects. However, actual comparisons based on units of energy produced, demonstrate that the impact may be less than the cumulative effect of several small projects yielding the same power and generating capacity.

## 2.14 Dams

Dams make water available for potable use, industry, irrigation, flood mitigation, and generation of hydropower. Today there are at least 45,000 large dams and nearly half of the world's rivers have at least one large dam. Dam building peaked in the 1970s, when on average two or three new large dams were commissioned each year. By then, especially in North America and Europe, most technically attractive sites had already been developed. India and China are now building the most dams.

Dams clearly play an important role in meeting people's needs. However, they also have considerable environmental and social impacts, which have generated substantial opposition to the building of further large dams. This led to a special meeting in Gland, (Switzerland), April 1997 (supported by the World Bank and IUCN), where the World Commission on Dams (WCD), was established. Its charge was to (1) review the development effectiveness of large dams and assess alternatives for water resources and energy development, and (2) develop

Reference
E7 Observer (2000). Hydropower: Energy of the Future. E7 Observer, No 24, Special Issue, 2000

internationally acceptable criteria, guidelines and standards, where appropriate, for the planning, design, appraisal, construction, operation, monitoring and decommissioning of dams. The Commission published its findings and recommendations in its report *Dams and Development: A New Framework for Decision-Making,* 16 November 2000.

According to the report, the degree to which large dams delivered planned services and net benefits varied substantially, with a considerable portion falling short of physical and economic targets. Furthermore, it was confirmed that large dams have generally led to serious environmental impacts, and had a marked tendency towards schedule delays and significant cost overruns. On the positive side, it was concluded that services provided by dams are considerable and the longevity of large dams was confirmed, with many dams continuing to generate benefits over 30 to 40 years of operation.

Alternative options to dams for meeting water demands mentioned in the report include demand management, improved hydrosystems management, basin and catchment management to reduce reservoir and canal sedimentation, enhanced groundwater recharge, water/wastewater recycling, and rainwater harvesting. Seven strategic priorities for decision-making were developed, and 26 guidelines proposed for the planning and implementation of future dams. It concluded that the end point of any project must be the sustainable improvement of human welfare. If a large dam is the best way to achieve this goal, it deserves support. Where other options offer better solutions, they should be favoured.

The International Commission on Large Dams (ICOLD), the International Commission on Irrigation and Drainage (ICID), and the International Hydropower Association (IHA) responded jointly to the report. They stated that the report presented an unbalanced negative judgement on the role of existing dams, while barely recognising their benefits. They were in basic agreement with the principles of the strategic priorities for decision-making, but regarded the 26 guidelines for the planning and implementation of future dams as unrealistic.

Opposition to the report also held that no reference was made to the fact that dams are often the only solution to water problems, and that in areas of intermittent river flow, such flow can virtually not be used for development without storage. It claims also that the commission failed to make an objective assessment of alternative water supply options.

## 2.15 Climate change

The Intergovernmental Panel on Climate Change (IPCC) was jointly established by UNEP and the World Meteorological Organisation (WMO) in 1998, to assess existing knowledge about the science of climate change, the associated environmental, economic and social impacts, and the possible response strategies. The 1999 report of the IPCC foresees that global temperatures will rise faster and higher than previously predicted, causing an accelerated rise in sea level, with drought and floods as some of the consequences. Events that seem to support these forecasts have already occurred. Although specific predictions about climate change on a regional level are not yet possible, scientists almost unanimously agree that the climate will change globally.

The world transportation and power generation industries constitute the main sources for the rise in greenhouse gas emissions. Some 60% of the world energy consumption is in the form of fossil fuels: coal, oil and natural gas. These energy sources, in addition to being non-renewable, contribute to climate change potential and acid rain on a planetary scale. After remaining more or less stable for more than 10,000 years, the concentrations of two key greenhouse gases – carbon dioxide and methane – have risen dramatically over the last two centuries. Since the industrial revolution, carbon dioxide has increased by 30%, methane by 145% and nitrous oxide by 15%.

In the longer term, any manifestation of climate change forecasts will constitute a major obstacle to improving the relative sustainability of development. Many millions of people may be forced to move from their homelands, due to increasing temperatures and drought. Even where precipitation might increase, it is unknown whether it would occur at the time of year when it could be used. Furthermore, this holds the potential for increased flooding.

Any rise in sea level from melting polar ice caps would cause a widespread intrusion of salt water into estuaries and coastal aquifers, plus the flooding of low-lying coastal areas. More dams may be needed in future to avoid sudden and destructive floods caused by climate change, adding fuel to the controversy over large dams, discussed in section 2.14

The threats of climate change also have a social dimension. According to Public Services International, trade unions identified climate change as the foremost threat to their future, considering the potential effects on workplaces, employment security, and the need for equitable transition programmes.

It is important to develop risk management and disaster reduction systems and to put in place early warning and monitoring systems. Increased funding to research this topic is required, as well as close collaboration between scientist working in this field. With IPCC, UNEP is assisting research institutions in 60 developing countries to assess the impacts of climate change and prepare detailed strategies for their vulnerable socio-economic sectors. Most efforts should, obviously, be targeted at reducing greenhouse gas emissions at source and conserving forested areas that are important sinks for carbon dioxide as well as habitats for many threatened species.



## 2.16 Shared water resources

Some 269 rivers and numerous aquifers are shared by two or more nations and approximately 15% of all countries receive more than 50% of their available water from upstream countries. In these cases, access to water and water quality management depends not only on national policies, but also on international relations and agreements. Competition for water among nations could become a potential source of conflict, but also a source of cooperation. Quality issues can more readily be the basis of collaboration, if only by getting parties to share information and develop joint action plans

According to the Global International Waters Assessment, the current usage of natural systems in the case of international waters, is unsustainable, as evidenced by the decline of fisheries, coastal ecosystems, freshwater quantity and quality, and the quantity and quality of water in aquifers.

Transboundary water is the most complex challenge facing water managers, and while IWRM can be shaped to fit the challenge, the practical experience of its application under these conditions is severely limited.

A positive development is the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, an international agreement that entered into force on 6 October 1996. An associated Protocol on Water and Health was signed by over 30 countries on 17 June 1999.

The Global Environment Facility (GEF) has a mandate to provide incremental funding to assist countries in incorporating environmental considerations in the management of international waters consistent with sustainable development goals.

## 2.17 Technology and new sources of freshwater supply

### 2.17.1 Desalination of seawater

The desalination of seawater is an obvious non-conventional source of freshwater, which has been exploited since 1957, when Kuwait became the first country to rely on desalination for drinking water. Today there are more than 7,500 desalination plants in operation worldwide, of which 60% are in the Middle East. In many other parts of the world, the cost of new conventional water supplies are more expensive than for existing supplies, and in some cases are already comparable to desalinated seawater. With desalination becoming increasingly efficient and affordable, the desalination of seawater can be expected to accelerate.

Energy use to desalinate water is high, and may contribute inadvertently to the climate change problem. The use of solar power would be ideal, but at present only lends itself to small-scale applications. Reverse osmosis of brackish water using solar energy is also becoming an attractive option to provide new fresh water resources in remote areas.

### 2.17.2 Water reuse

The hydrological cycle ensures that, one way or another, all water is reused. A great deal of water is reused unintentionally, but planned water reclamation is increasingly practiced, involving the reuse of treated municipal wastewater. The latter route constitutes an obvious and viable option for supplementing conventional water supplies. It also serves to ameliorate water pollution by diverting pollutants from the water environment

The practice of water reclamation came into prominence and accelerated since the early 1970s. It is now increasingly imbedded in water management policies and planning scenarios, ranging from national policies, to policies for states, cities and smaller communities. The key concept is that it is the end use that determines the acceptability of water quality and thus the appropriate level of treatment.

Agricultural irrigation is by far the most prevalent form of wastewater reuse. Wastewater-fed aquaculture is also applied to a significant extent. However, in some wastewater irrigation schemes no formal treatment is applied. The environment is used as an open treatment system, and while benefits from nutrient provision are important, the lack of an accounting for collateral costs of pollution from organic and inorganic substances gives a biased view in favour of the practice.

The use of upgraded sewage effluent in industry has made great strides, often in response to incentives. The industry with perhaps the greatest reuse potential is cooling in power generation.

Water reclamation for environmental reuse is also becoming very popular, including the creation of water bodies for landscaping, boating, fishing, wetlands and wildlife habitats. There are many opportunities for urban non-potable reuse such as irrigation of parks, playing fields and private gardens; fire fighting; toilet flushing and washing of vehicles and paved areas. For area-wide application, a dual distribution system is required as successfully pioneered at various locations in the United States.

