VISION FOR WATER AND NATURE

A WORLD STRATEGY FOR CONSERVATION AND SUSTAINABLE MANAGEMENT OF WATER RESOURCES IN THE 21ST CENTURY

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A Vision is presented here of a world in which the benefits of freshwater and related ecosystems to humankind are optimised, while the intrinsic values of these systems are respected and preserved. In this world, the mutual dependence of people and ecosystems is accepted, and unavoidable loss of ecosystems' functions and biodiversity is more than compensated through restoration.

This Vision describes a world in which **environmental security** is guaranteed because everyone values and accepts personal responsibility for the conservation and wise use of freshwater and related ecosystems. The maintenance of environmental security is based on integrated management of all land and water use through an ecosystem-based approach within river and drainage basins, including their associated marine and coastal zones.

It is also a world in which **social security** is strengthened by providing everyone with equitable access to and responsibility for safe and sufficient water resources to meet their needs and rights, by means that maintain the integrity of freshwater and related ecosystems.

Finally, it is a world where ecosystems are managed and used in a fair and equitable manner for **economic security.** Efforts are made to rectify and reverse existing trends in demographics, consumption patterns and human-nature relationships, in order to ensure that the current and future demands for water resources are realistically achievable without compromising the ecological, biological and hydrological basis and integrity of freshwater and related ecosystems.

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Preface

I am pleased and proud to present to you the Vision for Water and Nature, the environment and ecosystems component of the World Water Vision. It is a major attempt to fully integrate environmental issues into water resources management, and constitutes a vital part of the World Water Vision's perspective for water, life and environment for the 21st century.

IUCN – The World Conservation Union took the lead in developing the Vision for Water and Nature and worked with a large group of organisations and individuals to produce this Vision. From January 1999 until early 2000, extensive consultations with stakeholders took place. Three thought-provoking papers served as the focus of three theme workshops on freshwater ecosystem management for social, economic and environmental security. A dedicated internet site and discussion group yielded more inputs. Results from this process were provided to other fora and to the World Water Vision team, and vice versa. The result is a daring Vision for the next century.

This Vision goes beyond environment and conservation. It explores and defines a new path for integrated and sustainable land and water resources management. The people involved dared to look ahead at the conservation of nature and the sustainable management of water resources in the 21st century – a time at which, I hope, all inhabitants of this planet will feel responsible for their water and ecosystems; a time at which we all will acknowledge the crucial importance of ecosystems and act wisely to manage and conserve them; a time at which we will drink the water and think of the well-spring.

Ecosystems are our life support systems. They are the foundation for environmental, social and economic security.

The group consulted in this process shared ideas and experiences to create this Vision, and IUCN, together with members and partners, is dedicated to making it become a reality. Now, at the start of a new millennium, I hope the World Water Vision and this Vision for Water and Nature serve that same purpose: to inspire people to contribute their vision and their work. Freshwater and related ecosystems are the source of life and the responsibility of all.

Yolanda Kakabadse
President, IUCN - The World Conservation Union

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The number of contributors to this document is so extensive that they unfortunately cannot all be mentioned here by name.

The core members of the Water and Nature team were drawn from all parts of the IUCN – The World Conservation Union network. These individuals worked to develop and implement the process, as well as to ensure that the environmental concerns were heard throughout the other facets of the World Water Vision: Malcolm Mercer, Project Director; Chris Morry, Project Manager; Ger Bergkamp, General Technical Coordinator; and Debbie Gray, Project Officer. This core team was complemented by IUCN professionals who led the development of certain themes within the Vision. These include Cristina Espinosa, Gabriella Richardson, Lucy Emerton, Andrea Bagri, Frank Vorhies, Rocío Córdoba, Hans Friederich, and Tabeth Matiza Chiuta. Many others throughout the IUCN network played important roles in organising and attending the meetings, obtaining input from others, spreading the word and providing their valued advice.

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Finally, a great many people have devoted their time and energy to the development of this Vision. These people represent institutions ranging from international organisations and financing institutions to national governments, river basin organisations, academia, local NGOs and concerned individuals. While the sheer magnitude of contributions makes it impossible to individually acknowledge everyone who took time to comment on draft versions of the Vision or participate in workshops, and the thousands more who visited the website, expressed an interest in the process and supported us in spirit, we would like to thank each and every one you for helping to make this truly a shared Vision.

World Water Vision: Its Origin and Purpose

Over the past decades it has become gradually evident for those directly involved that there is a chronic, pernicious crisis in the water world. The participants in the 1st World Water Forum in Marrakech in 1997 called for a World Water Vision to increase awareness of the water crisis throughout the population and develop a widely shared vision of how to bring about sustainable use and management of water resources.

The World Water Vision draws on the accumulated experience of the water sector, particularly through sector visions and consultation for Water for People (or Vision 21), Water for Food and Rural Development, Water and Nature, and Water in Rivers. It draws on the contributions of regional groups of professionals and stakeholders from different sub-sectors that have developed integrated regional Visions through regional and national consultations in more than 15 regions worldwide. As the Vision developed and evolved, more and more networks of civil society groups, NGOS, women, and environmental groups joined in and contributed to the consultations. The participatory process that led to the World Water Vision makes it special. Since 1998, about 15,000 women and men at local, district, national, regional and international levels have shared their aspirations, as well as developed strategies for practical action towards the sustainable use and management of water resources. The recent availability of Internet communications made such a consultation possible in the short timeframe. This is not an academic exercise. It is the start of a movement. Over the coming months and years stakeholders will develop action plans to implement the recommendations of the World Water Commission and the strategies presented herein.

The World Water Vision aspires to be an inspiration to women and men to overcome obstacles and achieve fundamental changes. Its message is for everybody, particularly for the leaders and professionals who have the power and knowledge to help people to turn visions into reality. It challenges those directly affected by the water crisis to initiate action and to call on their leaders to bring about sustainable water resources use andmanagement.

The Vision recognizes that if sustainable water resources use and management is to be achieved, people's roles must change. The main actors will be individuals and groups in households and communities who, with new responsibilities for the use of water and water-related services, are part of a collective strategy. Public authorities will need to empower and support them, and carry out the work that households and communities cannot manage for themselves. Water sector professionals and environmentalists will provide these stakeholders with the information they need to participate in decision-making and help implement their decisions. All these groups working together can achieve this Vision.

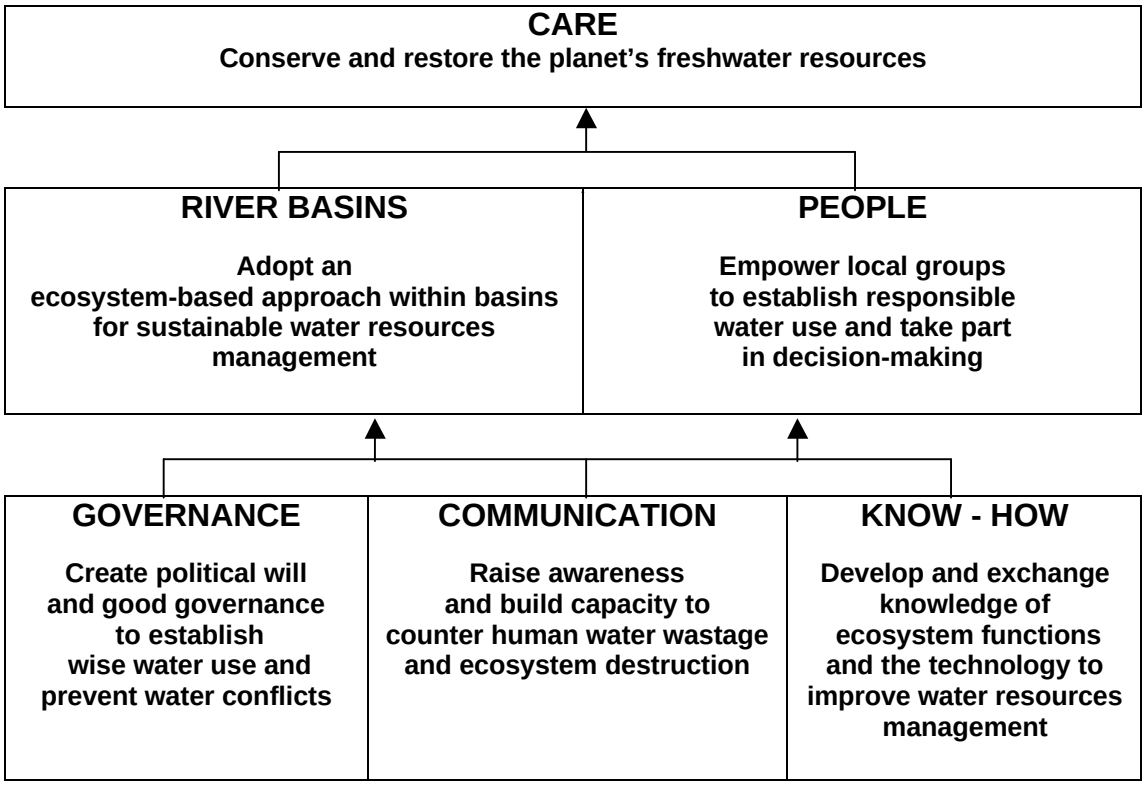
Key Messages and Actions Required

- The current and predicted extinction of freshwater species and decline in ecosystems that are vital for our water resources destroys the basis for sustainable development of communities and societies. In the last century alone, more than 50 per cent of the developed world's wetlands have disappeared.

- Ecosystems and the life they contain have a right to the water they need to survive, to preserve their intrinsic values and enable them to continue to provide goods and services to humankind.

- If humanity continues to misuse and destroy water resources and the ecosystems on which these depend, individuals and societies will ultimately suffer social and economic insecurity engendered by severely degraded rivers, lakes and groundwater reserves, and will be confronted with increasingly serious conflicts in times of scarcity.

- This is an unacceptable future. Experiences from around the world show, however, that an alternative is at hand. Building on known sustainable practices and conservation measures, human behaviour can be changed to realise the world vision presented here. This will require us to take immediate and effective actions:



Executive Summary

A year of worldwide consultations, conducted by IUCN – The World Conservation Union, has led to the development of a Vision for Water and Nature. This is an integral part of a *Vision for Water, Life and the Environment for the 21st Century* (the World Water Vision).

The Vision

This document provides a fresh perspective on worldwide water resources management and use. It is a Vision for a world in which environmental, social and economic security are guaranteed by fundamental changes in human attitudes and behaviour towards freshwater and related ecosystems. Moving from a synopsis of current and predicted problems, the document presents a conceptual framework based on key human interactions with nature, followed by a comprehensive plan of action.

Degradation of ecosystems and water resources

Water, once revered for its life-giving properties, has become a commodity. All too often it is taken for granted and routinely exploited. Throughout the world, human use of water has already led to dried-up and polluted rivers, lakes and groundwater resources. Potable water is becoming increasingly scarce. By the year 2025, it is predicted that water abstractions will increase by 50 per cent in developing countries and 18 per cent in developed countries. Effects on natural ecosystems will be dramatic. In the past century, over 50 per cent of the world's wetlands have been lost. Of the more than 3,500 species currently threatened worldwide, 25 per cent are fish and amphibians. The inevitable result of further human abstraction of water on this scale will be degradation or complete destruction of the terrestrial, freshwater and coastal ecosystems that are vital to life itself.

The causes are many, and it is wrong to single out one group and hold them responsible. We are all responsible. Growth in human populations, increasing consumption, infrastructure development, land conversion and poor land use, overexploitation of species and ecosystems, and release of chemical and biological pollutants into water, land and air all threaten the ecosystem functions that produce our freshwater resources. Societies seem to be incapable of developing coherent social and political responses to this unbound resource extraction and degradation. Declining resources and distinctly unequal access to the remaining resources form the basis for conflicts at all levels of society that are already showing signs in some places of erupting into violence.

This is an unacceptable future. However, experiences from around the world show that an alternative exists. Building on known sustainable practices and conservation measures, we can realise the Vision presented here.

We have a choice to make, and the time for action is now.

Ecosystems are the source of water and life

We need to recognise that social well-being, economic stability and the natural environment are interdependent. Degradation of any one of these worsens the condition of all three. To reverse this downward spiral in which we find ourselves, two fundamental concepts must be understood:

- Ecosystems have intrinsic values and provide essential goods and services;
- Sustainability of water resources requires participatory ecosystem-based catchment management.

Actions for a sustainable water world

The Framework for Action found in the Vision for Water and Nature proposes six goals that will lead us to a sustainable water world. We, as societies and individuals, must choose to:

- CARE FOR THE PLANET'S ECOSYSTEMS by respecting, conserving and restoring the planet's freshwater resources;
- ADOPT AN ECOSYSTEM-BASED APPROACH within river basins for sustainable water resources management;
- EMPOWER PEOPLE to establish participatory, equitable and responsible water use;
- CREATE POLITICAL WILL AND GOOD GOVERNANCE to facilitate wise water use and prevent water conflicts;
- raise awareness and strengthen capacity to CHANGE HUMAN BEHAVIOUR to reduce water consumption and waste and protect ecosystems;
- develop and SHARE KNOWLEDGE and technology to improve water resources management.

The strategy presented here builds on important international agreements, and is supported by the identification of specific goals, targets and activities. This strategy is not a prescription, but is intended to assist in bringing about change. Different nations, cultures, communities, people and institutions will have to employ diverse sets of actions to bring about desired changes.

There are many activities that are recommended as part of the six goals described above. It goes without saying that there are also many individuals and groups who will have a role to play in these activities. Here are a few of the activities that demand priority, along with an indication of the groups that are most directly implicated:

- governments, both national and sub-national, must institute participatory ecosystem-based catchment management, and all sectors and interests must take active part in these processes;
- international trade and financial institutions, such as the World Trade Organisation (WTO) and, the World Bank (WB), as well as governments at all levels, must establish incentives for conservation based on ecosystems' full economic, ecological, cultural and intrinsic values;
- national governments, working hand-in-hand and, as appropriate, through the United Nations, must define rights and ownership for international and national water and land resources;
- educational institutions and non-governmental organisation (NGOs) must take the lead in training community leaders;
- institutional reform, nationally and internationally, must be given priority by all those who have the power to effect such reforms, guided and encouraged by the public at large, who will benefit most directly;
- private sector corporations, municipalities, private landowners and individuals must take full personal responsibility for compliance with existing laws, regulations and ethical codes, and governments must be vigilant to enforce these in order that they have the strength of purpose that they need;

- community-based groups and NGOs, supported by governments and educational institutions, must build and strengthen education and communications to bring about appropriate behavioural changes;
- research institutes, management agencies, universities, international environmental NGOs (ENGOs) and the private sector water management industry must develop, maintain and exchange knowledge and information for the sustainable use of freshwater and related ecosystems.