Direct potable reuse is the most controversial form of wastewater reclamation. Many professionals see it as an attractive opportunity given current technology. However, such advanced treatment is not economical except in rare instances where extreme water scarcity or insufficiency makes alternatives like transfers from distant basins more costly. On the other hand, indirect potable reuse has been ongoing since the introduction of waterborne sewerage. In most of the world's major rivers, effluents (treated and untreated) are discharged and then withdrawn for potable use downstream - for example the Thames in England, the Rhine in Europe, and the Ohio in the United States.



### 2.17.3 Artificial rainfall enhancement

The ideal atmospheric conditions for precipitation formation occur when there is a relatively low concentration of aerosol nuclei, but with a wide range of particle sizes. Research indicates that the combined effect of many anthropogenic influences tends to increase the concentration of aerosol particles, and to homogenise particle size distribution. This can indirectly decrease precipitation potential.

Many studies have been conducted over several decades around the world, to develop methods for weather modification and specifically rainfall enhancement. There have been some very promising results in the last decade on the use of small hygroscopic particles for rainfall enhancement in continental convective clouds. Various experiments around the world by leading scientists and institutions have produced similar positive effects and this technology is partially supported by in-situ measurements and numerical modelling studies.

The World Meteorological Organisation is maintaining an active interest in positive weather modification. It provides information to its member countries in the form of guidelines, progress reports, workshops and conferences.

## 2.18 Poverty

More than a quarter of the developing world's people live in poverty, of which the lack of a healthy living environment, including inadequate access to safe water and sanitation, is a major component. Thus the UNDP's Human Development Report includes the lack of access to safe drinking water (along with access to health services and inadequate nutrition) as one of the five specific components of poverty.

The critical dilemma facing the water supply and sanitation sector is that the provision of these basic services in poverty-stricken communities, while a primary requirement of poverty alleviation and eradication, suffers a lack of economic sustainability because users' ability to, and willingness, to pay is very weak.

Poverty elimination is now a major theme for international development. The Social Summit in Copenhagen in 1995, the largest summit ever held, accepted the goal of poverty eradication 'as an ethical, social, political and economic imperative of mankind'. The Development Assistance Committee of the OECD donor countries has focused on halving the proportion of people in poverty by 2015.

There is a direct link between expanded provision of water services and the ability-to-pay by those who benefit. Better ways must be found to link affordable payments for services with subsidies that provide public health and economic benefits.

## 2.19 Privatisation

Globally, the vast majority of water supply and sanitation services are provided by government agencies and public sector bodies. Over the last decade or so, private sector involvement in water supply and sanitation services has steadily increased, and is an issue that was strongly advocated by the World Water Council at the Second World Water Forum in The Hague, 2000.

The rationale is that experience suggests the single greatest stimulus to improving service quality is competition, resulting from the participation of private companies in the provision of products and services that support the water and sanitation sector. Private sector and private-public sector provision of services requires responsible regulation, and information on comparative performance for transparency and accountability.

However, the private sector will only invest its money, managerial skills and know-how in a transparent regulatory environment without undue political interference, expecting a reasonable return on its investment with acceptable risks. For this reason the potential for increased private intervention is considerable with regard to the provision of services to more affluent urban areas of developing countries.

International private investments in water supply in developing countries have risen from virtually nothing to an accumulated $25 billion over the period 1990 to 1997. However, the extension of services to the poor remains more problematic, hinging on pricing and cross-subsidy policies. On average, only 30% of the costs for water services are now recovered in developing countries. Opposition to privatisation emerges where the quality and security of the service is openly secondary to the interests of shareholders.

Under a privatisation scenario, governments will have to play an important regulatory role. Reservations have been expressed about the capacity of governments in developing countries to manage large commercial entities, due to a lack of regulatory capacity in most of these countries. This is a compelling argument in favour of the participation by the private sector (alongside other stakeholders) in strategic capacity building that strengthens users' education, local monitoring, regulatory frameworks and basic infrastructure together – all as agents of market stability.

Public Services International (PSI) takes a strong viewpoint against privatisation in the report *Water in Public Hands* (June 2001). It states that experience by PSI members has shown that broader social and economic objectives associated with water are placed in jeopardy by some market-based approaches. The following problems associated with the privatisation of water services are listed:

- unfair competition through domination of the market by a few multinational enterprises,
- higher prices to the water users,
- serious water equity issues with the poor being penalised by unfair pricing and debt burdens,
- difficulty in terminating unsatisfactory concessions,
- poor results from private management.
- private sector reluctance to extend services to the poor,
- use of water profits to subsidise other global investments,
- increased difficulty in regulation, loss of transparency and secrecy.

## 2.20 Targets and investment requirements

The Framework for Action and Vision 21 initiatives identified targets and investments needed as a result of these initiatives.

Annexe 1 (page 44) contains a detailed summary of targets, costs, and investment requirements.



# **Part 3:** Integrated water resources management (IWRM)

## 3.1 IWRM history and definition

Water planners, investors and engineers of the last century have to one degree or another recognised the linkages between water and sanitation systems, and the communities with in which they function. As the 20th century progressed, there was increasing realisation of the need to consider more than the benefits and costs of individual projects. The creation of the Tennessee Valley Authority in the 1930s represented a first approach to IWRM. Although it lacks goals that prioritise sustainable environmental protection, it did enable improvements in public health, flood control, power generation, water supply and regional economic stimulus.

In mid-century, the Ruhr River Association established coordinated monitoring and wastewater management programmes. The United Kingdom provided leadership with its River Basin Authorities, the first truly multiple function water management entities that included significant environmental considerations. Water planning activities became increasingly river basin oriented.

Regional or basin-wide water quantity allocation became the subject of numerous national and international activities including work on such rivers as the Danube, the Colorado, the Rio Grande, and the Jordan. Planners began to theoretically recognise the need for a planning process that integrates economics, environmental sustainability, institutional issues and community involvement, with water management systems, regulations and investments.

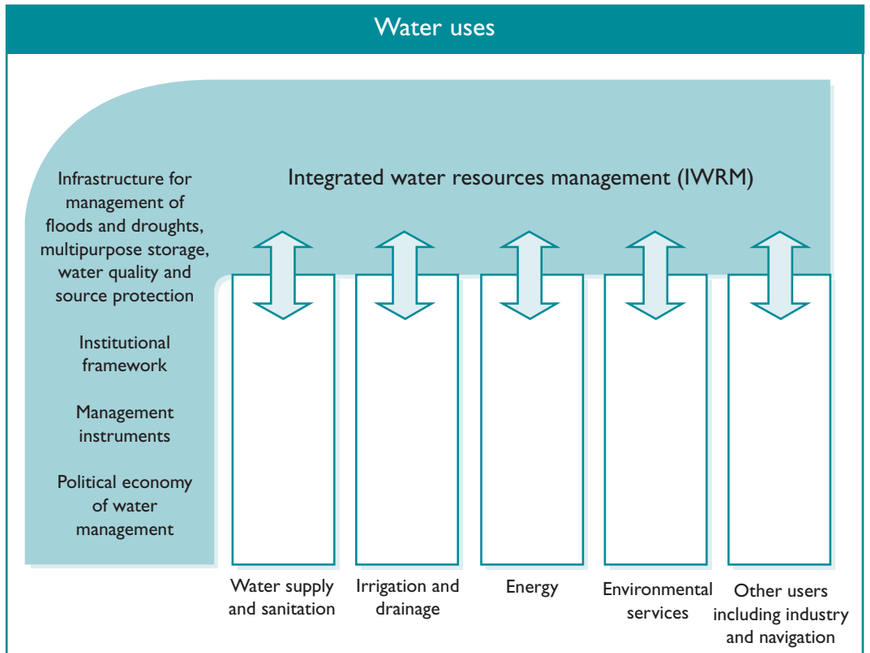
Against the preceding background, the IWRM concept became formally established in global thinking in the period 1990 to 1992. It was postulated in the New Delhi Statement (1990) and the Dublin Statement (1992). Chapter 18 of Agenda 21 deals specifically with water resources, and strongly emphasises IWRM as the key driver in the protection of water quality and the sustainable use of water. This is clearly evident in the very title of chapter 18: 'Protection of the Quality and supply of Freshwater Resources: Application of Integrated Approach to the Development, Management and the Use of Water Resources'.

GWP provides the following broad definition of IWRM: 'IWRM is a process that promotes the coordinated 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.'

IWRM is truly an evolving process: 'IWRM has neither been unambiguously defined, nor has the question of how it is to be implemented been fully addressed. What has to be integrated and how is it best done? Can the broad principles of IWRM be operationalised in practice – and, if so, how?,' (United Nations Global Water Partnership, Technical Advisory Committee, 2000.)

The essential challenge for effective IWRM is to find the right balance between protecting the resource itself – ground and surface water – while meeting social and ecological needs and promoting economic development. Practical procedures for the implementation of IWRM are not yet well defined, but at the same time, many investments including those described in this report are urgently needed and cannot be delayed. The challenge is to find the appropriate way to include factors related to IWRM without delaying achievement of the World Water Vision goals.