The purpose of this document is to provide a Vision for how water resources can be managed sustainably, and a way to make this Vision a reality. The current outlook for the health of freshwater and related ecosystems and availability of water is not good. But with commitment and effort, we can choose to follow a path towards sustainable water use and management in this new millennium.

Part I. THE VISION

1. THE VISION

2025:

ON THE PATH TO CONSERVATION AND EQUITABLE SHARING OF OUR FRESHWATER RESOURCE LEGACY

Early on a February morning in the year 2025, on a vast floodplain of the Sahel, Ibrahim Diaw leads his herd of long-horned cattle to their dry-season pastures. He watches the animals closely with squinted eyes and with soft calls he urges them on. The grazing routes for nomadic herders are based on the ecosystem restoration programme initiated at the turn of the millennium. Using these migration pathways no longer results in violent conflicts with farmers, as was the case forty years ago after intensive irrigated rice schemes were constructed throughout the plain. Now his herd prospers through access to large expanses of restored perennial grassland, including those of the new Wahta Biosphere Reserve. Throughout the wet and dry seasons, water holes provide drinking water for his animals and the floodplain 'works' for the benefit of Ibrahim and the local people. They can now count on stable livelihoods based on recession agriculture, semi-intensive production, and artisanal and small-scale fishing. Ibrahim walks in the grass and thinks of the past – desiccated flats, 25 years without a single wedding in the village, his father who thought that they had been forgotten by God…. He thinks that efforts to mitigate the impacts of infrastructure development are about to pay off: the dikes have been put to good use, artificial flooding schemes are effective and water is no longer wasted. Ibrahim's floodplain is alive and its water resources are used wisely.

The Global Times World Water Day: March 22, 2025

From Wasteland to Wetland:

Record Set in 2024 after 25 Years of Collaborative Efforts

BY DAN BRADFORD / NEW YORK

A worldwide record for water resources restoration was achieved last year. Through 25 years of concerted global effort and cooperation, by 2024 an area equivalent to the size of the entire Great Lakes basin in North America, and water courses equivalent in length to the entire Rhone and Rhine rivers combined, have been restored to full health throughout the world. UN Secretary General Maria Petrova says, "*This is the biggest achievement of the Water Resources Action Programme presented in 2000 and the subsequent actions that flowed from it*."

These results contrast sharply with the increase in industrial, agricultural and household water requirements predicted at the beginning of this century. At that time, rivers were running sewers, entire species of fish were disappearing, and wells were drying up all around the world.

"*Imagine if you are seeing water use increases of 50 per cent and the level in your well is already falling more than two metres a year. In 2000, the loss of almost a thousand species of fish, frogs and snails was forecast*," says Christen Andrews, Water Resources Specialist of The World Conservation Union. "*Today, water managers have demonstrated fundamentally different behaviour. They keep our rivers, lakes and wetlands alive*."

What brought about this fundamental change? The historic achievement, announced earlier this week, calls for a review of the efforts leading to this success.

Caring for the water's wealth

At the turn of the century, environmental degradation led to a growing awareness among experts of the linkages between environmental degradation, economic instability and social insecurity. The World Water Vision process pooled experiences and knowledge from around the world and created a strategy for conserving the world's freshwater resources.

This strategy came at the right time. People all around the world started to act for the conservation of their water and ecosystems. "*When I was at primary school we learned not to waste the water we have. This has guided me throughout my professional career. Care for the water wealth*," says Timothy Mbeke of the Department of Water Affairs in South Africa.

Aware that top-down, sectoral, and purely technological solutions to the world's water problems were largely ineffective, people began working together. They restructured water management schemes – basing them on ecosystems' needs and the goods and services these provide. Women played an essential role, because of their direct concern and involvement in the majority of day-to-day water use issues. Now, the needs of communities are directly addressed as the basis for preserving the quantity and quality of water and fish in lakes and rivers.

Eventually governments at all levels, from local municipalities to international bodies, realised that only a holistic catchment approach to participatory integrated management of water resources would work. From there it was an easy step to recognise the necessity of incorporating all land and water issues into these planning frameworks – from forest practices in the uppermost limits of the watershed, to the coastal deltas, mangrove swamps, and estuaries, whose rich fisheries are dependent upon a clean and seasonally-varied regime of water flows.

Valuing ecosystems' benefits

The goods and services provided by ecosystems, such as clean water, fish and fuelwood, were assigned values equivalent to their true economic worth. This allowed conservation to be justified not only in ecological, cultural and intrinsic terms, but also on economic grounds. Tax breaks and compensation schemes supported environmental protection. These new incentives, together with public pressure, made industries reduce production costs and pollution by investing in cleaner technologies and reducing water use and effluents.

Guus Rietveld, a Dutch farmer with 150 hectares of agricultural land, remembers the large investments he made to get to the close-to-zero-emissions levels required today. "*We had to combine the latest technology with innovative ideas. But we were able to cut our costs dramatically, which allowed us to invest in new ways of production*." Today, domestic and agricultural effluents are controlled and purified through various means, including artificial wetland systems and vegetated buffer strips along riverbanks and lakeshores.

Another industry that has gone through a major reform is construction. Today, the planning of dams, dikes and roads is based on reduction of environmental and social costs. Pressure from environmentalists and community groups, combined with a greater willingness of the industry to change, brought about this practice. In the last

25 years, annual construction of new dams has decreased by 83 per cent.

Empowering people for conservation

The key to success of the last decades lies in cooperation. A central element of the World Water Vision's strategy as the empowerment of individuals – of men, women and children representing all ethnic groups and social classes. Without equal rights to, access to, and control over water and land resources, inequity and conflict would continue.

"*Our rights are now defined and we have clear agreements on fishing in the lagoon*," says Vietnamese fisher Thi Thanh Thuy Dinh. "*We are prepared to work hard to keep our lagoon alive*."

Poor governance and lack of political will were some of the major obstacles to this change. Recall that it was only twelve years ago last week that tensions over disputed water rights in the Jordan valley erupted into bloodshed before cooler minds finally prevailed. Civil society played a major role in overcoming political reluctance to act. Grassroots initiatives demonstrated to governments what could be done through simple cooperation. Public pressure made them build on these extensively. Today, private and public institutions are accountable, and are oriented towards the local delivery of services and conservation of ecosystems.

Educating for change

The biggest and least visible change of the last 25 years has been in our attitudes, beliefs and fundamental values. Advocates at all levels have facilitated change through innovative education and communications programmes. "*Change the way a person thinks, and you change the world,*" to quote Mohammed Al Azra, the 'Water: Our Wealth' campaign leader.

Community-based awareness-raising programmes, such as 'Water: Our Wealth,' have dramatically increased public understanding of the need for ecosystem protection and sustainable water use. Continued investments in primary and secondary education ensure more equitable access to knowledge. Schools, universities and training institutions have incorporated interdisciplinary programmes for environmental appreciation and conservation into their curricula. In many countries, understanding of ecosystems is now common among the majority of resource managers and policy makers.

Information to innovation

One of the pillars of the water management success has been the gathering and sharing of information. Communication technologies had a tremendous effect on the way water resources information and knowledge were distributed and used. International, regional and national databases and information clearinghouses established at the beginning of this century have contributed greatly to the spread of information on environmental water issues. For example, the creation of the ABIS (Aquatic Biodiversity Information System) global geographic database in 2006 provided a powerful common source of reliable information in graphic form, depicting losses and preservation of aquatic biodiversity. As an information tool, this was in no small measure responsible for energising the global community to stem the calamitous decline in aquatic biodiversity that was taking place at the turn of the century.

People at all levels have been empowered as they gained access to these information sources. Scientists in many developing countries generated

major innovations and have decreased their reliance on technical expertise from developed countries. A dialogue was established between scientists and holders of traditional knowledge, which now forms the cornerstone of many innovative resource management practices. Drawing on both technological innovations and traditional knowledge,

dramatic improvements have been made, for example, in the agricultural sector.

Contrary to what was believed in the early part of the century, genetically modified crops (GMC) have only been introduced on a small scale. The emphasis today is on crop diversity, with strong reliance on locally adapted indigenous varieties, appropriate cropping techniques, and soil and water conservation to increase food production. Cristina Gomez of BIODIVI Inc. puts it like this: "*We never believed in GMCs, but have invested in research on local crop varieties that have adapted to more salty conditions and are naturally more resistant to pests and disease. Utilising simple cross-fertilisation techniques that would have been familiar to pioneer plant breeders one hundred and twenty-five years ago, we have been able to produce new varieties in only a few plant generations. These hydrids combine the salt- and disease-resistance of the so-called "weed plants" avoided by farmers in the past, with the more highly productive features of varieties favoured in industrial-scale agriculture. We are now working with communities to grow these and sell them on the global market*."

As a result of technological breakthroughs and public pressure, cheap and effective solar-powered desalination is now widely used in many arid and semiarid countries for domestic water supply. Irrigation is more efficient due to the growing use of automated, drip and subsurface systems. Industrial and domestic water reuse is now common practice, and non-water-based systems of sewage treatment and other methods of ecosanitation have been applied in many areas to reduce pollution and to make full use of human waste as agricultural fertiliser.

On the path towards sustainable development

Though last year's record restoration effort shows what can be achieved, there are still major hurdles to overcome. Contamination of water continues to be a major threat to the security of many societies. The clashes between the members of the Rhine River Board in February demonstrate that constant vigilance is needed to protect water quality, ecosystems and biodiversity.

Concerned citizens must continue to advocate change. Poorly-conceived economic incentives and a lack of political will still prevent some organisations and governments from following a sustainable development path. Says Hiroshi Yamanaka of Tokyo Management School: "*A lot has changed. But we still need major technological, social and financial investments to solve remaining water conflicts.*"

At the turn of the century, the change in water management was begun. Social, political and technical measures were used in mutually-reinforcing ways. And even though our fresh water can at times look troubled, the success of the restoration programme now shows we have taken that first important step down the path to sustainable development.

2. THE PROBLEM: A BLEAK GLOBAL FRESHWATER OUTLOOK FOR 2025

2.0 Introduction

At the start of the new millennium, the world is faced with the certain realisation that, through unsustainable population growth, economic expansion and rising per capita consumption, humanity is finally reaching the limits of renewable water resources. No longer can engineering and technical solutions that characterised development and growth in the 20th Century be depended upon to support further growth in population, consumption and improvements in the quality of life for the billions of people on the face of the planet. With increasing frequency, the freshwater and related ecosystems that supply and renew the water needed by humanity have themselves been degraded to the point that they can no longer support the diversity of life and life-giving functions they have always served. In addition, increasingly uneven distribution of and control over water resources is leading to a concentration in power, resulting in resources being controlled by fewer and fewer people. These ominous warning signs are ignored at all our peril. Humankind must now choose a new development path for water resources.

Fortunately, some positive developments that contrast with this bleak picture can also be seen, making it clear that it is possible to cope with population growth while meeting people's legitimate aspirations for a minimum level of secure livelihood. Many of these possibilities, however, are still on a local scale and have, until now, not resulted in a global change of direction. The Framework for Action (see Part II - Section 4) builds on these positive initiatives, and proposes a possible way forward that does not necessarily lead us down the path of widespread water resources degradation and conflict that is portrayed below.

2.1 Developing world: Towards overpopulation and resource plundering

Population growth will remain an important driver of environmental degradation in the developing world. In most developing countries, population will continue to grow at a rate of 2-3%, with the result that 80% of the world population will live in these countries by 2025 (UNEP 1999). About 50% of these people will live in urban areas that are located mainly in coastal regions and near rivers, compounding the impacts on these ecosystems. Increasingly, westernised consumption patterns will aggravate the inequitable allocation of resources. Likewise, globalisation will contribute to inequity, as the greatest number of people will not benefit from investments in the global economy. A changing climate will start to affect many aspects of ecosystems, societies and economies as a rising sea level, for example, will affect many low-lying coastal areas through saltwater contamination of coastal aquifers and wells. The need to feed the world population will, in turn, lead to increased and likely more water-demanding agriculture, just as the need to produce more exports and compete in the increasingly global economy will accelerate industrial production (see Box 2.1).

The above factors will lead to greater pressures on freshwater and related ecosystems, mainly through increases in infrastructure development, water abstractions for agriculture, industry and municipal use, conversion of land for resource development, and pollution (see Annex 1). In China, for example, 6% annual growth is projected in spending on dams, mainly to provide hydropower. Total water abstraction for developing countries will increase by 46% to 3,800 km^3/year by the year 2025 (see Table 2.1). Growing rates of population and industrialisation will cause domestic and industrial use to take up a larger relative portion of the extracted water, with most still being abstracted for agricultural purposes. More and more, crops

Box 2.1 Conditions foreseen for Africa in 2025, given unabated water resources degradation.

Population growth is the main driver for change in Africa, followed closely by climate change. Acting together, they present a frightening future scenario. A reduction and higher variability in precipitation, deforestation and desertification are likely to increase scarcity of freshwater resources. By 2025, total water abstractions will have risen by 54% to 337 km^3/year, agricultural use accounting for 53% of this. Expansion of irrigated land beyond the current 6% will cause further soil salinisation and waterlogging and, in many cases, a further loss of valuable wetlands.

Dam construction and disposal of untreated sewage and industrial effluents will increase sharply, for example, in the Senegal, Nile and Niger basins. Major threats to water quality are eutrophication, pollution, and proliferation of invasive aquatic plants like water hyacinth. Exploration of oil and gas fields forms a major threat in some areas (e.g. Niger delta, Lake Chad basin). In many African river basins, forest loss is very high (from 43 to 90% or more) and, if unabated, will dramatically affect the conditions in all major river basins. Groundwater resources comprise a major source of water for several countries, such as Namibia (40%) and Libya (95%), and will come under growing threat of overexploitation. Threatened biological diversity currently includes over 104 fish, 12 amphibian, 29 reptile, 53 bird and 89 mammal species, and these numbers will increase during the coming decades.

Most countries in North, Northeast and Southern Africa will face considerable water stress in the decades to come. Water resource degradation will fuel tensions between riparian states since most African basins are shared by two or more countries (e.g. the Nile and Okavango basins). The number of environmental refugees is likely to rise rapidly (WRI et al. 1998, UNEP 1999, Shiklomanov 1999).

such as cotton, flowers, bananas and soya beans will be produced for export. In many regions, surface and groundwater resources will be depleted due to increased irrigation for cereal and other food and forage crop production. In some regions, pressure to provide income-generating employment and to assist in the national balance of trade will lead to even further depletion of water resources to support unsustainable non-food agricultural production for export. Increases in agricultural production will stimulate pesticide use. Together with sewage from cities that lack adequate treatment facilities, pollution of surface and groundwater systems will rise sharply. Further expansion of large-scale monocultures will push more farmers to convert natural ecosystems, such as upper catchment forests and wetlands, into agriculture production areas, inducing a severe degradation of water resources. In Southeast Asia and Latin America, for example, upper catchment degradation is foreseen to have severe consequences for the region in terms of flooding and reliability of water supply (see Boxes 2.2 and 2.3).

Table 2.1 Water withdrawal by water use sectors as a percentage of total water withdrawal for 3 developing regions. Total water withdrawal for 1995 and 2025 is, respectively, 2,600 and 3,800 km^3/year (Shiklomanov 1999).

	1995: % of total use (2,600 km^3/year)				**2025**: % increase/decrease compared to 1995 values			
	Agriculture	Industry	Domestic	Reservoir	Agriculture	Industry	Domestic	Reservoir
Africa	63.0	8.1	4.4	24.7	-15.7	+122.0	+ 36.4	- 7.7
Asia	80.0	6.9	9.9	3.2	- 10.0	+ 37.7	+ 53.5	+ 3.1
S. America	58.6	17.2	15.4	8.7	- 24.6	+ 31.4	+ 54.5	+ 12.2

These augmenting pressures will induce a significant change in the state of many of the developing world's freshwater and related ecosystems. No longer will many of these ecosystems be able to provide goods and services essential for societies to survive (see Annex 1). Increased infrastructure development will alter timing and quantity of river flows, and block fish migrations. Overabstraction of water will lead to depletion of groundwater and biodiversity. Degradation of catchments will result in increasing erosion and flooding. Wetlands, dramatically reduced in numbers, will no longer provide flood abatement. The loss of species and habitats will dramatically reduce the world's biological diversity, and resulting declines in fish production will further exacerbate demands for protein from livestock production and agriculture. Most rivers will have become open sewers that no longer contain fish and other life forms, but transport pollutants to degraded coastal and marine ecosystems.

Box 2.2 Projected 2025 impacts on Asian water resources, given a 'business as usual' approach.

Population growth will be a major factor in water-rich South and Southeast Asia. By 2025, this region, which comprises only 30% of the world's land area, will be home to 75% of the world's population. In the Mekong River basin, for example, the population is expected to almost double and, despite a projected 400% growth in the basin's economy by 2025, 70% of the population will continue to be rural and agrarian, requiring land to grow crops and water to catch fish. The tremendous biological diversity of Southeast Asia will be under greater and greater threat; already more than 216 fish, 47 amphibian,104 reptile, 521 bird and 515 mammal species are on the brink of extinction.

By 2025, most parts of the generally parched West Asia will be desertified or threatened with desertification, leading to conflicts over water resources in such areas as the Euphrates and Tigris river basins. Soil erosion, salinisation, alkalisation and nutrient deposits will have a profound effect on land and water resources. Oil production will continue to cause major hydrocarbon pollution of freshwater and marine ecosystems.

In many coastal areas throughout Asia, seawater intrusion, new settlements, industrial growth, increased fishing pressure and reduction of freshwater inflow from rivers will cause major ecosystem destruction. Urbanisation will induce a rapid expansion of megacities that produce large quantities of untreated sewage. Energy demand is expected to have doubled by 2010. Dam construction for hydropower, domestic and industrial use and irrigation will sharply increase, pressuring freshwater ecosystems. Deforestation caused by logging and forest fires will increasingly threaten water availability and quality in many river basins, and high sediment loads will drastically reduce the lifetime of numerous planned reservoirs (WRI et al. 1998, UNEP 1999, Shiklomanov 1999, Witoon 1999).

Box 2.3 Latin America's water resources prospects for 2025, without intervention.

Latin America's development will be characterised by further expansion of megacities, in which 85% of the population will live by 2025. The large metropolitan centres will not likely be able to cope with the resource needs and waste production of households and industries. Currently only 2% of the sewage from urban centres is treated. Untreated effluents will cause major problems with water supply downstream, and proliferation of pathogenic diseases from pollution and vector-borne diseases from expanded reservoir construction is likely. Conflicts will arise at many levels, ranging from small upper catchments to large international river basins.

Based on an average South American deforestation rate of 3% (1990-1995), it is estimated that, by 2025, more then 50% of the current forest cover will be lost. Increasing evidence shows that deforestation and land conversion in Central America has severe impacts on the water supply, and aggravates the threat of landslides and mudflows posed by hurricanes and extreme precipitation. The effects of El Niño are also expected to become more extreme, leading to more frequent flooding during wet cycles and water shortages during dry cycles.

In Central America, the construction of small- to medium-size dams, which is projected to increase sharply during coming decades, is likely to affect freshwater biological diversity dramatically. Already 103 fish, 27 amphibian, 76 reptile, 353 bird and 263 mammal species are threatened. Mining is another major threat to water resources throughout Latin America. Past mercury emissions from gold mining, for example, were estimated at 5,000 tonnes for the period 1970-1995 (WRI et al. 1998, UNEP 1999, Shiklomanov 1999).

The impacts of continued water resources degradation are especially felt by the poorest people and nations. They will become more vulnerable to a wide range of fluctuations in the global markets. Poor nations and producers that profit little from global markets will see prices for many of their products fall further, forcing them to violate their land and water resources simply in order to survive. Floods and droughts also typically affect the poorest people most severely, as they often live in vulnerable areas and have no financial resources for avoidance, mitigation or adaptation. On the other hand, it must never be forgotten that floods do provide an essential service to millions of floodplain inhabitants. Their livelihoods depend on floods to replenish the soil and nutrients of the floodplains used in flood recession agriculture and for pasturage, and to clean and renew streams to permit fish passage for migration and the enhancement of fish production. Increasing pollution from cities, industries and agriculture will take its toll in greater rates of illness and rising prices for safe drinking water and human health care. The loss of freshwater biological diversity directly threatens the economic basis of many societal groups, such as fishers and flood recession farmers, and indirectly affects whole societies by eroding the basis of essential ecological food webs.

2.2 Developed countries: Rising consumption and continued overexploitation

While population growth is low, overall consumption patterns and economic growth continue to act as major drivers for environmental degradation in developed countries. Increasing consumption and export is nurtured by a growth in agricultural production, which relies heavily on monocultures requiring large inputs of pesticides and genetically modified seeds developed by a small number of patent-holding monopolies. Corresponding increases in demand for industrial production perpetuate energy consumption that depends on fossil fuels, large-scale hydropower and nuclear energy, thereby offsetting anticipated higher material- and energy-efficiency of production.

In turn, expanding economies, consumption patterns and lifestyles will continue to place much pressure on freshwater and related ecosystems. Total water abstraction will increase by 17% to 1,400 km^3/year (see Table 2.2). To meet this demand, land will continue to be converted for agricultural, industrial and human use. Further dam construction for hydropower and irrigation will be limited to a few countries (e.g. Spain) since fossil fuel prices remain low, good new dam sites are rare, and public opposition to dam construction in most developed countries is increasingly effective at the political level. Insufficient investments are made, however, to remove existing dams and dikes, and to rehabilitate degraded freshwater and related ecosystems such as wetlands, floodplains and deltas. Surface and groundwater resources are rendered useless due to contamination with pesticides, manure, and nitrogen and phosphorus from fertilisers. Overextraction of water resources will continue in many regions, causing severe damage to natural habitats and aquifers, and causing seawater intrusion in coastal areas (see Boxes 2.4 and 2.5).

Table 2.2 Water withdrawal by water use sectors as percentage of total water withdrawal for 3 developed regions. Total water withdrawal for 1995 and 2025 is, respectively, 1,200 and 1,400 km^3/year (Shiklomanov 1999).

	1995: % of total use (1,200 km^3/year)				**2025**: % increase/decrease compared to 1995 values			
	Agriculture	Industry	Domestic	Reservoir	Agriculture	Industry	Domestic	Reservoir
Europe	37.4	14.7	44.8	3.2	- 0.5	- 4.8	+2.2	- 3.1
North America	43.5	10.7	41.5	4.4	- 4.8	+15.0	- 0.5	+9.1
Australia &Oceania	51.0	10.9	23.5	14.8	–8.2	+3.7	+11.1	+6.1

The augmenting pressures will affect the state of many of the developed world's freshwater and related ecosystems to the extent that they will no longer perform essential functions such as provision of clean drinking water (see Annex 1). In temperate areas connected to mountain regions, such as parts of northwest Europe and North America, increasing late-winter flooding is projected as a result of climate change. If greenhouse gas emissions remain unmitigated, temperature is expected to rise up to 7 degrees Celsius in some areas and rainfall is projected to change dramatically (see Figure 2.1).

Box 2.4 Despite progressive measures, continued degradation of European water resources is expected by 2025.

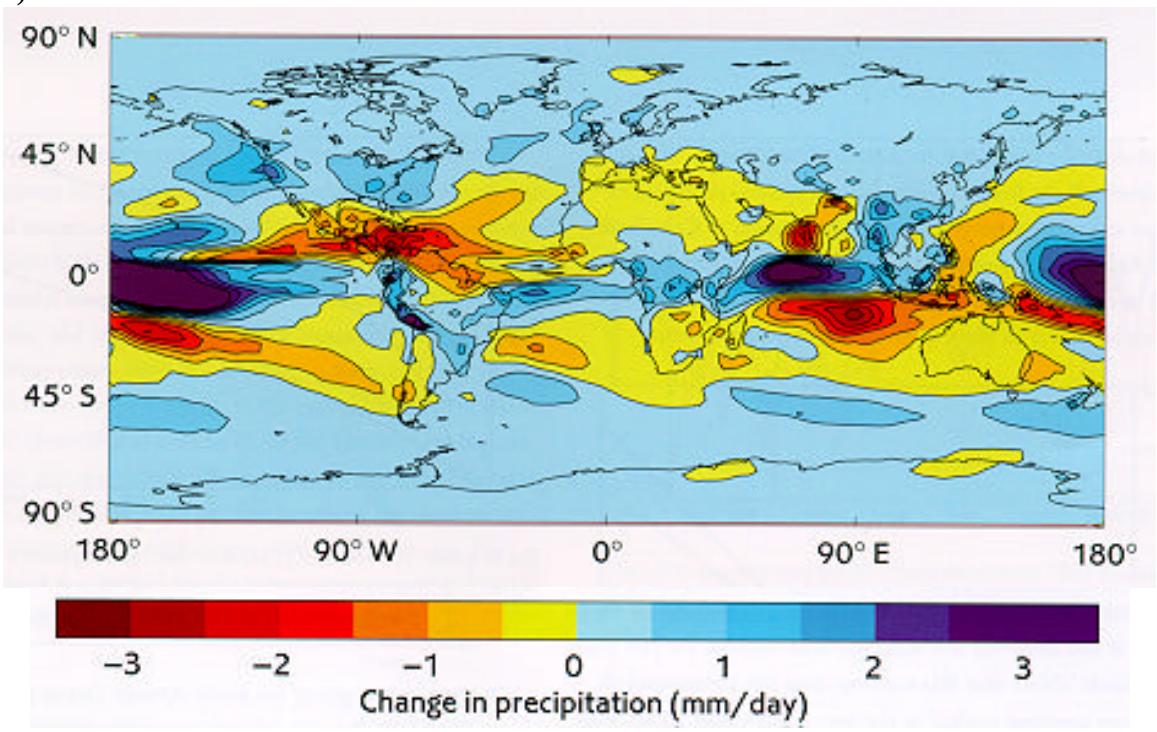
In Europe, overall consumption will increase and pollution-generating farming and industry will continue. The projected economic growth of 1.5% per annum will continue to exacerbate environmentally destructive practices. Public understanding of the role of the consumer society in degradation could, however, lead to more frequent and profound shifts in production methods. Water abstractions are projected to rise by 23% from 455 to 559 km^3 per year.

Dam construction is mainly considered for Spain and along the Donau. Other infrastructure development will continue, such as dikes and roads, although environmentally sound designs will more commonly be employed. Climate change is expected to lead to increased late-winter runoffs and reduced river flows in some of the main rivers, such as the Rhine basin. Overabstraction of groundwater resources will continue to cause falling groundwater tables that, in turn, will increasingly threaten critical ecosystems such as wetlands (e.g. in the Netherlands, Germany, Spain, Hungary, Slovenia and Poland). Already 60% of European cities are overexploiting their groundwater resources. Surface and groundwater pollution from nitrogen will remain problematic in the Northwest, and increasingly in South and Central Europe. Other pollutants, including pesticides, heavy metals and hydrocarbons, will also contribute to the poor water quality of most European rivers in 2025. Acid rain will continue to affect many water bodies in Central and Eastern Europe.

Falling groundwater tables will cause several agricultural areas to be taken out of production as aquifers run dry. Nitrate levels in drinking water will more frequently exceed international health standards in many countries. Investments in sanitation and soil and water reclamation will require major shifts in budget allocations and political priorities. The challenge for Central Europe will entail bringing together the industrial development needed for economic growth with environmental protection needed to maintain the water resources on which economic growth depends. The new European Water Framework Directive could be turned into the policy vehicle that is so needed for change to happen (WRI et al. 1998, UNEP 1999, Shiklomanov 1999).