A recent World Bank proposal contains the following diagrammatic representation of IWRM and its relation to sub-sectors:




## Box 6: Principles of IWRM

- IWRM should be applied at catchment level.
- It is critical to integrate water and environmental management.
- A systems approach should be followed.
- Full participation by all stakeholders, including workers and the community.
- Attention to the social dimensions.
- Capacity building.
- Availability of information and the capacity to use it to anticipate developments.
- Full-cost pricing complemented by targeted subsidies.
- Central government support through the creation and maintenance of an enabling environment.
- Adoption of the best existing technologies and practices.
- Reliable and sustained financing.
- Equitable allocation of water resources.
- The recognition of water as an economic good.
- Strengthening the role of women in water management



## 3.2 Principles and elements of IWRM

IWRM principles have been elaborated upon and refined by several international meetings. Principles that are generally accepted for effective IWRM, are listed in box 6. These elements are expanded on in Annexe 2.

Table 1 lists a range of activities that might be appropriate. The elements are conceptual and it is recognised that the elements to be included in each IWRM plan or programme will vary by location, both as to applicability and level of effort expended.

**Table 1: IWRM activity list**

| IWRM activity | Basic approach | Comprehensive approach |
|---|---|---|
| 1. Establish regional and catchment goals | Short-term needs considering long-term factors | Long-term needs considering short-term impacts |
| 2. Comprehensive information base | Obtain existing information and experience | Combined available information with new data reflecting management needs |
| 3. Projecting future conditions | Predictions based on recent experience and goals | Develop alternative scenarios reflecting alternative goals and investments |
| 4. Governance | Accept existing but review concepts that assist in new goals | Analyse alternative concepts and opportunities for change |
| 5. Strategy development | Design activities consistent with multiple existing goals | Consider alternative strategies and their relative value in achieving multiple objectives |
| 6. Environmental integration | Consider sustainability of projects in the context of present and likely policies on sustainability | Develop integrated programmes that optimally achieve multiple objectives to assure asset and environmental sustainability |
| 7. Operating practices | Assure co-ordination of present and proposed activities | Create new efficient operating practices to optimise public service |
| 8. Strengthen local capacity to implement IWRM | Optimise existing capacities to support IWRM goals | Carry out diagnosis of capacity gaps and prioritise actions to strengthen those capacities considered to be strategic for improving sustainability of IWRM |

## 3.3 Progress in the development of IWRM

Progress towards more informed and intelligent decision-making with regard to resource and environmental programmes has been steady. However, progress has been characterised by only partial integration of all the related activities. Various international agencies are promoting the concept and numerous meetings have taken place and initiatives launched to facilitate the development and implementation of IWRM.

The UN Economic and Social Council, acting as the preparatory committee for the World Summit on Sustainable Development, Johannesburg, September 2002, concludes as follows in its report *Water: A key resource for sustainable development:*

'Despite many major international water meetings that have had an impact on the formulation of integrated national water policies and programmes, the implementation of integrated water resources management has not been fully achieved in either developed or developing countries. Water management issues continue to be dealt with on the basis of fragmented sectoral approaches.'

While this statement is true in general, water management efforts at all levels are increasingly considering individual project actions in a broader context that includes the sustainability criterion. The principal challenge for the water sector is how to achieve a wide range of goals, in widely varying institutional, geographic and cultural contexts, without significantly delaying high-priority improvements. Strategic planning to identify, design and implement priority actions is the core strategy.

## 3.4 Obstacles to the implementation of IWRM

A main obstacle to the successful implementation of IWRM is weak funding, particularly in developing countries. There are also other obstacles.

### 3.4.1 Fragmentation of institutional responsibilities

It is recognised that in most countries, a major obstacle to the planning and implementation of IWRM principles, is the division of responsibilities that frequently results from historic patterns of administration unable to adapt to changing conditions. For instance, surface and groundwater, water and wastewater are often planned, regulated, and managed separately. In addition, there is insufficient linkage to planning and management in other sectors that impact water management, notably urban planning and industrial development.

The most important missing link is probably that between land use and water use. For example, land use planning, including activities such as deforestation and urbanisation, has a direct impact on the quantity and quality of water available. Serious questions should be asked about the suitability of sitting urban centres or thirsty agriculture in water-stressed regions. The sustainability of the natural resource base is too often ignored.

Institutional transformation to support IWRM is essential. Failure to achieve this can often be ascribed to a lack of political will.

### 3.4.2 Workplace approaches

Public Services International (PSI) reports that there is a general lack of understanding of and attention to the positive contribution that innovative work-place approaches can play in achieving IWRM objectives. Experience has demonstrated the efficacy of workplace-based approaches (industry and agriculture) to tackle issues of water usage and pollution control, with the potential for 'spill-over' into changed patterns of personal and community life.

Thousands of workplace health and safety committees around the world have provided models for workplace action on such issues as chemical contamination, environmental quality and occupational health. Workers constitute invaluable sources of knowledge and experience, usually requiring only the opportunities and mechanisms to contribute.

PSI reports that it had achieved success in working with employers to develop workplace eco-auditing tools, as a first step in developing an integrated approach to water-related issues in the production process. Workers were involved in:

- water consumption and cleanliness at the workplace: attention is given to upkeep, maintenance and cleaning of work sites and related properties; and to human support services (such as sanitation, food, beverages and personal water consumption at work);
- wastes from the workplace: audits reveal where it is possible to reduce consumption and introduce cleaner production through waste minimisation and recycling, etc;
- water-related impacts of workplace inputs: full accounting of materials and resources brought into the workplace points to changes in purchasing policies (relevant to environmental considerations), but also to appropriate staff education and training programmes.

### 3.4.3 The potential complexity of the IWRM concept

The IWRM concept is at once simple and complex. It is just common sense to consider actions affecting an essential life-sustaining resource such as water in the context of natural environment and man-made facilities, systems, regulations and planning. There are numerous examples or models of programmes that reflect elements of IWRM.

But as our understanding of the inter-relationships increases, past resource management concepts are not likely to be fully adequate to the task.

Chapter 18 of Agenda 21 succeeded in firmly lodging the IWRM concept in the collective mind of the water industry. A penetrative analysis of the various elements that constitute IWRM was assessed. This was presented in the form of a detailed list of actions that would be necessary for the implementation of IWRM. It is possible that a perceived complexity of IWRM, as projected in Agenda 21, presented a barrier to its rapid implementation. Agenda 21 was more object-oriented, less process-oriented.

Exactly how these multiple actions could be implemented was not fully explored. The vision of grand-scale IWRM, without explicitly allowing for strategic planning or a phased approach, is a daunting prospect, especially for poor countries with low installed capacity to carry out even the most basic aspects of the approach. IWRM is, after all, a management model derived from developed countries and, like any model, it must be adapted to local realities and shaped to address local priorities.

### 3.4.4 Need for reference projects

It is obvious that, in view of regional differences, there can be no universally applicable blueprint for IWRM. Stakeholders in each region must design a process that will serve their particular needs and circumstances. The administrative, socio-economic, land-use and environmental resource character of catchments will indicate opportunities and constraints for their management.

Although the historic knowledge base in this field contains many examples of partial success, as measured by today's standards, the concept could be advanced by providing models or reference projects that demonstrate implementation of the elements discussed in this report.

There is also a need for performance indicators to measure when the principles of sustainability, equitable use of water and participation have been achieved. A sufficient knowledge base is lacking and there are few proven strategies and models to move from theory to practice.

The Framework for Action expresses this need for success stories as follows: 'Without documented proof of success, many governments and others are sceptical that communities can manage their own supplies, particularly at any scale larger than a village.'

A number of collaborative initiatives are ongoing which should serve to establish a valuable body of reference projects.

- the ToolBox on IWRM is one of the flagship projects of the GWP. The ToolBox brings together global knowledge about and experience with IWRM in an assessable form. Case studies form a central element of the Toolbox and provide a valuable dissemination mechanism for improving practical understanding of IWRM;
- the HELP initiative by UNESCO and the WMO. It is aimed at establishing a global network of catchments to improve the links between hydrology and the needs of society;
- the Danube Environmental Programme, implemented under the Global Environment Facility (GEF) International Waters programme, with the WHO as a collaborating partner;
- one of the objectives of an initiative by the GEF, IUCN, the World Bank and the World Wildlife Fund (WWF), is to demonstrate, in collaboration with participating countries, how to operationalise integrated land and water resources management in six to ten river, lake and coastal basins.

### 3.4.5 Lack of adequate skills, expertise and awareness

In accepting the approach that IWRM should be implemented at catchment level, the implication is that the necessary expertise, skills and resources will be available to the relevant catchment authorities. Most developing countries at the present time lack sufficiently skilled human resources at local level. Even in the case of more developed countries, there is still very little installed capacity within government for managing the required reforms implied by IWRM.