Due to the developed and new infrastructure, floodplains, disconnected from their rivers, will no longer be able to provide even minimal floodwater storage and peak flood attenuation. In the Rhine basin, for example, it is projected that flood risk to societies along the river will increase primarily due to continued expansion of urban and industrial areas into the floodplain, and that competing demands between industry, transport, agriculture and drinking water will make environmental conservation increasingly difficult. Agricultural, industrial and urban-based pollution will also increase the burden of disease and raise costs of clean drinking water and health care. In many areas, contaminated soils and sediments will continue to form chemical time bombs that pollute surface and groundwater resources for many years after their original release or deposition. Pollution will increasingly affect human and environmental health alike (see Box 2.5). Invasive plant and animal species will increasingly proliferate and affect waterways and bodies, disrupt entire ecosystems and cause a severe decline in freshwater biological diversity.

a)



b)

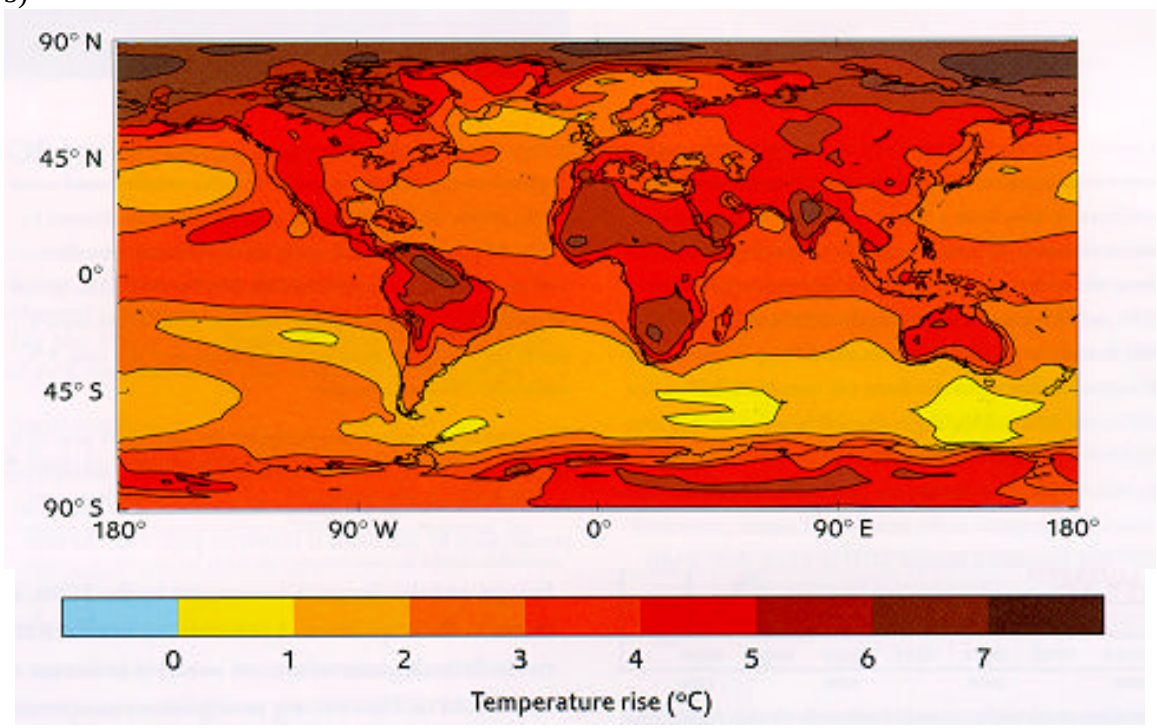


Figure 2.1 Global climate change predictions for 2080, resulting from scenario with unmitigated C02 emissions, showing (a) change in annual average precipitation, and (b) change in annual average temperature. Reproduced with permission from The Meteorological Office, Hadley Centre for Climate Predications and Research (HCCPR 1999).

Box 2.5 World's highest per capita water use will continue to degrade North American resources.

North Americans will continue to use more water per capita than any other region, and population growth and higher living standards will continue to demand more water of good quality. Agriculture, power generation and domestic use are responsible for the majority of the water abstractions. By 2025, the total abstractions will have risen by 15% to 786 km^3 per year. Climate change is expected to start to increase the demand for irrigation water.

Overextraction of the Ogallala aquifer, which supplies over 20% of U.S. irrigated land, will occur if projected use increases take place. The rising levels of pesticide and herbicide runoff and infiltration, together with heavy metals, will continue to pollute surface, ground and drinking water and increasingly affect human health and the environment. Already, in 1995, consumers were advised to limit their consumption of fish because of mercury, PCB and DDT levels that had risen by 14% over the previous year. Overfertilisation will cause greater eutrophication of water bodies and groundwater systems, causing a continued degradation of freshwater ecosystems, especially in the western coastal states and south/southeast of the Great Lakes region. Invasive species will increasingly infest waterways, and biological diversity will further decline. North America's freshwater animals are already the most endangered species group on the continent, dying out five times faster than those that live on land, with a rate similar to the loss of rainforest species. Since 1900, at least 123 species have been lost from North America's waters. A further 190 fish, 27 amphibian, 35 reptile, 84 bird and 94 mammal species are currently threatened with extinction, as 51% of species decline in numbers.

Dam construction is likely to be limited, and upcoming relicensing of dams will provide an opportunity to establish more environmentally benign operations. Investments in other water-related infrastructure could be implemented in more environmentally benign ways, but no clear trend has emerged so far. Resolving conflicts regarding the distribution of water rights, and the growth of municipal and industrial demands, will become a major challenge. Reconciling these with recreation, aesthetic enjoyment and wildlife habitat conservation will be progressively more important (Riccardi and Rasmussen 1999, Shiklomanov 1999, UNEP 1999, WRI et al. 1998).

The decline of the state of many freshwater and related ecosystems will affect societies to such an extent that direct large-scale social and economic repercussions will be manifested (see Annex 1). For example, investments in water pollution abatement and control will likely double to US$ 250 per capita per year. Consumers, instead of polluters, will likely pay most of these costs. The destruction of natural freshwater habitats will also affect other economic sectors such as tourism. Increasingly, the need to reconcile the water requirements of different economic sectors will become the focus of water managers and other natural resource managers. Disenfranchised social groups and natural environments that are unable to press their claim for a rightful share, will be increasingly deprived of water if their requirements are not legally protected.

Given their economic and social advantages, developed countries will have much more opportunity to respond to the challenges of water resources management in the coming decades than countries in the developing world. Financial, technical and organisational capacity is the backbone of this enhanced potential. Improvements in water quality, for example, could be carried out in many developed countries by a combination of technical means and strict enforcement of existing regulations on effluent emissions. An exception is likely to be Persistent Organic Pollutants (POPs) derived from pesticides and herbicides, which will continue to be highly concentrated in many water systems. To improve riverine conditions, the upcoming relicensing of many dams will provide opportunities to establish more environmentally-sound dam operations or initiate dam decommissioning. Flood forecasting based on advanced technologies forms another example of how developed countries will be able to respond to increasing water resources pressures. However, a much more fundamental rethinking of water resources management is needed to improve the current situation.

3. THE CONCEPTUAL FRAMEWORK: HUMAN-WATER-NATURE INTERACTIONS

3.0 A pressure-impact-response model of water resources degradation

Sustainable development and caring for the earth form the basis of the Vision for Water and Nature. This implies ensuring that human development meets the needs of the present without compromising the ability of future generations to meet their own needs. It also means improving the quality of human life while living within the carrying capacity of supporting ecosystems. Economic, social and environmental components of the global system are intimately linked, and degradation of one component affects the conditions of the other two. Environmental degradation inevitably leads to a decline in social and economic security (see Annex 1). Loss of social and economic security, in turn, causes environmental degradation to continue, initiating a downward spiral of environmental degradation, poverty and social disruption. Understanding and accepting the mutual dependence between people and ecosystems forms the departure point for changing the ways that we manage water resources in the future.

Important drivers for environmental degradation are an unsustainable rise in world population and booming economic growth, which lead to increased natural resource consumption, social inequity and poverty. Resulting increases in the demand for water resources further pressure the ecosystems that provide this resource, through resource overexploitation, environmentally disruptive infrastructure development and water pollution. This continues to lead to the dramatic decline of the state of many of the world's ecosystems. Wetlands and upper catchment forests have disappeared, and the quantity and quality of many surface and groundwater systems is reduced and seriously degraded. People are more exposed to environmental hazards and, in many areas, experience water scarcity. Health problems and conflicts over limited resources erode the security of individuals, families and societies who, in response, either develop strategies to mitigate or adapt to the changes, or neglect them altogether. These drivers, pressures, states, impacts and responses provide us with a conceptual basis for unravelling the complex linkages between societal behaviour and either degradation or conservation of freshwater resources (see Figure 3.1).

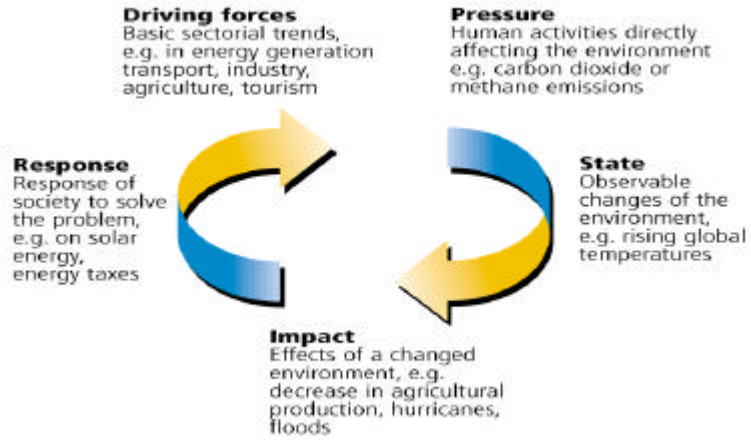


Figure 3.1. Driver-pressure-state-impact-response model for understanding linkage between societal behaviour and the degradation or conservation of freshwater resources (Jesinghaus 1999).

3.1 Ecosystems have intrinsic values and provide essential goods and services

To reverse the downward spiral of environmental degradation, people must first understand and appreciate the wealth that healthy, functioning ecosystems represent in the form of both their intrinsic value and the many socio-economic benefits they provide. These can be summarised as the range of functions (goods and services) that ecosystems deliver to humankind. These functions, which form the basis of the security of individuals and societies, include production, regulation, habitat and information functions. Lakes, rivers, and the coastal and nearshore marine ecosystems that form the highly productive link between the freshwater and marine environment, provide valuable fishing grounds and a major protein source for many societies. Upper catchment terrestrial ecosystems and wetlands regulate water quantity and quality by storing water, reducing sediment loads, and filtering and breaking down chemical and biological contaminants. Ecosystems provide habitat for fish, birds, amphibians and other organisms whose nurseries are essential to maintaining foodwebs that, in turn, form the basis of production. Tourism and recreational opportunities provided by ecosystems, such as rivers and lakes, often form an important source of local income and security (see Table 3.1; Annex 1).

Table 3.1 Natural ecosystems provide many goods and services (functions) to humankind that are often neglected in (economic) planning and decision making (adapted from de Groot 1992).

1. REGULATION FUNCTIONS *The capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems*	**3. PRODUCTION FUNCTIONS** *Resources provided by natural and semi-natural ecosystems*
Maintenance of biogeochemical cycling (e.g. air-quality regulation and CO_2-buffering)	Food (e.g. edible plants and animals)
Climate Regulation (e.g. buffering extremes)	Raw materials (e.g. thatch, fabrics)
Water regulation (e.g. flood protection)	Fuel and energy (renewable energy resources)
Water supply (filtering & storage)	Fodder and fertiliser (e.g. krill, litter)
Soil retention (e.g. erosion control)	Medicinal resources (e.g. drugs, models, test organisms)
Soil formation & maintenance of fertility	Genetic resources (e.g. for crop resistance)
Bioenergy fixation	Ornamental resources (e.g. aquarium fish, souvenirs)
Nutrient cycling (i.e. maintenance of the availability of essential nutrients)	**4. INFORMATION FUNCTIONS** *Providing opportunities for reflection, spiritual enrichment and cognitive development*
Waste treatment (e.g. water purification)	Aesthetic information (e.g. valued scenery)
Biological control (e.g. pest control and pollination)	Recreation and (eco-) tourism
2. HABITAT FUNCTIONS *Providing refugia to wild plants and animals (and native people) in order to maintain biological and genetic diversity*	Cultural & artistic inspiration (i.e. nature as a motive and source of inspiration for human culture and art)
Refugium function (for resident & migratory species)	Spiritual and historic information (based on ethical considerations and heritage values)
Nursery function (reproduction habitat for harvestable species)	Scientific educational information (i.e. nature as a natural field laboratory and reference area)

Respecting the intrinsic values of ecosystems, and the benefits they provide, implies leaving water in ecosystems to maintain their functioning. This water, together with the water that is needed to meet basic human needs, is a reserve that has priority above all other water uses. Only water resources in excess of these basic needs should be thought of as "available" for allocation to other uses. 'Water resources,' in the broadest sense, include water in all compartments of the water cycle, together with all the living resources this water supports, such as fish, amphibians and water flora. The interdependency of water cycle elements and processes,

such as rainfall, evaporation, transpiration, and soil moisture, surface and groundwater, and coastal and marine waters, requires us to manage water resources within their basic hydrological units: the catchments and groundwater aquifers (see Figure 3.2).

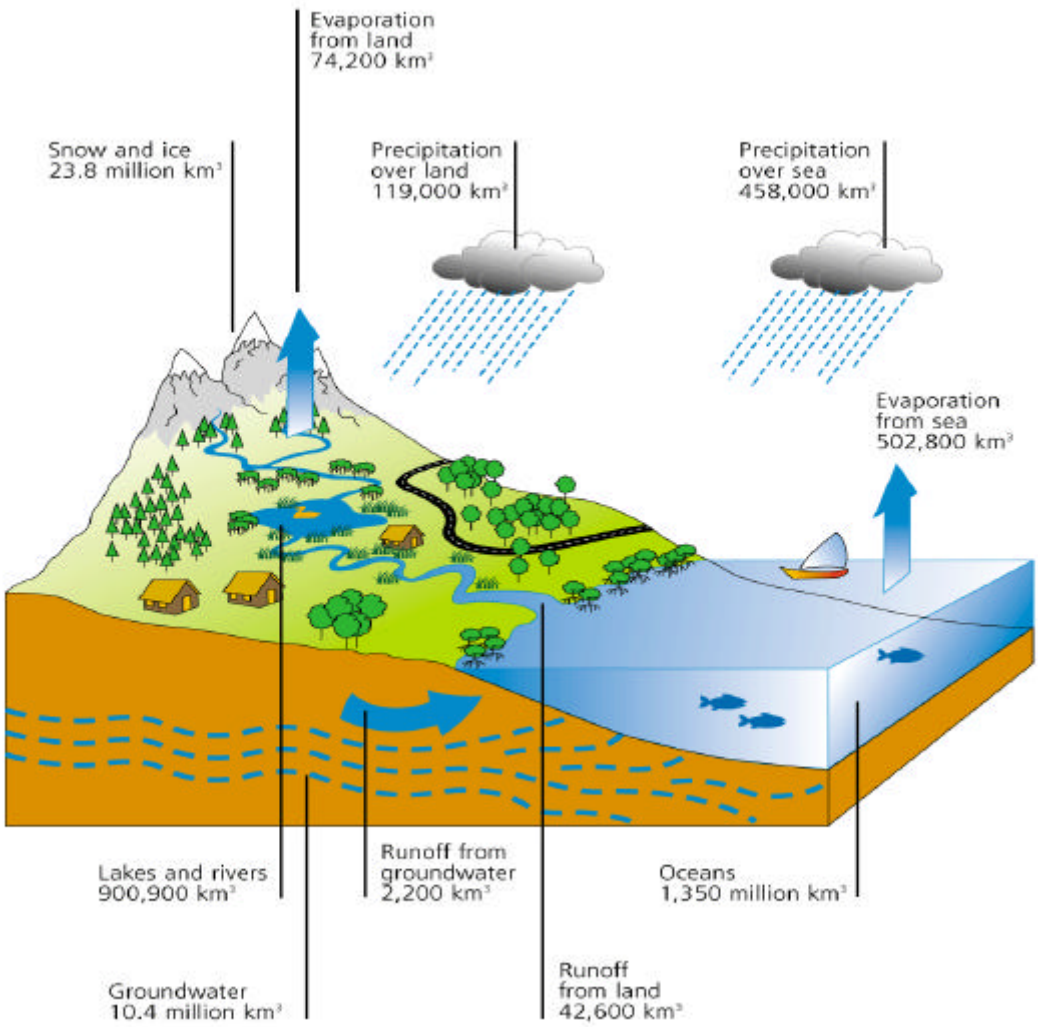


Figure 3.2 General description of the water cycle (Shiklomanov 1999).