Integrated capacity building is therefore of overriding importance for supporting the implementation of IWRM. Universities and research institutions, in both developed and developing countries, should be better geared to educate and train people who can successfully plan, implement and maintain IWRM strategies under constantly changing social, economic, environmental and political conditions

A vision of education, training and awareness-building needs in the context of IWRM was presented at the Second World Water Forum in The Hague, 2000. This was contained in a Framework Paper *Water-Education-Training (W-E-T): Towards a sector vision of educators and those to be educated.* The paper was coordinated by the International Hydrological Programme (IHP) of UNESCO, and was issued under auspices of UNESCO, UNDP, the IHE Delft and the World Bank Institute.

The W-E-T Vision aims to reflect the whole scope of education, including the formative years at pre-school, primary and secondary educational levels, vocational training, university and professional education at undergraduate and postgraduate levels, life-long continuing education and training, as well as informal and innovative ways of knowledge and information transfer. It also emphasises the essential role of research in education and training.



A further noteworthy development is the International Network for Capacity Building in IWRM (CAPNET). It is an associated programme of the GWP and UNDP, with the Netherlands as initial sponsor.

### 3.4.6 Lack of adequate and reliable data

IWRM can only be rationally and effectively implemented if consistent and reliable data are available on all water-related issues – information gaps have the effect of making important water issues invisible. This was clearly implied in chapter 18 of Agenda 21, stating that there was growing concern that hydrologic services and related bodies were less able than before to provide essential information, especially information on groundwater and water quality. Unfortunately it does not seem as if the situation has improved, and may even have deteriorated, as indicated in the following reports:

- The UN Economic and Social Council, in its report of March 2001, emphasises the crucial importance of data collection at field level, and concludes that there has been a decline in the quantity and quality of information on the availability and use of water resources.
- The World Hydrological Observing System (WHYCOS) comments in 1998, that many developing countries are unable to maintain their systems for acquiring water-related data and for disseminating them to decision-makers, engineers, resource managers and the public.
- Vision 21 states that beginning in the 1960s, data on access to safe drinking water and sanitation services had been collected by national governments and the UN. However, different countries often use different definitions of 'access' to water. Some countries have changed their definitions of adequate sanitation; not all countries report data on access; data from different years are sometimes conflated; and the quality of data is sometimes compromised by political considerations.

There are three major initiatives to strengthen data generation:

- WHYCOSS was launched in 1993 by the WMO, in association with the World Bank. Its objectives include the strengthening of the technical and institutional capacities of hydrological services to capture and process hydrological data.
- The GEMS/WATER Programme was initiated in 1976 by UNEP and the WHO, with the assistance of UNESCO and WMO, to improve water quality monitoring capabilities in participating countries, and to determine the status of regional and global water quality.
- In March 2000, the UN system announced that 24 UN organisations will combine their efforts to create a biennial Assessment of the World's Freshwater. The effort is designed to reduce major global information deficiencies and gaps. The World Water Development Report will be the central product of a people-centred, comprehensive initiative to assist developing countries to improve their monitoring, assessment and reporting capacity, with particular focus on water quality, water use, health impacts, and river basin management.

It should be recognised that any decision-making database for IWRM needs to be at the catchment-scale. Informed decision-making requires the use of reliable data on local watershed conditions that encompass several topics: hydrology, ecology, water quantity, water quality, climate, stakeholder needs and priorities, as well as cultural values, attitudes and behaviours.

Lack of access to existing data can be a major problem, especially at the local and river basin level. Government agencies tend to be over-protective of their data, and access is denied to other stakeholders even though the data are public-funded, public domain information. A related data issue is the multiplicity of data

formats used that renders integrative interpretation very problematic, if not impractical. Also, there is often a lack of clear criteria for the selection of indicators that can provide the data that policy makers need, and its presentation is usually not conducive to simple application. Attention must be paid to universally strengthening the link between science and policy.

### 3.4.7 Gaps in available knowledge and technology

There is a range of priority areas where research must be increased. Furthermore, knowledge and technology that do exist or become available should be effectively transferred to those that can benefit from them.

Some of the research issues that need to be addressed at global level, include:

- climate change - expected range of impact on water and food security;
- public health risks;
- water requirements to maintain healthy freshwater ecosystems;
- intrinsic and utility valuation of ecosystems,
- life cycle assessment studies on activities that impact water-related issues;
- demand management;
- effective, robust and low cost sanitation systems;
- development of crops that are more drought and salt tolerant.

Research in these areas is ongoing, but needs to be accelerated and synergy created through collaborative research. It is also important that some of these issues be researched in developing countries, as research and developement (R&D) and the development of human resource capacity are two sides of the same coin. Proposals have been made by the World Water Council and in the Framework for Action that an innovation fund be established for this purpose.

Suggestions for the creation of Virtual Centres of Excellence to address some of these issues, are presented in Section 4.2.

As far as the transfer of information and technology is concerned, various initiatives have been launched, or are in the process of being launched. For example:

- the GWP recently created an Infonet service for water conservation in agriculture, coordinated by the International Programme for Technology and Research in Irrigation and Drainage (IPTRID);
- GLOBWINET is an Information Network on IWRM, focusing on trans-boundary river basin organisations, water legislation, and national water administration. It is a GWP-associated programme;
- the Euro-Mediterranean Information system, Know-how in Water (EMWIS) is a regional network covering 27 countries and is disseminated in 15 languages;
- the STREAM Programme, led by the International Reference Centre, has synthesised the lessons of four years of action research on community water management in 22 communities in six countries;
- more than eight organisations have combined their efforts in the Sanitation Connection. It makes up-to-date information available online relating to sanitation issues (http://www.sanicon.net).



# **Part 4:** Proposals for facilitating the implementation of IWRM

## 4.1 A phased and simplified approach to IWRM

It is suggested that a new 'marketing strategy' for the implementation of the IWRM concept be launched. This should steer away from urging the immediate launch of comprehensive grand-plan IWRM strategies, and propagate a far more realistic approach based on flexibility, incremental and evolutionary gains, and an initial approach directed at key issues of importance to all stakeholders. The best way to eat an elephant is bit by bit!

This initial focus on one or more priority problems creates cohesion and promotes willingness to take responsibility for management decisions. Other issues can be taken on board once experience and initial success is achieved. This allows for an adaptive management approach, which responds to changes in information and circumstances, and to gains in experience and understanding.

A study on various Australian and United States initiatives (Margerum, 1999), revealed that major implementation problems in catchment management were experienced, due to weak planning. Strategic plans were only wish lists. Plans lacked strategic focus and effectiveness and were often too broad and too vague to provide direction. It is better therefore to develop a relatively simple plan based on common objectives, than a grand-scale plan that cannot be implemented.

The phased approach does not imply that the vision of comprehensive IWRM and sustainability be abandoned - it just means a flexible, step-wise approach towards the ultimate goal. The larger, long-term operational context of simplified, priority phases is still the IWRM context. This is an approach particularly appropriate for developing countries with clear water supply and sanitation priorities, but no clear planning and implementation framework.

GWP in concert with resource planning agencies is well positioned to propagate this approach.

## 4.2 Virtual centres of excellence

There are certain areas of knowledge and technology – supportive of IWRM – where it is necessary to accelerate research and create research synergy through effective collaboration. This could be achieved through the establishment of 'Virtual Centres of Excellence' (VCEs), each comprising a collaborative network of nodes, across the globe, working on complementary topics.

VCE research would focus squarely on filling in knowledge and technology gaps that stand in the way of sustainable water management issues such as water supply and sanitation provision. Working partnerships between VCEs and stakeholders in target communities – in the spirit of IWRM – should be encouraged so that applied research tackles strategic topics within local cultural contexts.

The interactive peer review that is implicit in the VCE concept will significantly enhance the credibility of research, which is crucial for accelerating the adoption and diffusion of knowledge and technology. If such VCEs were to function in association with a UN agency such as UNEP, credibility would be further enhanced.

UNEP could act as the co-ordinating/facilitating agency for the development and operation of such VCEs. Depending on the nature of a

Reference
Margerum R D, (1999). Integrated Environmental Management: The elements Critical to Success. Environmental Management 24 (2), 156-166

specific VCE, it could either maintain the overseeing function itself, or delegate it to a prominent institution. It is foreseen that limited financial support would be provided, mainly for travel purposes. Invitations would be widely directed to the global research community to join a specific VCE, but research expenses would be borne in-house. Meetings of researchers would be necessary from time to time to discuss research objectives, methodology and collaboration. This would need financial support.

Examples of topics that are particularly pertinent to IWRM and could be accelerated and strengthened through the establishment of VCEs', are discussed below.

### 4.2.1 Water-related resource economics

The degradation of the aquatic environment can only be effectively countered and corrected through an improved understanding of its value, functional requirements and the availability of monitoring systems. Sustainability and environmental goals and related actions cannot only be measured in economic terms. Benefits must include intangibles, such as aesthetic value, but how can these factors best be included in priorities and decision-making?

There is an urgent need for resource economic studies to assess the costs and benefits of implementing natural resource protection, rehabilitation, and wise use. Such studies are difficult and complex, and outcomes will differ between various regions. However, it is important that the methodologies followed should be able to stand the scrutiny of international peer review. This would engender international credibility for study outcomes.

This research theme could significantly benefit from the establishment of a relevant VCE. Such a VCE could deliver outputs that can become key inputs in driving the sustainability of water management practices.

### 4.2.2 Water requirements to maintain aquatic ecosytems

Another knowledge area that needs to be urgently expanded in order to promote IWRM is understanding the quantitative and qualitative water requirements of ecosystems. This information is vital for environmental water allocation. Natural system advocates insist on conditions as close as possible to those unaffected by humans. However, a more realistic approach requires evaluation of resource use and related environmental benefits such as the sensitivity of stream-flow to modification for water supply, and impacts of diverted flows on aquatic ecosystems. There is a significant need for standards of practice and criteria for water allocations that support aquatic ecosystems.

There is ongoing research on this topic at some centres around the world. By placing this research on a higher profile through the establishment of a VCE, peer interaction will accelerate progress in a very complex field. Outputs can feed into decision-support models for environmental water allocation and water quality control. It must be stressed, however, that academic VCEs must move away from the complex theoretical models that cannot be used by water planners, in favour of simple, practical gains in our collective knowledge base that further the goals of IWRM. Interaction with stakeholders should ensure this, steering the research in the appropriate direction, with peer review providing quality control.

### 4.2.3 Industrial by-product recovery

Product recovery from industrial waste streams, and the recycling and reuse of wastes can reduce treatment costs and result in reduced need for raw materials, including water. It is generally recognised that it is necessary to transition from the traditional regulatory environment to one that provides incentives for resource conservation, including practices that would result from 'integrated resource management'.



A considerable range of case studies, demonstrating industrial by-product recovery at pilot and full-scale, has been reported. Although case studies refer to specific industries and locations, the relevant technologies could well be applied in other industries with similar types of waste streams.

However, the recovery of by-products from waste streams in industry is not yet a widespread practice. A basic reason is that the type of by-products that can be produced from a specific factories waste streams, mostly do not fall within that factories mainstream range of products

The establishment of a VCE on this topic can serve a number of purposes. The recovery concept will gain higher visibility by linking together those who are researching or applying product recovery processes. The transfer of recovery technology between industries with similar types of waste streams can be promoted, and it can stimulate commercial ventures to undertake by-product recovery and marketing on behalf of factories.

### 4.2.4 Life cycle assessment in the water sector

The fundamental concepts of Life Cycle Assessment (LCA) – historically referred to as engineering economy and sometimes called life cycle analysis – provide a tool to understand, manage and reduce the environmental impacts associated with a product, process or activity, by considering all life cycle stages, from 'cradle-to-grave'. Each stage has associated costs and environmental burdens, and LCA allows the comparison of these burdens in a systematic and scientific way. This materials balance methodology is thermodynamically rigorous because all input mass is accounted for as output product, stored mass or waste stream.

LCA has been well researched in the field of industrial manufacture, and is finding increasing application. However in the water field, very little LCA research has been done. It needs a stimulus that could be provided by the establishment of a VCE on LCA application in the water sector.

### 4.2.5 Water minimisation clubs

An alternative strategy to assist smaller manufacturing companies in improving their environmental performance, is to establish regional waste minimisation and effluent treatment 'clubs', in which the industrial members can be collectively encouraged and assisted to cost-effectively implement cleaner production practices. Experience in Europe has indicated that it takes time to establish the culture of waste minimisation clubs but, once established, large savings (financial and environmental) can be achieved. In South Africa the development of waste minimisation clubs has also been successfully pioneered and the approach is spreading to all the major industrial areas of the country, using local expertise.

The strategy of waste minimisation clubs need to be widely disseminated, particularly to developing countries where support to adequately deal with industrial pollution, is often lacking. A VCE on waste minimisation clubs could be an ideal vehicle to perform this function. The industry associations may be tapped to reinforce this concept, together with those organisations that are promoting the concept of cleaner production.

## 4.3 Integrated urban water management

The fundamental premise is generally accepted that IWRM should be applied at catchment level, recognising the catchment or watershed as the basic hydrological unit of analysis and management. At implementation level, there is a growing conviction that integrated urban water management (IUWM) could be pursued as a vital component of IWRM within the specific problematic context of urban areas.

Cities are dominant features in the catchments where they occur, and successes in IUWM will make important contributions to the theory and practice of integrated catchment management (ICM) and IWRM in the broader basin context. Thus, IUWM is not seen as a goal in itself, rather a practical means to facilitate one important sub-system of the hydrological basin. IUWM must inter alia endeavour to optimise the interfacing of urban water concerns with relevant activities beyond the urban boundaries, such as rural water supply, down-stream use, and agriculture.

IUWM means that in the planning and operation of urban water management, consideration should be given to the interaction and collective impact of all water-related urban processes on issues such as human health; environmental protection; quality of receiving waters; water demand; affordability; land and water-based recreation; and stakeholder satisfaction.

In addition, IUWM requires involvement by stakeholders such as those responsible for water supply and sanitation services, storm water and solid waste management, regulating authorities, householders, industrialists, labour unions, environmentalists, downstream users, and recreation groups. While local authorities are well placed to initiate and oversee IWRM/IUWM programmes, planning and implementation should be driven by a combination of top-down regulatory responsibility and bottom-up user needs/obligations. Top-heavy governmental approaches are to be discouraged because they become bureaucratic and unresponsive to the concerns of water users.

IUWM is already a formal sub-programme of UNESCO's International Hydrological Programme (IHP). It is furthermore strongly supported by IWA and the International Council for Local Environmental Initiatives (ICLEI). The UNESCO Symposium on Frontiers in Urban Water Management: Deadlock or Hope?, Marseille, June 2001, issued the Marseille Statement (attached as annexe 3 on page 51) which recommends the adoption of IUWM.

It is urged that the Johannesburg World Summit on Sustainable Development, Johannesburg, September 2002, endorses and supports IUWM methods as an important part of IWRM.

## 4.4 Co-ordinating the activities of international agencies

International agencies cannot provide the massive financial investments for providing water and sanitation services or for implementing full-blown IWRM approaches. However, they can and do play a vital role in providing support for issues such as capacity building, research, guidelines for good practice, pilot IWRM programmes, monitoring and data collection. However, a serious problem is the lack of coordination between the various agencies which, in addition to anything else, serves to create a 'confusion barrier' between programme outputs and those who can benefit from them.

The situation is well described in the following statement contained in *Water: A key resource for sustainable development* (UNESCO, March 2001):

'There is no single international institution that deals exclusively with water resources issues. Those issues are by their nature cross-cutting and multi-disciplinary and any international institutional set-up must deal with a wide range of related environmental, social and economic questions at all levels. Taking this into account, there is need for international organisations involved in the water sector to further prioritise co-ordination, collaboration and integration of work.'



Duplication of effort is one of the most serious costs of bad communication.

This view was echoed in the Ministerial Declaration adopted in the Ministerial Session of the International Conference on Freshwater, Bonn, December 2001: 'We call upon the Secretary General of the United Nations to strengthen the coordination and coherence of activities within the UN system on water issues in an inclusive manner.'

To set up co-ordinating structures will take time. An initial measure that can go a long way towards eliminating confusion and promoting access and use of agency outputs, would be the compilation of a database, a 'road map', of agency activities, on a single Web site. This would be updated as new programme outputs become available or new initiatives are launched.

## 4.5 Launching structured south-south initiatives

Traditionally, the transfer of information and technology to developing countries, mainly occurred in north-to-south mode, which to some extent is a 'top-down' approach. More emphasis needs to be placed on south-south initiatives, as many developing countries have similar circumstances.

The GWP initiated a network of nine regional water partnerships and some 20 Country Water Partnerships in the south. This is a good example of a structured south-south initiative. The various partnerships bring stakeholders in countries, regions and inter-regionally together, to discuss and act on water problems using experience from other parts of the world.

IWA has taken a strategic decision to collaborate with others in the launching of south-south initiatives. This will involve the bringing together of those with successful 'home-grown' technologies and strategies, with those that could potentially benefit from them. Examples of these with great potential for south-south transfer, would be: the condominial sewerage system in Brazil; the Orrangi approach in Pakistan; water demand management protocols developed in Namibia; water harvesting techniques in India; and the water services investment models developed and widely applied in South Africa.

IWA and the WSSCC are in the process of planning the launch of a south-south initiative, which would serve as a pilot project for extension to a wider series of initiatives on a sustainable basis.