3.2 Sustainable water resources management through participatory ecosystem-based catchment management

To maintain the goods and services provided by ecosystems, water resource managers need to adopt an approach that treats water resources as an integral part of ecosystems; that is, as a limited natural resource, and a social, environmental and economic good whose quantity and quality determine the nature of its use. Such an approach has two fundamental requirements: (i) the management of catchments as an integrated ecosystem, and (ii) participatory planning and management. Water resources should be managed on the basis of river or drainage basins in an integrated fashion, with a continued and deliberate effort to maintain and restore ecosystem functioning within both catchments and the coastal and marine ecosystems they are connected with. A participatory catchment management approach addresses not only the issues of natural resources conservation and management, pollution control and sustainable agriculture, but also the concerns of governments, local populations, and their expert advisors. Through democratic, participatory planning and management, the ecosystem-based approach within catchments/river-drainage basins sets out an alternative to conventional top-down and sectoral approaches that fail to produce desired results and often lead to further environmental degradation.

Why care for catchments or river/drainage basins?

Water and land use have reciprocal effects: land use depends on water appropriation, and the quality of freshwater ecosystems is directly affected by land use. Compounded by the stresses of population growth, global warming and deforestation, catchment degradation increasingly results in such extreme conditions as flooding and drought. The degradation of water resources cannot be addressed in isolation; rather, we must consider functioning of ecosystems simultaneously at different hierarchical levels, both in space and in time. That is to say, we must think about planning and management interventions at local levels (e.g. field, farm, village) as well as at regional levels (e.g. catchment and river/drainage basins).

Why participatory planning and management?

Catchment boundaries do not normally coincide with sociocultural and political boundaries, and catchments have therefore not generally been managed as a unit. Many human boundaries exist within and across a catchment, such as individual farms, villages, sacred grounds, ethnic groups and provincial boundaries. Given the ‘mismatch’ between a catchment perspective and socio-economic and political realities, it is important to involve stakeholders representing all views. Local communities, including men, women and children, provincial governments, technical institutions, non-governmental organisations (NGOs) and (in appropriate circumstances) donor agencies should work together on problem definition, planning and management of the natural resource base. In this way, global objectives of conservation, sustainable management and poverty alleviation are twinned with both local objectives and the development of locally-relevant adaptive management systems.

Part II. FRAMEWORK FOR ACTION

4. THE CHANGES NEEDED

4.0 The choice we face: Neglect or care

In order to satisfy growing human and environmental water needs and rectify the destruction, degradation and pollution of ecosystems, a new strategy is needed. This strategy for a sustainable society should provide real improvements in the quality of human life, while at the same time conserving the vitality and diversity of ecosystems.

To achieve a sustainable society that cares for its resources, we must establish a fundamentally new paradigm for the use, development and conservation of water resources. This means establishing an ecosystem-based catchment management approach. It requires that we 'learn to care' about our water world; a world in which water resources will no longer be overused, but conserved and restored for the benefit of both natural ecosystems and humankind. In this world, more equitable distribution will bind people, societies and nations, reducing the schism between 'haves' and 'have-nots'. It envisages people-centred development that values both quality and quantity, that concentrates on equitable sharing, that recognises the need to maintain the diversity and productivity of ecosystems, and that values long-term sustainability above short-term revenue. Development and nature conservation are not opponents, but partners that must form a strategic alliance to create a sustainable water world.

Moving from this vision to action requires that we appreciate the intrinsic value of ecosystems and maintain ecosystems' abilities to provide goods and services to humankind. For this, we need to build on existing and new, predominantly small- and medium-scale approaches to sustainable water resources management. Based on local empowerment and adaptation to local conditions, these approaches maintain and restore the goods and services provided by freshwater and related ecosystems. Using soft engineering, appropriate technology, indigenous crop varieties and ecosystem-based management know-how, in combination with traditional and appropriate social and economic mechanisms, the security of communities and societies can be ensured while ecosystems are maintained and restored.

The vision and actions presented here build on important international agreements such as the World Charter for Nature, the Dublin Principles, Agenda 21, the Convention on Wetlands (Ramsar 1971) and the Convention on Biological Diversity (see Annex 2). A follow-up to these important international statements and agreements is needed as part of a renewed world effort to redress the continued degradation of water resources. Required changes are not cosmetic or short-lived; rather, they are fundamental and far-reaching, and will demand the full dedication of all nations and peoples.

The strategy presented here is not a prescription, but is intended to assist in bringing about change. Different nations, peoples, cultures and institutions will have to employ diverse sets of actions to bring about desired changes. Wealth, quality of life, and environmental conditions vary around the globe, and will continue to change over time. For this reason, the goals and actions described here are in broad terms, and the targets, rather than being defined in arbitrary numerical terms, reflect the general objectives of the vision. Each individual, institution and country will need to interpret and adapt these to local needs, abilities and opportunities. While diversity should be the basis for the world's path towards sustainability, one requirement is universal: *Joint action for ecosystem-based conservation of river and drainage basins, making a deliberate effort to profoundly reconsider our attitudes and behaviours towards water resources, their uses and their management.*

4.1 Caring for and managing freshwater resources in river or drainage basins

Maintaining the water resource base of our planet will require individuals to accept the duty of caring for other people and other forms of life, now and in the future. At its root, this is an ethical principle that requires us to respect the community of life, and share both the benefits and costs of water resource use and conservation. This ethic implies sharing water resources among different communities and interest groups, among people who are poor and those who are affluent, and between our generation and those who will come after us. It is a matter of both ethics and practicality to establish management for water resources that does not threaten the survival of other species and their habitats, but builds on their protection and maintenance. There are finite limits to the capacity of the earth's freshwater and related ecosystems[1] to withstand human abuse without serious and irrevocable deterioration. We must bring human population growth and our lifestyles into balance with nature's capacity and the limits of the renewable water resource base.

Participatory ecosystem-based catchment management

The interdependencies between land, water and segments of human society require NGOs, governments, local groups, private companies and donors, in consultation with stakeholders, to jointly develop and implement an ecosystem-based catchment management approach in order to sustainably manage water resources. The augmenting pressure of increasing water demand and resulting conflicts, together with the greater variability and uncertainty in global environmental and hydroclimatological conditions, underline the urgency of establishing such an approach. The notion of participatory ecosystem-based catchment management incorporates the opportunities and limitations provided by ecosystems, societies and economies, rather than relying on conventional single-use, top-down planning and management.

In terms of nature conservation, this approach promotes the protection and rehabilitation of upper catchments, rivers, lakes, groundwater reserves, riparian zones, wetlands, floodplains, and coastal areas (see Box 4.1). This is not to be done in isolation of other catchment uses; on the contrary, biodiversity and environmental protection require the establishment of interdisciplinary, intersectoral, and interinstitutional projects – both large and small – that develop strategies in a holistic way, building primarily on the needs of the catchment inhabitants. It comprises finding enough space for natural ecosystems, species and people, and restoring basic processes so that water moves through ecosystems with the appropriate flow regime, temperature and chemical composition.

Box 4.1 Protection of 'cloud-forest' catchments to maintain the water supply of Quito city (Ecuador).

Protection of high-elevation forest, or 'cloud forest', can augment water supply since water retained from condensation is as effective a water source as precipitation. The Nature Conservancy (TNC), the Ecuadorian Forest and Natural Areas Institute (INEFAN) and Quito's Municipal Sewage and Water Agency (EMAAP-Q), together with companies and local groups in and around Quito, recognise the importance of maintaining the catchments of the Quijos, Tumiguina and Blanco rivers, especially the upper catchment areas located within the Antisana and Cayamba-Coca ecological reserves. In 1998, a fund for the protection of the catchment was established. Water consumption fees will be negotiated with the various users to be directly invested in catchment protection to maintain water supplies and protect biodiversity, based on management plans to be developed during the coming years. This initiative exemplifies a collaborative effort to recognise the value of services provided by a protected catchment (Hamilton 1997, TNC 1998).

[1] Every action that takes place on land has an impact on the water resources of the catchment or basin in which it takes place. This is why a true ecosystem basis to freshwater resources planning and management is advocated, taking into account all land and water use at the catchment and basin level and related coastal and marine ecosystems.

This approach can truly be considered a 'paradigm shift', and promising initial steps are currently taking place in many parts of the world. In Cameroon, for example, a floodplain is being brought back to life through the Waza Logone rehabilitation scheme. In 1978, a dam constructed for rice irrigation greatly restricted the seasonal flooding of the downstream floodplain along the Logone River, causing severe ecosystem degradation and the disruption of traditional livelihoods. In 1988, IUCN – The World Conservation Union initiated a project to rehabilitate the floodplain, including the 171,000 ha Waza Park. Pilot water releases through newly constructed openings in the main river levee have enabled restoration of approximately 60 per cent of the affected floodplain. The renewed flooding dramatically improved the living conditions for the people and their environment, without affecting the rice scheme. This ongoing project has already shown that ecosystem rehabilitation and water allocation for irrigated rice do not have to compete, but can exist side by side for the benefit of local people and ecosystems (Braund 2000).

Applying an ecosystem-based approach is a gradual process, since it takes time for farmers, fishers, women, youth and other potential users to conduct their own testing and adaptation before deciding whether to adopt such new approaches. Initial development and implementation of models may begin slowly, with a few cases of replication here and there, but there is bound to be an upsurge in acceptance as success stories abound. The green revolution took 30 years to show results (which were not all positive); participatory ecosystem-based catchment management cannot be expected to prove itself in a single project cycle of 3 to 5 years. Patience, along with proper monitoring and evaluation to learn how to care for and adapt to changing conditions, will be essential (see Box 4.2).

Box 4.2 The Murray Darling Basin Initiative: The world's largest catchment management programme.

The Murray Darling catchment covers more than one million square kilometres – one-sixth of Australia – and includes 24 major rivers. Salinity is a natural feature of the catchment. The problem is that changes in land use and water use have intensified this aspect of the catchment, resulting in conflict with human and environmental needs. Removal of natural vegetation has altered the water balance of the land so that water tables have been rising, leading over time to salinisation of the soil. Saline inflows, in turn, affect river water quality, endangering important aquatic and riparian ecosystems as well as threatening domestic water supplies for the city of Adelaide and much of South Australia.

In recognition of this, and other problems in the catchment, the Murray Darling Basin (MDB) Initiative was established in 1987. The natural resources management strategy that deals with the management of the riverine environment, irrigated and dryland regions, and basin-wide issues, underpins the MDB Initiative. The riverine environment sub-programme covers three broad areas: improvements to water quality; river flows with respect to balancing human and environmental needs; and nature conservation. A salinity and drainage strategy has been proposed for irrigated regions. Through this strategy:

- Improved land management techniques are being introduced to minimise the amount of irrigation water being added to the water table. Through the use of new crops and more efficient irrigation technology, this will encourage the use of land within its sustainable capacity.
- Engineering works are being constructed to intercept highly saline groundwater and pump it to suitable disposal sites before it flows into the main river system.
- New operating rules have been introduced to reduce evaporation losses from reservoirs.

In addition, the MDB Initiative recognises the role of wetlands in enhancing river water quality, and a Floodplain Wetland Management Strategy has been developed that aims to maintain, and where possible enhance, the floodplain wetland ecosystems. Constructed wetlands are being specifically designed to reduce nutrient loads from farm runoff, sewage treatment, industrial plants and urban runoff.

Throughout Australia, Integrated Catchment Management and the Landcare system have encouraged farmers and other rural industries to work together with government and rural communities to solve a wide range of rural problems (Campbell 1994). The Landcare system combines elements of community and environmental education, action research and participatory planning. More than 2000 voluntary Landcare community groups are currently working to develop more sustainable systems of land and water use within catchments, supported by a national ten-year funding programme.

Leaving enough water in ecosystems to provide services

As the source of water and life, ecosystems must be protected and wisely managed by the industries, municipalities, households and farmers who rely on them. Some ecosystems, such as upper catchment 'cloud forests', springs and certain wetlands, directly provide us with clean water. Other ecosystems contribute to the regulation of water resources, reducing flood peaks and removing chemicals (see Annex 1). Ecosystems need water to fulfil their basic requirements and maintain these functions.

To achieve this will entail users to leave the required amount of water within ecosystems, while achieving equitable allocation of the abstracted resources. By leaving enough water in ecosystems, biodiversity and key habitat characteristics can be maintained – including interconnections between channels and floodplains, and upstream and downstream areas, including coastal and marine areas. Techniques are increasingly available for determining the quantity, quality and seasonal flow regime required for maintaining rivers, lakes and coasts. These can be used to establish needed reserves of water; that is, amounts that cannot be taken from the ecosystem if it is to maintain key processes, habitats and species and continue to serve the vital functions upon which humanity depends.

To leave water in ecosystems will, in many cases, require a reduction in the total amount of water abstracted from rivers and groundwater systems. Inevitably this will require a corresponding reduction in the water demands of agriculture, industry and direct human consumption. To reduce total human water demand requires both behaviour changes, such as reduced consumption, and technical improvements in water distribution, such as improved irrigation efficiency and water supply leakage reduction.

Controlling pollution and waste

Degradation of freshwater ecosystems and the resources they provide is due partly to pollution and waste disposal. In many catchments, pollution of watercourses and groundwater reserves needs to be controlled, from specific as well as diffuse sources. Municipalities urgently need to treat effluents from expanding urban areas. In the developing world, sanitation services and wastewater treatment within megacities should be given a high priority, as cubic kilometres of untreated and polluted discharge is threatening downstream ecosystems now and into the near future.