In addition, more equitable, collaborative north-south partnerships should also be encouraged, for example between university stakeholders carrying out basic enabling scholar-practitioner cross-disciplinary research for IWRM (see VCEs above). This will foster a much-needed cross-fertilisation of ideas and cultural awareness that is presently seriously lacking, as well as a healthy realisation of common water priorities that bridge the development divide.

## 4.6 Demonstation sites for dry and low-water-use sanitation systems

From the perspective of growing water shortages in many countries, as well as the increasing pollution of surface waters, the sustainability and universal applicability of the western model of water-based sanitation is being seriously questioned in many quarters. However, the prestige and utility value of waterborne sewerage is so high, that even the poor are often prepared to pay for it, provided the quality of the service is high enough.

Research should, therefore, also include the development of dry or low-water-use sanitation models for upscale market acceptance, in those areas where water

sources are protected and conventional sanitation services prohibitive.

The pit latrine (traditional or the ventilated improved pit latrine – VIP) is, of course, a dry system and the most common form of sanitation for informal settlements and peri-urban areas around poor cities. However, acceptability is not always high, and proper account is seldom taken of hydrogeological conditions, resulting in groundwater pollution.

Novel dry sanitation systems, as well as eco-sanitation (sanitation involving minimal water usage, and separation and reuse of faeces and urine) which avoid groundwater pollution and allow organic fertilizer recovery, are being tried and implemented around the world. Such initiatives are scattered and institutions interested in exploring the application of these sanitation systems find it difficult to logistically access demonstration units on a comparative basis.

The use of dry or low-water-use sanitation systems can be promoted by establishing demonstration sites where different systems can be displayed. Such demonstration sites should:

- be developed on, or adjacent to, the premises of creditable organisations that can oversee proper maintenance, and supply brochures and cost information;
- exhibit units that are supplied at no cost by the vendors of the various technologies;
- located judiciously across the globe, in order to shorten access distances for those who may be interested.

This is an initiative that may be launched on pilot scale by the WSSCC.

## 4.7 The role of professional water associations

Perhaps the single greatest weakness in achieving what are to a large extent agreed-upon IWRM goals, is the lack of sufficient bridging between those who do enabling science, those who establish policy and those who implement management plans.

An invaluable resource to the global water sector that has never been fully utilised by international agencies, is the immense pool of expertise, and goodwill, represented by the members of international professional water associations. Collectively, the professional associations comprise what could be seen as a 'mediating stakeholder' between science, policy formation and policy implementation. By involving professional associations, appropriate advocacy can be spread among members who in turn will 'pass on the message' to the workplace.

Associations can also draw on the expertise of their members to the benefit of ongoing programmes. Professional associations are well positioned to assist in the generation and transfer of knowledge and technology, and to provide scientific support in policy formation.

At present, this important stakeholder is largely ignored and, on occasion even snidely so. This is evident from the following quote from a document which referred to preparatory discussions for the Second World Water Forum, The Hague, March 2000:
*'Organisations such as the International Water Association, the International Water Resources Association and others have been told, in no uncertain terms, that their role is to support the wider community, not to tell it what to do. It was in fact only as a last minute concession that the professionals were given a chance to make their presentation to the forum's plenary meeting. The message was very clear. The agenda lies with communities of water users, not with self-appointed technicians.'*



In this context it is encouraging to note the following statement in the document *Water – A Key to Sustainable Development,* which contains the recommendations arising from the International Conference on Freshwater, Bonn, 3 to 7 December 2001: 'Professional and scientific organisations, with their extensive knowledge and experience, should contribute increasingly to manage water. They should widen their professional scope and engage with more interdisciplinary and cross-sectoral approaches'.

A mechanism to involve professional associations would be through memoranda of understanding between specific agencies and associations.

# **Annexe 1:** Targets, costs and investment requirements

## Targets

Box 1 presents targets for global water security, mainly generated by the Framework for Action and Vision 21 initiatives. These are indicative targets and governments are expected to establish their own national water security targets based on the global targets. The extent to which governments do this, will demonstrate their political will and commitments to move forward with sustained funding and infrastructure support. Set targets should be clearly defined and indicators developed to enable progress to be monitored. GWP is prepared to assist countries in developing their targets.

The indicative water security targets developed by the Framework for Action and Vision 21, included in box 1, represent a synthesis of the deliberations of the many hundreds of people that have been consulted.

## Costs and investment requirements

Information presented in the World Water Vision report is that total investment in water services (water supply and sanitation) in 1995 was $70 billion to $80 billion a year. The largest investor in services was government - the traditional public sector - that contributed about $50 billion a year. The private sector, ranging from small water vendors to private municipal and metropolitan utilities, contributed about $15 billion. International donors contributed a further $9 billion for both water and sanitation services and irrigation and drainage. The international private sector contributed about $4 billion a year.

The World Bank's database on Private Participation in Infrastructure, showed that the total private investment for water supply and sanitation in developing countries was only $25 billion, of which zero is in South Asia and less than $0.25 billion in Africa (the two regions with the largest unserved populations).

The Framework for Action states that achieving water security goals implies at least a doubling in the level of investment in developing countries to some $180 billion per year. It suggests the indicative figures presented in table 1.

The *World Water Vision* report presents annual investment needs to achieve water security, as reflected in table 2. Although the annual total of $180 billion is the same as the estimate presented in table 1, the breakdowns differ.



**Box 1: Global water security targets**

| Sector | 2015 | 2025 |
|---|---|---|
| **WATER SUPPLY**<br>United Nations Millennium Assembly Declaration | Halving the number of people who are unable to reach or to afford safe drinking water – that is an additional 1.6 billion people to be served | 95% of people with safe water |
| Vision 21 | Ditto | |
| Framework for Action | Ditto | |
| **SANITATION**<br>Vision 21 | Percentage of people who lack hygienic sanitation halved – i.e. an additional 2.2 billion people to be served. | 95% of people with safe sanitation |
| Framework for Action | Ditto | |
| **POVERTY**<br>World Summit on Social Development, Copenhagen, 1995 | Proportion of people living in extreme poverty in developing countries to be reduced by at least one-half | |
| **CHILD MORTALITY**<br>UN Conference on Population and Development, Cairo, 1994) | The mortality rate for infants and children under the age of five should be reduced in each country by two-thirds of the 1990 level | |
| **DIARRHOEAL DISEASE**<br>Vision 21 | Diarrhoeal disease incidence reduced by 50% | |
| **HYGIENE EDUCATION**<br>Vision 21 | 80% of primary school children educated about hygiene | 95% of primary school children educated about hygiene |
| **SCHOOLS EQUIPPED WITH FACILITIES FOR SANITATION AND HAND WASHING**<br>Vision 21 | All schools | |

| Box 1 continued: Global water security targets | | |
|---|---|---|
| Sector | 2015 | 2025 |
| **AGRICULTURAL WATER**<br>World Water Vision<br><br>Framework for Action | Increase water productivity for food production from rainfall and irrigated farming by 30% | Meeting about half the increased demand for agricultural water use by increasing water productivity. |
| **INTEGRATED WATER RESOURCES MANAGEMENT**<br>Framework for Action | Comprehensive policies and strategies for IWRM in process of implementation by 2005 and in 75% of countries by 2015 | |
| **FLOODS**<br>Framework for Action | Reduce the risk from floods for 50% of the people living in flood plains by 2015 | |
| **FRESHWATER ECOSYSTEMS**<br>Framework for Action | National standards to ensure the health of freshwater ecosystems, established in all countries by 2005; programmes to improve the health of freshwater ecosystems implemented by 2015 | |

In table 1, the estimated annual investment to achieve the water supply and sanitation targets by 2025 amounts to $30 billion and in table 2 the figure is $75 billion. Vision 21 estimates an amount to the order of $2 billion to $6 billion per year. The latter figures are arrived at as follows: 1.4 billion people lack water, which can be provided at basic level for between $15 and $40 per person, using the community management methods promoted in Vision 21. 2.8 billion people lack sanitation and adequate hygiene, which can be provided at a basic level between $10 and $35 per person.

So, the total required for everybody in the world to attain the Basic Water, Sanitation and Hygiene Requirement is in the range $50 billion to $150 billion. To achieve the goals in a timescale of 25 years, an annual expenditure of the order of $2 billion to $6 billion is required. This is less than the governments are spending at present.

The much lower investment requirements as estimated by Vision 21 can to some extent be ascribed to the fact that its estimates are based on the use of more appropriate technologies and close community involvement. Nevertheless, the huge differences in estimated investment requirements for water supply and sanitation indicates how difficult it is to make such estimates, particularly so in the absence of reliable data from so many of the developing countries.

To find the additional investments to meet the estimated requirements will be crucial. This will require political will and commitment, a global elevation of the water profile and, perhaps most importantly, a drastic improvement in water management protocols at all levels to build investor confidence.

The economic sustainability of water and sanitation services depends largely and



| Table 1: Indicative annual costs of water services for developing countries (USD billion per year) (Framework for Action) | | |
|---|---|---|
| Use | Present | 2000 to 2025 |
| Access to drinking water | 13 | 13 |
| Sanitation and hygiene | 1 | 17 |
| Municipal wastewater treatment | 14 | 70 |
| Industrial effluent | 7 | 30 |
| Agriculture | 32.5 | 40 |
| Environmental protection | 7.5 | 10 |
| Total | 75 | 180 |

| Table 2: Annual investment requirements for water resources (World Water Vision) | | | | |
|---|---|---|---|---|
| Use | USD billion | | Share (%) | |
| | 1995 | Vision 2025 | 1995 | Vision 2025 |
| Agriculture | 30 - 35 | 30 | 43 - 50 | 17 |
| Environment and industry | 10 - 15 | 75 | 13 - 21 | 41 |
| Water supply and sanitation | 30 | 75 | 38 - 43 | 42 |
| Total | 70 - 80 | 180 | 100 | 100 |

appropriately on the recovery of costs through user fees or tariffs that are equitably assigned based on ability to pay. Under-served or unserved, marginalised users in many places already pay high financial costs of not having safe piped water, for example, because they are forced to pay for water trucked in by suppliers.

This water may be of dubious quality yet is expensive. The positive correlation between user willingness-to-pay and service quality is well known, but still this market driver has not been fully exploited in a way that promotes more sustainable use of scarce resources while protecting human health.
Surcharges to water supply bills for sanitation service is a convenient billing method. Transparent, simple metering and billing procedures that respond efficiently to customer concerns also increases willingness-to-pay. There should be a concerted effort to move away from heavily subsidised public utilities that divert funds from other sectors like health and education, and a strong push towards fair, equitable cost recovery of quality service provision.

# **Annexe 2:** Principles of effective IWRM

1) IWRM should be applied at catchment level. The catchment is the smallest complete hydrological unit of analysis and management.. Integrated catchment management (ICM), therefore, becomes the practical operating approach. Although this approach is obviously sound and finds wide acceptance, too narrow an interpretation should be avoided. This alternative viewpoint is dealt with in section 4.3 (integrated urban water management).

2) It is critical to integrate water and environmental management. This principle is widely and strongly supported. IWRM can be strengthened through the integration of Environmental Impact Assessments (EIAs), water resources modeling and land use planning. It should also be understood that a catchment or watershed approach implies that water should be managed alongside the management of codependent natural resources, namely soil, forests, air and biota.

3) A systems approach. A true systems approach recognises the individual components as well as the linkages between them, and that a disturbance at one point in the system will be translated to other parts of the system. Sometimes the effect on another part of the system may be indirect, and may be damped out due to natural resilience and disturbance. Sometimes the effect will be direct, significant and may increase in degree as it moves through the system. While systems analysis is appropriate, analyses and models that are too complex to be translated into useful knowledge should be avoided.

4) Full participation by all stakeholders, including workers and the community. This will involve new institutional arrangements. There must be a high level of autonomy, but this must at the same time be associated with transparency and accountability for all decisions. In this context Vision 21 states: 'The real breakthrough came when the agencies all recognised that the most effective action came from the energy of people themselves.' Care should be taken to ensure that those participating in any catchment management structure do indeed represent a designated group or sector of society. It is also important to ensure that representatives provide feedback to the constituencies they represent. IWRM seeks to combine interests, priorities and disciplines as a multi-stakeholder planning and management process for natural resources within the catchment ecosystem, centred on water. Driven bottom-up by local needs and priorities, and top-down by regulatory responsibilities, it must be adaptive, evolving dynamically with changing conditions.

5) Attention to social dimensions. This requires attention to, amongst other things, the use of social impact assessments, workplace indicators and other tools to ensure that the social dimension of a sustainable water policy is implemented. This will include the promotion of equitable access, enhanced role of women, and the employment and income implications of change.

6) Capacity building. At many levels in the process – even at the governmental level – stakeholders lack the necessary knowledge and skills for full application of IWRM. Community stakeholders may not be familiar with the concept of water resource management, catchment management, corporate governance, and their role in these. Many, even in developed countries, do not even know what a catchment or watershed is. The water stakeholders must, therefore, collaborate in designing and implementing strategic elements of capacity building as part of the evolving IWRM process. Capacity building categories include education and awareness raising about water; information resources for policy making; regulations and compliance; basic infrastructure; and market stability. Early and ongoing stakeholder collaboration and communication in capacity building is also important from the viewpoint of 'leveling the playing field' in anticipation of disputes that may arise. Filling strategic skills/capacity gaps supports IWRM, facilitates dispute resolution, and builds practical understanding of the scope of sustainable natural resource development challenges and opportunities.

7) Availability of information and the capacity to use it to make policy and predict responses. This implies, firstly, sufficient information on hydrological, bio-physical, economic, social and environmental characteristics of a catchment to allow informed policy choices to be made; and secondly, some ability to predict the most important responses of the catchment system to factors such as effluent discharges, diffuse pollution, changes in agricultural or other land use practices and the building of water retaining structures. The latter hinges on the adequacy of scientific models: Models should be as complex as the problem requires and no more so. It is recognised that predicting ecosystem response to perturbation with reasonable confidence is severely taxing current scientific capabilities, stimulating ongoing research.

8) Full-cost pricing complemented by targeted subsidies. This principle was strongly urged by the World Water Council at The Hague, the rationale being that users do not value water provided free or almost free and have no incentives to conserve water. Wide support for this principle was engendered, but also significant opposition from those who felt that the interests of the poor might not be sufficiently protected, even under an associated subsidy system, however well designed. Opposing views held that full-cost pricing, when applied in its narrowest sense, offends the principle that water is a public good, a human right, and not simply an economic good. Reiterating the economic sustainability of water and sanitation services depends largely and appropriately on the recovery of costs through user fees or tariffs that are equitably assigned based on ability-to-pay. Under-served or unserved, marginalised users in many places already pay high financial costs of not having safe piped water, for example, because they are forced to pay for water trucked-in by suppliers. This water may be of dubious quality yet is expensive.

9) Central government support through the creation and maintenance of an enabling environment. The role of central government in ICM should be one of leadership, aimed at facilitating and coordinating the development and transfer of skills, and assisting with the provision of technical advice and financial support, to local groups an individuals. Where specific areas of responsibility fall outside the mandate of a single government department, appropriate institutional arrangements are required to ensure effective inter-departmental collaboration. Effective IWRM is a top-down meets bottom-up process.

10) Adoption of the best existing technologies and practices. This includes management instruments. Professional associations such as the IWA are primary sources of

knowledge on BMPs (best management practices), and BAATs (best appropriate affordable technologies). Multi-stakeholder, consensus-oriented forums for IWRM should avoid lowest-common-denominator solutions through adherence to BMPs and BAATs that are adaptive to local needs.

11) Reliable and sustained financing. In order to ensure successful implementation of IWRM approaches, there should be a clear and long-term commitment from government to provide financial and human resources support. This is complemented by income from a healthy water and sanitation market, especially when local providers of goods and services that support the water sector are active players, and when there is active reinvestment in the sector.

12) Equitable allocation of water resources. This implies improved decision-making, which is technically and scientifically informed, and can facilitate the resolution of conflicts over contentious issues. There are existing tools (such as multi-criteria analysis) to help decision-making in terms of balancing social, ecological and economic considerations. These should be tested and applied.

13) The recognition of water as an economic good. The recognition of water as an economic good is central to achieving equitable allocation and sustainable usage. Water allocations should be optimised by benefit and cost, and aim to maximise water benefits to society per unit cost. For example, low value uses could be reallocated to higher value uses such as basic drinking water supplies, if water quality permits. Similarly, lower quality water can be allocated to agricultural or industrial use.

14) Strengthening the role of women in water management. A review by the World Bank of 121 water projects showed that ensuring women's participation in decision-making positively affects both project quality and sustainability.



# **Annexe 3:** Marseille Statement

The UNESCO Symposium on Frontiers in Urban Water Management: Deadlock or Hope?

Held in Marseille, France, from 18 to 20 June 2001, having considered the importance and urgency of addressing the management of urban water systems in a proactive and vigorous manner, and building upon the resolutions of previous international conferences and meetings, including the Dublin Statement (1992), the Agenda 21 of the UN Conference on Environment and Development (Rio 1992), the Beijing Declaration (1996), the Habitat-II Agenda (1996), the Declaration of Marrakech (1997), the Declaration of Paris (1998),the Paris Statement (Symposium on Water, City and Urban Planning, 1997), and the Ministerial Declaration of the Hague on Water Security in the 21st Century(2000), urges all stakeholders in urban water management to consider the guidelines, measures and recommendations listed below.