For industries need to reduce their effluents to acceptable levels, governments need to enforce regulations and provide incentives to companies to comply with national legislation. In many cases this can be achieved by developing more efficient production processes in which raw material use is reduced, and material cycles are closed, in combination with adequate residual effluent treatment. These strategies can provide huge opportunities to cut production costs, creating a win-win situation that should form the basis of sustainable industrial development.

Diffuse sources of pollution, such as agricultural runoff and infiltration, require tackling at the base. Farmers need to establish good land husbandry all across catchments in order to reduce agricultural runoff of sediments, fertiliser, pesticides and herbicides. An emphasis on the management and conservation of water and organic materials, both above and in the soil, forms the basis for achieving conservation of soil and water resources within the food production process. Together with a reduction of chemicals used for disease control (e.g. through integrated pest management), this will not only benefit farmers directly through increased production and

reduced costs (e.g. fertilisers), but also provides benefits for all catchment inhabitants and ecosystems downstream.

Reconsidering infrastructure development

Sustainable water management requires a different approach to infrastructure development: an approach that 'lives with nature,' as opposed to one that 'strangles nature.' Leaving more space for natural ecosystems will require governments and developers to reallocate financial resources and redesign new or decommission existing infrastructure such as dams and dikes (see Box 4.3). Avoiding the huge environmental impacts of many infrastructure developments throughout the world will, in many cases, be much more profitable then paying for later repairs. Approaches to water management that take advantage of natural features of the ecosystem are therefore often much less costly than large-scale infrastructure developments.

Box 4.3 U.S. Army Corps of Engineers to invest in environmental protection for flood control.

Flood-prone communities in the United States have welcomed the new approach taken by the Corps that focuses on flood mitigation and riverine restoration by, simply, getting out of the way. U.S. Congress allocated US$ 200 million to develop pilot projects, in addition to the US$ 533 million the Federal Emergency and Management Agency has already spent on a similar approach that involved removing over 20,000 structures during the last six years. The Corps will pay 65% of the cost of buying properties in floodplains, tear down structures such as dams and dikes, relocate property owners, and restore freshwater and related ecosystems. Already more than 100 communities have expressed interest in the programme, of which they have to finance 35%. The traditional Corps philosophy was always, "Deeper, straighter, wider; just to see how fast you could get the water out of the area", said Dennis Murphy, chairman of the Mill Creek Watershed Council, who is interested in participating in the new programme. If successful, the Corps pilot project could initiate a much larger long-term programme and a major change in water management culture in the United States (Maddox 1999).

In France, for example, the decommissioning of dams in the Loire catchment presented an opportunity to rejuvenate the riverine ecosystem. With the adoption of the Natural Loire River Plan in 1994, the French Government initiated the decommissioning of three dams on tributaries of the river. It concluded that the existence of the dams could no longer be justified since their ecological impacts were no longer compensated for by their economic return. The objective of their removal was to restore the riverine ecosystems and bring back the great Loire salmon, which is the only salmon in Europe still able to migrate over a distance of more than 800 km from the estuary to its spawning sites. In two cases, upon expiry of the dam licenses, the facilities were transferred back to the State which, between 1996 and 1998, had invested FF 6 million and FF 14 million, respectively, in their decommissioning. The third dam was decommissioned by Electricité de France for a total of FF 7 million in 1998. Decommissioning of dams is increasingly seen as an option to bring back the proper functioning of river ecosystems. In many countries, like France, the United States and Canada, the relicensing of a dam facility provides the opportunity to improve the dam structure to allow environmentally-appropriate flows, or to decommission the dam if environmental impacts are judged too severe (Delaunay 1999).

For new infrastructure developments, developers should integrate high quality environmental impact assessment (EIA) studies into the planning phase, not merely as an add-on to the project development. In this way, the results of an EIA can be directly linked to the design and implementation of avoidance, mitigation and compensation measures. For existing infrastructure, operators will have to comply with modern environmental standards that allow for environmental flows, establishment of migratory species passages, and compensation for affected habitats and species.

In 2025, the basic needs of freshwater and related ecosystems are cared for…

GOAL Critical freshwater and related habitats and species are protected through implementation of sustainable water and land resource use and control of pollution from agriculture, industry and domestic water use.

TARGET 2025 Protection of majority of upper catchments, wetlands, rivers and groundwater reserves effectively implemented.

ACTIONS

- NGOs, governments, local groups, private companies and donors, in consultation with stakeholders, to jointly develop and implement well-monitored pilot projects on participatory ecosystem-based catchment management, and protect and rehabilitate freshwater species and critical habitats, such as upper catchments, river channels and banks, wetlands, floodplains and coasts;
- Industries, municipalities, households and farmers to implement water-saving measures to reduce water use and allow appropriate amounts of water to be left in rivers, lakes, wetlands and groundwater aquifers;
- Farmers, municipalities and industries to reduce emissions of nutrients, untreated effluents and hazardous waste through compliance with existing regulations and closing the material cycles, including resource-use reduction and waste (water) treatment;
- Governments to minimise dam construction and support decommission of non-efficient/high-impact dams; developers to optimise the design of new dams to allow species migration and mitigate other environmental impacts; and operators to change dam management practices to fulfil water requirements of all up- and downstream ecosystems.

4.2 Incentives for conservation based on an ecosystem's full values

Sustainable water resources management requires us to recognise the range of goods and services ecosystems provided to humankind as well as the intrinsic value of ecosystems (see Annex 1). The goods and services ecosystems provide hold tremendous value, which needs to be reflected in water resources development schemes. Local governments and NGOs, together with resource managers and consultant agencies, must address these values and the high cost of degradation by reconsidering current subsidies which, by maintaining the status quo, are in fact a causative factor of degradation and do not contribute to sustainable development. At local levels, increased participation in water resources management could be twinned with increased financial responsibility. At catchments levels, innovative financial mechanisms need to be implemented to finance catchment-wide maintenance of ecosystem services and the implementation of conservation measures. A range of economic instruments will be needed to counter development practices that overexploit resources, pollute life-support systems and destroy ecosystems and biodiversity, based on proper analysis of values, rights and entitlements.

Valuation of ecosystem goods and services

The economic, ecological, cultural and intrinsic value of ecosystems' goods and services should be reflected in their use by people and the price institutions pay for use. Reflecting water's true value, without compromising people's rights to fulfil their basic human needs, will create an incentive to reduce use, degradation and pollution of water resources in many but not all parts of the world. It will require major changes in the ways costs and benefits of development schemes and infrastructure projects are calculated, including the full social and environmental costs. To enable this, resource managers, NGOs and consultant agencies will need to quantify the

ecological, sociocultural and economic values of freshwater and related ecosystems as much as possible, and include them in the cost-benefit analyses of the planning process (see Box 4.4).

Box 4.4 Benefits from traditional floodplain use higher than large-scale irrigated agriculture in Nigeria.

Recent estimates of the value of Hadejia-Jama'are floodplain use in northern Nigeria indicate that traditional practices provide higher benefits than crops grown on the Kano irrigation project. Benefits derived from firewood, recession agriculture, fishing and pastoralism were estimated at US$ 12 per litre of water, compared to US$ 0.04 per litre for benefits derived from the irrigation project. This evaluation is particularly important for the region, as more than half of the wetlands have already been lost to drought and upstream dams. Even without accounting for such services as wildlife habitat, the wetland is more valuable to more people in its current state than after conversion to large-scale irrigated agriculture. This example shows that if proper cost-benefit analyses are made, which include the value of goods and services provided by ecosystems, then large-scale development schemes turn out to be less profitable than improving the management of the unaltered ecosystem (Barbier & Thompson 1998).

Methods for quantifying the full value of the goods and services of freshwater and related ecosystems are increasingly available, but need to be further improved. To know these values is one step; incorporating them in decision-making and management is an entirely different exercise. All countries, peoples and water users need to adopt economic, social, political and legal mechanisms to fully incorporate these values.

Local payment to accountable institutions for effective services

In some cases, an appropriate instrument would be for NGOs and local governments to work with local institutions to price available water resources, after the basic water needs of people and ecosystems are met. Water pricing should thus not be carried out for water quantities required for fulfilling basic human and environmental needs. It should, among other things, be based on progressive (block) tariffs and the polluter-pays principle. Water pricing, however, cannot be carried out without the development of a proper legal and institutional system that protects the voiceless and delivers the services.

At local levels, the capacity to pay is largely determined by the benefits that can be gained directly from payment. The willingness to pay increases significantly if payments are made to local institutions that can be held accountable for delivery of services. Participation of those who pay in the management of these local institutions is essential. If payment and delivery are twinned with trust and transparency, considerable progress can be achieved in local water resources management.

Restructuring subsidies and taxes

Some existing economic policies and instruments stimulate freshwater ecosystem degradation, excessive water extraction and pollution through perverse subsidies, distorted prices and taxes. Governments will have to change these by developing new policies, guidelines and economic instruments that provide incentives for sustainable ecosystem-based management. Internalising the economic implications of ecosystem degradation and loss of environmental security from global to local levels is an important instrument for addressing these challenges. To resist overexploitation and ecosystem degradation, sufficient funding needs to be provided to face the effects of globalised markets. This will require more effective and efficient ways of financing development, conservation and restoration activities, including private sector investments.

In the United States, for example, investment in catchment protection is expected to save New York City billions of dollars. The city has set aside US$ 250-300 million for the acquisition

of some 80,000 acres of land as part of an integrated strategy to protect water supplies from pollution. Watershed regulations are also being expanded to address related issues, such as the construction of impervious surfaces (e.g. roads and parking lots) close to reservoirs and watercourses, storm-water runoff, the unprotected storage of highway salt, and rigorous standards for sewage handling. Many of the city's 130,000 septic systems will be closed and strict standards will be set for the construction of new ones. Homes and businesses will be connected to newly constructed, city-subsidised tertiary treatment plants. Total investment in the strategy is US$ 1.5 billion; however, by protecting the water sources that supply New York from pollution, the city is able to avoid constructing a water filtration plant that would cost US$ 6-8 billion and would incur annual operating costs of $300 million (The Trust for Public Land 1998).

Investments made within and outside the water sector should incorporate the full economic, ecological, cultural and intrinsic values of ecosystems' goods and services in decision-making. Adjustments to the current approach for cost-benefit analysis need to be made to include the cost of losing some of these values as a result of development activities. Governments should analyse and remove perverse incentives that induce water resources degradation, including subsidies to crops with high water consumption, and low water tariffs for large quantity users.

Investments can also be an incentive for enterprises to change their behaviour. Stakeholder or consumer pressure on companies to reduce their water use can be an effective tool. These can often be linked to codes of conduct to which 'peer' companies within similar industrial or commodity sectors want to sign up. Lead companies often benefit from enhancement of public image or from first mover advantages. 'Seen to be green' is important in markets where a business has a high profile with the 'purchasing public' such as, for example, the water consumer (see Box 4.5).

Box 4.5 Norwegian investors to base investment decisions on water use intensity of companies.

Shareholders are typically interested in looking at companies that are better equipped than their competitors to succeed in a complex future. In Norway, two investment firms believe that companies that care for the environment and can handle social challenges will outperform those that don't. In 1996, these companies launched the Storeband Scudder Environmental Value Fund that focuses on investment in companies with high environmental performance scores. The Fund uses eight indicators of sustainability to guide investments, including the water-use intensity of a company. By achieving a more than 53% net return over the 30-month period since its launch, the Fund has demonstrated that investors can achieve a good return on investment while providing incentives to companies to improve their water-use intensity and become more socially and environmentally responsible (Willums 1999).

Innovative financing of sustainable catchment use and conservation

Financing of catchment conservation by NGOs, private companies and governments is a key element for change. Financial resources can be derived from proper costing of the goods and services provided by natural ecosystems (e.g. forests in upper catchments). Investments in conservation are often wiser than 'end of pipe' solutions such as river clean-ups. Innovative financing can also include the establishment of 'Catchment Trust Funds'. Voluntary contributions and service payments to a Trust are invested in conservation measures that improve catchment and water conditions from which Trust Fund contributors might directly profit.

In the United States, for example, the Oregon Water Trust was established in 1993 to acquire water rights for maintaining instream flows to enhance the recreational values and ecological health of watercourses. By 1998 it had protected flow in 450 miles of river throughout the state of Oregon, on the basis of deals with over 50 water rights holders. It has acquired US$ 654,000 of water rights through donations and acquisitions. Private foundations provide

90 per cent of its budget, while private groups and public agencies provide in-kind support to the Trust. The Trust sometimes reimburses private landowners for loss of income; for example, when leaving water instream and not using it for irrigation. The Trust is helping to transform attitudes about water and people's acceptance of water markets in general. It provides an example of an alternative way of bringing together agricultural and fisheries interests, landowners and environmentalists, to develop constructive ways for sustainable natural resource management.

Trust Funds should only be set up where effective legal and institutional frameworks are in place. Financing of Trusts or direct conservation investments can, in some cases, be based on 'Debts for Nature/Development Swaps.' These allow a developing country to invest in conservation and development for a reduction in part of its foreign debt. In general, existing aid mechanisms need to be strengthened and applied more to finance pilot projects in participatory ecosystem-based catchment management that can be replicated elsewhere.

In 2025, ecosystems' full values are recognised…

GOAL The economic, ecological, cultural and intrinsic values of ecosystems are fully incorporated in decision-making and management of water resources, using incentive measures and innovative financial and legal mechanisms.

TARGET 2025 New incentives or economic and legal mechanisms developed and implemented for nature and water resources conservation are applied in the vast majority of catchments.

ACTIONS

- Resource managers, NGOs, and consultant agencies to further develop and implement economic valuation in planning/design and monitoring/evaluation of water resources management projects and activities to enable balanced decision-making on multiple resource use, development and conservation;
- NGOs and local governments to establish payment and subsidies to strengthen existing, or establish new, responsible, transparent and accountable local institutions that provide improved water delivery, drainage and sanitation services;
- Governments to remove perverse subsidies that promote inefficient use of water or freshwater ecosystem destruction, and to establish subsidies that promote conservation of critical habitats and stimulate the use of intermediate technologies for water saving and pollution reduction in agriculture, industry, and at the household level;
- NGOs, private companies and governments to carry out 'debt for nature & development swaps' and direct financial resources to develop catchment trust funds that finance the implementation and maintenance of rehabilitation and conservation measures within specific catchment areas.

4.3 People's empowerment for responsible water use and conservation

Participation of local groups is essential for establishing grassroots sustainable water management and conservation. Faced with resource shortages, people will first address their own needs: their fields, their farms, their livelihoods, and their villages. Only when these are adequately addressed are they likely to consider catchment issues. Ecosystem-based catchment management can therefore only be implemented successfully when it takes a similar path; a path that is based on people's well-informed decision-making, and adaptation to changing conditions. This is a process that enables humans to improve their standards of living and lead their lives in dignity and fulfilment, while learning to conserve their resource base and contribute in a meaningful way to solidarity within their society.

Establishing public participation

Devolution of power to local levels, and people's participation in water management decision-making, requires individuals to take up new responsibilities and become actively involved. Water-related problems have taken a long time to reach this critical stage; persistence, tempered with patience, is needed to find solutions. Energy and capacities exist at local levels that can be complemented, where appropriate, with technical expertise provided by NGOs, CBOs, research institutes or governments.

Equitable sharing of water resources

Achieving sustainable use of freshwater ecosystem resources will require equity in both decision-making and sharing of resources. To achieve equity within and between households, communities and nations will require NGOs, governments and private companies to maintain and sometimes create efficient, representative and sustainable institutions for catchment management. These institutions will have to provide alternatives for disenfranchised individuals and communities whose security is based on access to freshwater ecosystems and whose control over these resources has eroded (see Box 4.6). Reducing the vulnerability and uncertainty of livelihoods is essential, and can be supported by providing greater choices in management and income generation to local communities. Empowered local communities should be given a fair share of the resources or the revenues from these to allow them to manage their livelihoods in a fair, sustainable and effective manner (see Box 4.7).

Box 4.6 Self-help Credit Management Groups for implementing sustainable catchment management (Gulbarga, India).

In 1988, a joint project between the state government and the Swiss Development Cooperation was initiated to give farmers increasing control over catchment resources. The project focused on developing farmers' skills, building confidence and developing organisational expertise to control resource use and increase productivity in a sustainable way. Central to the project was the development of Self-help Credit Management Groups (SHG), which are socially functional groups in micro-catchments that require no outside intervention to remain viable. Such groups usually have fewer than 20 members, who share a common interest and are largely homogeneous in terms of caste, class and livelihood. The SHGs developed skills to manage credit and institutionalise and administer cooperation. The project has shown that SHGs are very effective at practical resource management, but need to be complemented by Catchment Management Committees to incorporate the interests of landless and marginal farmers (Fernandez 1998).

Box 4.7 Local empowerment for sustainable use of resources: The CAMPFIRE experience (Zimbabwe).

Sustainable rural development requires strategies that enable people to improve their quality of life while maintaining their natural resource base. The Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe has developed an entrepreneurial approach to development based on sustainable wildlife management. By 1997, 30 districts and over 6 million people were involved, and household income had increased up to 25% due to the improved marketing of wildlife products. The sustainable use of wildlife products gives communities an alternative to destructive land use practices. The CAMPFIRE programme shows that wildlife protection and development can go together and provide benefits for both local people and the environment (The Zambezi-IMERCSA Newsletter 1998).

Gender equity in relation to water resources use and management is crucial for resolving potential water conflicts, enhancing social security, and improving strategies for water conservation, pollution control and demand management. The identification of obstacles to the broad and fair participation of women in water resources management is therefore fundamental for the implementation of sustainable and equitable resource use practices. While it is axiomatic that both women and men should have an equal right to access, around the world, women and men play different roles with regard to maintenance and use of water resources. Women often have unequal access to, control over and benefits from water resources. To establish a gender

balance in water management will require substantial but subtle changes to be made to the ways that both men and women collectively manage freshwater and related ecosystems. Everywhere – in the north and the south, in the east and the west – traditional and innovative mechanisms will need to be applied by NGOs, governments and private companies to specifically empower not only women, but also our youth and the elderly, within the water use decision-making and management process.

Defining rights and entitlements of local groups

Inequitable distribution of, and access to, water resources prevents millions of people from attaining a better life. Certainly economic growth is an important factor for change, but social justice cannot be achieved solely through economic means. It is imperative that governments clearly define water and land tenure, access and user rights. All people need to enjoy access to water resources and sanitation to attain a decent standard of living. Women, in particular, often rely directly on the natural environment, and are among the most affected by its pollution and decimation – yet all too often they are not involved in the major decision-making that determines its management and use. Likewise, everybody must accept and share the corresponding responsibilities, such as complying with conservation and protection regulations in order to safeguard the resource base.

Local groups share in ownership of water infrastructure and land

Land and water resources within catchments are owned by a wide variety of people and institutions. Most of the world's farmers are small landowners, although in some countries large farms are occasionally farmed by tenants. Water resources ownership is sometimes linked to land ownership, but most water resources are state owned. A proper definition of ownership is essential for sustainable management, and a fundamental prerequisite if local people are to invest in improvements to the land, spring, well, river or lake that they use.

Because government agencies or private developers own most infrastructure within catchments, revenue from such infrastructure (e.g. dams and reservoir facilities) seldom benefits those who are most affected by its development and operations. If the governments and developers were to enable local groups to become shareholders in large infrastructure, the people would not only benefit from the revenue but, as users, they would also be inclined to invest in conservation measures such as, for example, upper catchment afforestation or allowing instream flow for fish production.

Training leaders and community groups

Strong leadership at local levels is essential for bringing about change. Leadership can be individual, as in the case of a community leader who provides guidance and encouragement, or it can be collective, as in the case where a strong group spirit makes a collective change towards sustainable water resource use. NGOs and governments should develop new training programmes in pilot catchment areas for individual and group leaders, in order to initiate fair and equitable dialogue with state and private organisations concerning sustainable resource use and conservation.

In 2025, people are empowered and equitable access to water is ensured…

GOAL Empowered local groups develop responsible water-use practices and attain equitable access to water resources for all, while respecting ecosystems as equal 'partners'.

TARGET 2025 In all infrastructure projects and the vast majority of river or drainage basins, local groups take part in power-neutral negotiations of water and land resource allocations.

ACTIONS

- Establish effective public participation through involvement of NGOs and CBOs in decision-making and management of catchments;
- NGOs, governments and private companies to establish a social and gender balance in all water-related decision-making structures at all levels, ranging from the local community to international institutions;
- Governments to develop and enforce compliance with effective legal and policy frameworks that define the property and access rights to water resources, including the primary right of ecosystems for water;
- Developers and governments to share ownership of new and existing infrastructure, such as dams, gates and dikes, with local groups, to allow revenues to directly benefit these groups and have them directly involved in the operational management;
- NGOs and governments to develop training for local leaders and competent groups to allow them to communicate with institutions in a fair and equitable manner to ensure full participation in resource negotiations.

4.4 Political will and good governance for collaboration and consensus

Participation not only means local involvement in decision-making and management. Increasingly, a host of local, provincial/state and national groups and institutions, ranging from governmental to non-governmental, and technical to political, are involved in the planning and management of natural resources. Power-neutral negotiations are fundamental to participatory ecosystem-based catchment management. This requires participants to adopt and be committed to a transparent, truthful and faithful planning and negotiation process. To establish this process there are at least two prerequisites: firstly, an effective legal system that protects citizens against injustice should be in place and, secondly, an appropriate institutional set-up that provides equal opportunities for all parties to be informed and participate in the planning and negotiation process. In many cases, local groups will only be able to join the planning or negotiations when they are able to raise sufficient public attention and action or build a legal case that allows them to participate. Political freedom and guaranteed human rights are essential for achieving this.

Commitment to accept the responsibility to care for nature

Despite decades of discussions and efforts to improve water management around the world, little progress has been made due to the lack of a common will and commitment to make sustainable water management happen. At the political level, this has been caused partly by the fact that many direct effects of water resources degradation or depletion are beyond the common political time horizon of 3 to 5 years. Only in cases of catastrophic events or acute water scarcity has political will and awareness been raised. A critical step is thus the creation of political will and commitment among political parties, at local, national and international levels, to seriously invest human and financial capital in the protection of freshwater and related ecosystems.

Public awareness, private sector responsibility and a general commitment among local groups to protect water resources are fundamental to establishing change. Often underestimated but potentially influential is the role of religious groups (see Box 4.8). These can provide leadership, and raise the awareness of communities and individuals of the need to protect our environment and take personal responsibility for caring for it. Community-based groups, such as service and user groups, labour unions, and women's and youth organisations, also have a key role to play in stimulating changes in human behaviour to spread around the world.

Box 4.8 Catholic Church calls Columbia River 'sacred' and urges protection.

Catholic bishops in northwestern United States issued a 65-page document in May 1999 urging people to view the Columbia River as a 'sacred source of life and a symbol of our connection to the divine'. The river and its dams currently form a focal point for dam decommissioning. The published document precedes a pastoral letter to be published in 2000, in which responsibilities of citizens with respect to the management of the river are outlined. These range from saving the salmon to honouring treaties with Native Americans. As Bishop William Skylstad says, "The symbolism of water is life giving, cleansing and nourishing." This initiative exemplifies the actions that religious groups can take to preserve water resources (IRN 1998).

Compliance with existing laws, regulations and ethical codes

Community-level and broader institutional changes towards freshwater ecosystem conservation will not come without a real effort. Government leadership and political will is required to make this change happen. Civil society groups, including political parties and religious organisations, need to become involved in the water debate and pressure governments and corporate citizens at national and local levels to establish compliance. Likewise, agricultural enterprises and industries must take responsibility for compliance with existing regulations and for making freshwater ecosystem conservation a high priority.

Evidence shows that industry can, in fact, expand production and remain profitable while reducing freshwater consumption, providing it also maintains basic housekeeping, management attention, technological innovation and commitment from all employees. On the Danish island of Als, for example, in the Baltic Sea, one industry voluntarily reduced its water consumption to help restore local groundwater resources. Danfoss discovered in 1984 that their facility was responsible for the extreme lowering of the water table beneath the island. The danger of saltwater intrusion caused the local authorities, in 1989, to reduce the permissible water extraction for the facility to 2 million cubic metres per year. Danfoss had already started to detect and repair the major leaks in its water supply and sanitation system, which resulted in an 80 per cent reduction in water use, by 1998 (compared to the 1983 levels) (Danfoss 1998).

Policies and laws at international, national, subnational and regional levels should be further developed and harmonised by governments, and possibly United Nations agencies, to enable nature conservation and more equitable water and land resource use. The entire legal framework should facilitate accountability for environmental care for both the corporate and public sectors, as well as individuals. New laws should be based on principles derived from a wide consultative process (see Box 4.9). Besides legal frameworks, private companies, governments and NGOs will need to develop 'codes of conduct' that allow private and public groups of water users to develop environmental and water care on a voluntary basis, reducing water use and effluent emissions, and banning freshwater and coastal ecosystem destruction.

Box 4.9 Principles for a new water law in South Africa to manage resources sustainably and protect the environment.

The new water law in South Africa is based on 28 principles. First published in 1996, these have undergone a number of revisions to incorporate the comments received through public consultation before being approved by the South African Cabinet. The principles indicate that water, anywhere in the water cycle, is a common resource. No ownership is granted; only a right is given for environmental and basic human needs or an authorisation for its use over a fixed term. The principles recognise the unity of the water cycle together with the variable, uneven and unpredictable nature of water distribution. The objective of water management is to manage the quantity, quality and reliability of the nation's water resources to achieve optimum, long-term, environmentally sustainable social and economic benefits for society from their use. Basic human needs and environmental requirements are identified as 'The Reserve' and have priority of use by right. Water use for all other purposes is subject to authorisation. The new principles and law give not only guidance for South Africa, but provide a legal innovation for the world to consider for national legislative development (Asmal 1998).

Basin agreements implementation and institutional reform

Responsibility for the development and management of water resources needs to be delegated to catchment and drainage basin levels in a way that enables affected parties to be empowered and participate. In many cases, substantial institutional reforms will be required to develop a service-oriented approach that is receptive to local needs and perceives effective local participation as a valuable asset in the planning and management of water resources. To bring about this change, considerable political will and commitment needs to be developed; a commitment to reform current sector-oriented policies and to initiate and maintain good governance aimed at establishing participatory ecosystem-based catchment management. Establishing new or strengthening existing independent arrangements is therefore required for river and drainage basins at national and international levels.

To turn these ideas into reality, sources of funding will also have to be made available. Governments, for example, could potentially finance large infrastructure development, and provide emergency payments and green innovation subsidies, while private investors could fund the operation, maintenance and rehabilitation of large infrastructure projects. Community associations could support local activities, particularly their maintenance. Taxes could be collected from industrial water users and large-scale farmers, with small farmers contributing proportionately smaller amounts, and water pricing could be set for urban dwellers, with subsidization for the poor. On an international scale, ecosystem rehabilitation programmes could be funded by international donor agencies.

Networks of communities, research organisations, provincial/state and national authorities and organisations, river basin committees/authorities and NGOs will need to establish and strengthen cooperation, develop linkages with all stakeholder groups, and set up and maintain structures that ensure transparency, independence, accountability, democracy and use of 'best knowledge'. This will often require major reforms to allow people and institutions to change dysfunctional bureaucracies into service-oriented bodies that reach out to the public. Public or private organisations need to create partnerships that build on local initiatives and match these with appropriate know-how, technologies, new policies, laws and financial means.

In Coos Bay, Oregon, in the northwestern United States, successful partnerships managed catchments and reduced freshwater pollution to restore and maintain the coastal fisheries. Haynes Inlet has been known as a desirable shellfish production area because it provides rich mudflats and clam waters during storms. Shellfish production was, however, prohibited because of elevated faecal coliform counts. Downstream oyster growers began asking owners upstream in the catchment for help to reduce pollution levels. Some of them responded positively and started

to restrict cattle access, replant riparian areas and install nose-pumps for cattle to drink from. In addition, a new law was passed that safeguards landowners from losing their right to river access if streambank stock exclusion measures are carried out. The initiative showed that strong councils to represent landowners, technical guidance by coordinating agencies, and partnerships between upstream and downstream users, landowners, enterprises and state agencies are essential for a successful reduction of contamination levels, protection of habitat and conservation of biodiversity (Environmental Protection Agency 1997).

In 2025, political will and good governance reign…

GOAL Political will and good governance are established to avoid and mitigate conflicts, and to build collaboration and consensus among all stakeholders on the basis of informed participation.

TARGET 2025 In the majority of all catchments, stakeholders' full participation and transparency in decision-making is established.