Whereas:

- the current state of urban water resources, the result of long-term non-systematic development and piecemeal solutions to problems, is generally considered unsustainable, in all countries – whether developed, in transition or less developed;
- rapid growth of the urban population and the concomitant mounting needs for water services create formidable pressures on water supplies, on downstream lands, groundwater and stresses on receiving waters and their aquatic ecosystems, with an evident linkage to associated social and health issues;
- growing competition among various societal priorities – provision of food, health, education, economic development, ecosystem needs, and safe water and adequate sanitation necessitates new institutional structures to better handle aggregate demand. Current misuse of water resources leads to a diminishing supply of useable water and increases inequitable access;
- poverty, demographic pressure and the impact of globalisation and of other socio-economic factors means that the nature and the dynamics of urban water problems in the developing countries are substantially different from those of urban areas in the developed world. For instance, the growth of informal and refugee settlements poses grave supply, disposal and sanitation problems. On the other hand, cities in developed countries face ageing systems requiring urgent renovation. In both cases, adopting 'business as usual' approaches can lead to critical situations.

Recognising the current state of urban waters, action is required to:

- continue and intensify the efforts to provide water and sanitation services to the one billion people without supply today and the even larger population lacking sanitation by ensuring adequate resources;
- facilitate and develop innovative ways for the delivery and financing of water services, including mixes of private and public ownership;
- search for a better integration of land use and water management within the overall environmental management, standardise water quality regulations and increase incentives and sanctions for their enforcement;
- protect human health against problems caused by the urban use of new classes of chemicals;
- include in urban water resource management decisions, protection of aquatic ecosystems and natural habitats against cumulative impacts of urban

development and climate change through integrated management;
- reduce the growing losses of human life and material property in urban areas due to natural disasters, particularly floods and prepare for the impact of climate change;
- emphasise the development of novel approaches using emerging technologies that will reduce the use of treated water for sanitation, reduce leaks and waste, take advantage of rainwater as a resource, and that will lead to a fuller recycling and reuse of urban water.

The symposium recommends:

- the adoption of total integrated water cycle management in urban areas. The first step is to identify barriers to integrated management and to search for means of improving co-ordination. Integrated water cycle management should include conservative water and wastewater management through the integration of stormwater, groundwater and surface water use, reuse of treated wastewater, and recycling;
- to strive towards efficient, effective and sustainable urban water systems based on appropriate full cost recovery, including the application of well-conceived, socially sensitive, subsidies ensuring affordability of service.

and proposes:

- to develop and implement educational programmes on integrated urban water and environmental management, with assistance from UNESCO and its partners, at all levels, ranging from governments to general public. In developing countries, this programme should facilitate access to modern technologies, best practice procedures and their adaptation to local conditions. Ensure government support for this programme. The symposium invites the UNESCO/IHE Institute for Water Education to provide intellectual guidance in developing and monitoring the programme;
- define strategies and tactics for the appropriate implementation of integrated urban water management in all countries, including best management practices and procedures for the rehabilitation of systems;
- find new ways of financing and managing water services in countries in transition and developing countries, with design and control closer to the people. One possibility would be to increase co-operation among water supply utilities. A global water-sharing programme – citizens in water rich countries could reduce water consumption through conservation and donate some percentage of the savings towards an international fund supporting water supply projects in countries in transition and developing countries;
- develop and strengthen institutions for integrated urban water management, by enhancing public information and awareness, transparency of procedures, education, and public involvement in decision-making;
- establish and strengthen regional centres of excellence on urban water management, such as the new UNESCO Regional Centre on Urban Water Management in Tehran, particularly in countries in transition and developing countries. As part of this measure, reinforce the UNESCO endorsed network of urban water centres, such as IRTCUD and work with on going initiatives of the UN system, such as the cities programmes of Habitat and action plan on municipal wastewater of UNEP/GPA;
- emphasise concerted action by the international community and highlight the pressing urgency of collectively facing urban water problems in the national preparations for the World Summit on Sustainable Development, Johannesburg (October 2002). Ensure that at the Third World Water Forum (Kyoto, March 2003) urban water management is a major theme, utilising the Virtual Water Forum, and promote a pre-forum donor conference. Undertake appropriate case studies in the UN World Water Assessment Programme in co-operation with the International Hydrological Programme.

Finally:

- the symposium concludes that, considering the above, there are manifestly valid reasons to hold that threats of deadlock can be broken and that thus there is hope, and further stresses that institutions and technology, while being key components to success, must remain subservient to the goals of sustainability and social equity.

# **Annexe 4:** Abbreviations and acronyms

| | |
|---|---|
| **CAPNET** | International Network for Capacity Building in Integrated Water Resources Management |
| **EIA** | Environmental impact assessment |
| **EMWIS** | Euro-Mediterranean Information system on Know-how in Water |
| **GEF** | Global Environment Facility |
| **GW-MATE** | Ground Water Management Team |
| **GWP** | Global Water Partnership |
| **ISO** | International Organisation for Standardisation |
| **IUCN** | World Conservation Union |
| **IWA** | International Water Association |
| **ICLEI** | International Council for Local Environmental Initiatives |
| **ICM** | Integrated catchment management |
| **IHA** | International Hydropower Association |
| **ICID** | International Commission on Irrigation and Drainage |
| **ICOLD** | International Commission on Large Dams |
| **IHP** | International Hydrological Programme |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **IPTRID** | International Programme for Technology and Research in Irrigation and Drainage |
| **IUWM** | Integrated urban water management |
| **IWRM** | Integrated water resources management |
| **WMO** | World Meteorological Organisation |
| **LCA** | Life Cycle Assessment |
| **NGO** | Non-governmental organisation |
| **OECD** | Organisation for Economic Co-operation and Development |
| **PSI** | Public Services International |
| **SCOPE** | Scientific Committee on Problems of the Environment of the International Council for Science |
| **UN** | United Nations |
| **UNCTAD** | United Nations Conference on Trade and Development |
| **UNDP** | United Nations Development Programme |
| **UNEP** | United Nations Environment Programme |
| **UNESCO** | United Nations Economic and Social Council |
| **UNFPA** | United Nations Population Fund |
| **UNIDO** | United Nations Industrial Development Organisation |
| **VCE** | Virtual Centre of Excellence |
| **WCD** | World Commission on Dams |
| **W-E-T** | Water-Education-Training |
| **WHO** | World Health Organization |
| **WHYCOS** | World Hydrological Observing System |
| **WSSCC** | Water Supply and Sanitation Collaborative Council |
| **WWF** | World Wildlife Fund |

## UNEP contribution to the World Summit on Sustainable Development

**The mission of the United Nations Environment Programme (UNEP)** is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. **The UNEP Division of Technology, Industry and Economics (DTIE)** contributes to the UNEP mission by encouraging decision-makers in government, business, and industry develop and adopt policies, strategies and practices that are cleaner and safer, make efficient use of natural resources, ensure adequate management of chemicals, incorporate environmental costs, and reduce pollution and risks for humans and the environment.

**This report is part of a series facilitated by UNEP DTIE as a contribution to the World Summit on Sustainable Development.** UNEP DTIE provided a report outline based on Agenda 21 to interested industrial sectors and co-ordinated a consultation process with relevant stakeholders. In turn, participating industry sectors committed themselves to producing an honest account of performance against sustainability goals.

The full set of reports is available from UNEP DTIE's web site (http://www.uneptie.org/wssd/), which gives further details on the process and the organisations that made it possible. The following is a list of related outputs from this process, all of which are available from UNEP both in electronic version and hardcopy:

- industry sectoral reports, including
  - accounting
  - advertising
  - aluminium
  - automotive
  - aviation
  - chemicals
  - coal
  - construction
  - consulting engineering
  - electricity
  - fertilizer
  - finance and insurance
  - food and drink
  - information and communications technology
  - iron and steel
  - oil and gas
  - railways
  - refrigeration
  - road transport
  - tourism
  - waste management
  - water management

- a compilation of executive summaries of the industry sectoral reports above;
- an overview report by UNEP DTIE;
- a CD-ROM including all of the above documents.

UNEP DTIE is also contributing the following additional products:
- a joint WBCSD/WRI/UNEP publication entitled *Tomorrow's Markets: Global Trends and Their Implications for Business*, presenting the imperative for sustainable business practices;
- a joint WB/UNEP report on innovative finance for sustainability, which highlights new and effective financial mechanisms to address pressing environmental, social and developmental issues;
- two extraordinary issues of UNEP DTIE's quarterly *Industry and Environment* review, addressing key regional industry issues and the broader sustainable development agenda.

More generally, UNEP will be contributing to the World Summit on Sustainable Development with various other products, including:
- the Global Environmental Outlook 3 (GEO 3), UNEP's third state of the environment assessment report;
- a special issue of UNEP's *Our Planet* magazine for World Environment Day, with a focus on the International Year of Mountains;
- the UNEP photobook *Focus on Your World*, with the best images from the Third International Photographic Competition on the Environment.