ACTIONS

- Political parties, religious organisations and local groups to demonstrate commitment to conserve rivers, lakes, groundwater reserves, wetlands and coastal areas, through involvement in resolving water use conflicts and terminating destructive and polluting practices;
- Governments to stimulate and enforce compliance with environmental regulations; for example, during development and operation of water-related infrastructure, during operation of industrial activities and while farming;
- UN agencies, governments and NGOs to develop and implement effective and efficient mechanisms to negotiate transboundary problems and resolve or mitigate conflicts revolving around major international river basins;
- River basin organisations, governments, civil society groups, donors and investment agencies to facilitate and support the implementation of river/drainage basin or catchment agreements and policies, facilitated by appropriate staffing provided by governments;
- Private companies, governments and NGOs to develop and comply with voluntary 'codes of conducts' for various groups of water users to reduce water use and effluent emissions, and to ban freshwater and coastal ecosystem destruction;
- NGOs, research organisations, governments and private enterprises to design and implement strategies to share information with civil society groups (e.g. communities, women's organisations, youth groups, professional organisations) to enable informed participation in decision-making and ensure transparency.

4.5 Promote behavioural change by increasing awareness and capacity

Awareness of ecosystem benefits and the consequences of human-induced changes is essential for making a sustainable water world a reality. In order to want to act for environmental conservation, people must attain a general level of understanding of, and caring for, ecosystem functions and benefits (e.g. the water cycle, the role of catchment protection for drinking water and aquatic life, the biodiversity of freshwater systems, and the relationship between land-based activities and marine and coastal zones). Education, training and capacity building will put people in a better position to make informed choices and act to conserve the resources within their catchment area.

Awareness alone, however, is not enough to establish sustainable practices. People must also be willing and able to pay and be prepared to act in an environmentally responsible way. All

too often, discrepancy exists between awareness of water resource base deterioration and consequent changes in behaviour. Only when direct benefits can be clearly demonstrated is awareness likely to lead to a change in behaviour. The major challenge lies in bringing about the changes that do not provide direct immediate local benefits, but are nonetheless required to provide services downstream or in the future. Often catalysing events are needed to make this happen (see Box 4.10).

Box 4.10 Catalysing events needed for change: Yangtze flooding initiates discussions in P.R. China.

The 1998 flooding on the Yangtze River (P.R. China) has induced much discussion and some political action at the highest level. In late 1998, China's State Council banned logging in Sichuan province in response to the flooding of 64 million ha of land that caused over 3000 people to die. Further land reclamation in the Yangtze floodplain was prohibited and US$ 2 billion was allocated for reforestation projects in the upper reaches. Some Chinese officials, however, criticised the bans, citing them as often being poorly thought-out, badly implemented and rarely working; they pointed to the need for complementary action at the county and village levels. Although a state ban might not be the most effective measure, the Yangtze flooding did trigger important discussions on the management of China's major river basins. Awareness about the need for catchment management is the first step towards sustainable use (Pomfret 1998).

Communication materials to reach out

To bring about change, effective communication is needed between local groups, scientists, water managers and decision-makers, as well as the translation of their ideas into action. In order for this to happen, communication materials must be developed, both by and for local groups, to better understand the nature of the issues at hand. It is fundamental that youth organisations, women's groups and local resource managers develop and use do-it-yourself materials to promote the conservation of freshwater and related ecosystems.

A major shift also needs to take place in the outreach from research institutes and universities to civil society groups, communicating research findings in appropriate formats. Furthermore, two-way communication needs to be established between communities, scientists and governments to stimulate the exchange of ideas and develop extremely innovative research work on appropriate natural resources management approaches and technologies..

Up-to-date knowledge and information provided by technical experts needs to be twinned with local/traditional knowledge, and translated into understandable messages and modules. Substantial resources are needed to develop and disseminate these materials and maintain education networks.

Formal education and training to enable people to act

Primary and secondary education are the cornerstones of modern societies. The integration of environmental learning into school curricula – for example, information about the goods and services provided by ecosystems, the richness of species in rivers, lakes and coastal areas, and the cause-and-effect relationship between human actions and environmental conditions – forms the basis for environmental awareness and environmentally-responsible behaviour, now and in the future.

Schoolchildren can initiate catalysing events. Several years ago, for example, when students in Victoria, Australia, started to talk about salinity problems at home and showed maps with the results of school-monitoring activities, the issue was brought out in the open. Prior to this, farmers tried to deny the existence of salinity for fear of losing land value. The students provided a lever to bring the community together to address the problem (Mobbs 1995).

Universities and technical institutes should also further develop curricula for freshwater and related ecosystem management. These should include interdisciplinary programmes for engineers, socio-economists and social scientists, managers and environmental scientists to ensure that a holistic view of ecosystem management is shared by all relevant disciplines. Almost everywhere, scientists need special training to improve their communication with resource managers and the public, and to become more responsive to local needs.

Likewise, NGOs should develop training programmes for both community involvement and national capacity in environmental management. Particularly important is the education of youth, women, technicians and decision-makers on the economic, ecological, cultural and intrinsic values of freshwater and related ecosystems. Training is needed to develop national capacities to deal with ecosystem-based catchment management.

In developing countries, increased capacities would enable empowered communities to participate more widely in negotiations of water resources allocations and management. Current dominance of foreign technical assistance should be transformed into assistance for capacity building for academics and engineers.

Exchange of experience for solidarity and capacity building

Changing current practices on the ground requires farmer-to-farmer, woman-to-woman, and teacher-to-teacher exchanges intended to share hands-on practices and lessons learned, and develop self-help initiatives. These exchanges could take place on many scales, reaching from local to national and even international, where exchanges on specific topics are likely to be beneficial. It is essential that NGOs, governments and United Nations agencies actively facilitate the establishment of partnerships between local groups, scientists, engineers, decision-makers and managers, which should then form the basis for ecosystem-based catchment management (see Box 4.11).

Box 4.11 Environmental networks build on youth to implement successful conservation.

Environmental education networks are a new way of exchanging innovative approaches for reaching and working together in environmental conservation. An example of such a network is Earth Force (USA). This youth-driven organisation, created in 1994, is governed by a national Youth Advisory Board (YAB) made up of 15 members, ages 10 to 17. It builds on young people's overwhelming desires to act on behalf of the environment and to help their communities through voluntary service. Surveys show that, despite declining interest in political affairs, young people are increasingly involved in their communities. Through Earth Force, youth discover and implement lasting solutions to environmental issues in their community. In the process, they develop lifelong habits of active citizenship and environmental stewardship. Educators turn to Earth Force for innovative tools to engage young people in community problem solving (Earth Force website).

In West Africa, for example, a network of managers, policy makers and scientists helped improve floodplain management. In 1992, IUCN – The World Conservation Union initiated the development of the Sahel Wetlands Expert Group (SAWEG), whose aim is to build members' capacity to manage West African floodplain resources sustainably. SAWEG brings together approximately 100 specialists in water engineering, health, ecology, hydrology and law, based at universities, research centres, government institutions and river basin authorities in Burkina Faso, Cameroon, Chad, Gambia, Mali, Mauritania, Nigeria, Niger and Senegal. A series of meetings was organised to discuss topics such as water-quality modelling, participatory rural appraisal, training needs, legislation development and local participation in management. The outputs are pulled together in a book *The West Africa Floodplain Manual* (IUCN 2000). The experience with SAWEG has shown that cross-sectoral collaboration and exchange can best be facilitated through

an informal network that focuses on capacity building of its members to develop alternative and sustainable development options (Acreman 1996).

Strengthening human resources and capacities in both freshwater ecosystem assessment and management and implementation of local conservation measures will require training schools and on-the-job training facilities to be established. Donor funds will be required in some parts of the world to kick-start these activities.

In 2025, increased awareness and capacity provide the impetus for sustainable behaviour…

GOAL Awareness is raised about the need for ecosystem protection and sustainable water use, and human capacity is strengthened to enable behaviour changes that respect and are compatible with nature.

TARGET 2025 The majority of awareness-raising campaigns carried out at local, national and regional levels, based on information from local groups, universities and research institutes, lead to tangible conservation interventions and results.

ACTIONS

- Youth organisations, women's groups and professional organisations to develop and use 'do-it-yourself' communication materials to promote efforts from specific target groups to conserve wetlands, rivers, groundwater resources, lakes and coastal areas;
- NGOs and technical institutions to set up training courses and formal education programmes to develop national and local capacities to implement participatory ecosystem-based catchment management;
- NGOs, governments and UN agencies to develop local, national and regional interdisciplinary exchange programmes aimed at sharing hands-on practices and lessons learned, and developing self-help initiatives for freshwater ecosystem conservation and sustainable management of river/drainage basins.

4.6 Develop, maintain and exchange knowledge and information

Existing information on and knowledge about freshwater ecosystems and their functions needs to be further developed, especially in relationship to their sustainable use. Essential questions relate to best practices with respect to participatory ecosystem-based catchment management, water requirements of ecosystems, and benchmarks for freshwater ecosystems and species against which their future state can be evaluated. Scientific knowledge is, however, not the only knowledge that holds answers. Local knowledge and expertise is essential for the understanding needed to develop and implement sustainable management practices in catchments.

Importing ready-made solutions from elsewhere that ignore local knowledge, customs, rights and entitlements will most often result in a failure in the long run, and is socially unacceptable. This practice jeopardises the empowerment and engagement of local groups in sustainable water resources management. In some cases, local knowledge may hold the key to sustainable practices that protect catchments (see Box 4.12). In other cases, a part of the solution comes from adjusting an existing technological approach, such as redesigning a dam to allow environmental flows (see Box 4.13). Only a combination of traditional and new knowledge will provide the base of understanding needed for sustainable water management. The empowerment of a responsible and capable scientific community in the South is required, and should result in the development of an effective research capacity within a single decade in many countries.

Box 4.12 Traditional farming techniques in Honduras conserve soil and water resources during Hurricane Mitch.

Although Hurricane Mitch devastated large areas in Honduras and Nicaragua in 1998, the remote village of Guarita (Honduras) was only slightly affected in contrast to many of the surrounding areas. The traditional Quezungal farming method practiced by the local villagers had protected the upper-catchment and reduced the loss of crops to only 10 per cent. The method involves planting crops under trees whose roots anchor the soil, pruning vegetation to provide nutrients to the soil and conserve soil water, and terracing to reduce soil erosion. Methods previously taught at the agricultural colleges and practiced in surrounding areas caused much damage, as they are suited for cultivation of plains but are unsuited for farmland located on hillsides. The traditional Quezungal method avoids widespread slash-and-burn and improves soil fertility. It is now being actively promoted by the Honduran government in collaboration with the UN Food and Agriculture Organisation (FAO). This example indicates that traditional techniques can be superior to cultivation techniques imported from other agroecosystems. Sustainable management of soil and water resources requires the adaptation of techniques to local conditions and the incorporation of traditional knowledge in the development of improved water management (Gunson 1998).

Box 4.13 Technical adjustments to dam design allow for environmental flows (Lesotho).

The Lesotho Highlands Water Project (LHWP) is an interbasin transfer project that would export water from the Senqu/Orange River in Lesotho to South Africa. As part of the project, an Environmental Flow Assessment is carried out, financed by the World Bank. The study focuses on understanding the complete river ecosystem and on developing a series of flow scenarios. Each scenario describes a possible future flow regime in the river system (resulting from dam releases and catchment runoff) and the resulting conditions of the river. Preliminary findings have already influenced the design of the Mohale Dam in the form of a multiple-outlet structure, including a higher capacity, lower-level outlet. These structures would allow releases of varying quantity and quality, including occasional flood flows, to meet the requirements of downstream ecosystems. Although there is continuing controversy over the entire LHWP, and especially the risks to biodiversity occasioned by large-scale interbasin transfers, the Environmental Flow Assessment project, a landmark for the World Bank, exemplifies how a methodology can be adopted that integrates biophysical, social and economic considerations in water resources development (World Bank 1999).

Participatory catchment management and conservation – how to do it best?

The approach presented here is relatively new and only a very limited set of experiences have yet emerged. Essential to the approach is the establishment of monitoring and evaluation systems that enable us to track the progress and effectiveness of jointly-defined interventions. A key element is improving our understanding of the relationship within the catchment between poverty alleviation and nature conservation.

Indicators, both quantitative and qualitative, should be defined and used. These should not only entail purely scientifically-measurable variables, but also include the viewpoints of individuals and local groups; for example, their satisfaction with their current livelihoods, the degree of adaptation to introduced recommendations, and the woman-to-woman, fisher-to-fisher, farmer-to-farmer spread of new or improved methods. To gather that information and make it widely available will require a joint effort of many networks, to be set up by governments, NGOs, United Nations agencies, and local groups.

Ecosystem water requirements – setting environmental flows

Ecosystems need water to preserve species and maintain essential natural processes. Increasingly, scientists and water resource managers are developing methods to set standards for leaving water in rivers, lakes and aquifers for maintaining these systems. However, a considerable scientific effort is needed to gather the required basic information and improve our understanding of flow regime, water quantity and the quality requirements of these systems. Since disputes over the allocation of water among multiple users most often result in loss of the residential flows needed by ecosystems, methods must be devised that are not only scientifically sound but that will stand

up in a court of law and in the court of public opinion. A network of scientists and practitioners, comprising developers, technical institutes, NGOs and United Nations agencies, should be established to further gather required information, and to produce synthesised knowledge to define appropriate methods and models for instream flow requirements for specified conditions, ecosystems or species.

Biodiversity and ecosystem monitoring and benchmarking

Current information of freshwater ecosystems and biodiversity is incomplete and lacks a global coverage. These information and knowledge gaps prohibit, in many cases, raising awareness about the situation and promoting adequate actions to be taken. Priorities will need to be defined for these actions, partly on the basis of available scientific information on most rich or vulnerable ecosystems and species. Research institutes and NGOs will need to establish benchmarks for environmental indicators in order to evaluate the effectiveness of conservation interventions and the effects of other management activities. They will then need to use these indicators to conduct periodic inventories of the status of freshwater ecosystems, which can subsequently be linked to national monitoring strategies as defined under the Convention on Biological Diversity and the Convention on Wetlands (Ramsar 1971) (see Annex 2). National and global dissemination of information and knowledge is also needed, both by using new technologies and by greatly expanded collaborative networks of NGOs, CBOs, educational groups and governments.

Hydrometeorological networks maintenance and use

The collection, storage and use of hydrometeorological data is an essential element of catchment management. They provide the baseline against which project interventions can be evaluated. Improvements in environmental conditions at local levels will not, however, necessarily be immediately reflected in the baseline conditions of the basin. Variations in rainfall distribution over the catchment and the timing of events can create considerable interannual variability. A long time-series is therefore needed as a basis for adequate planning and management.

In many countries, the existing hydrometeorological networks are badly maintained and show increasingly severe data gaps that render them almost useless for many applications. Government must commit resources to existing networks, which they should maintain with assistance from UN agencies, in order to build the knowledge and information base that is needed and to develop and manage water resources sustainably.

Development and application of appropriate technologies

New, affordable, environmentally-sound, appropriate technologies for water management should be developed by companies and NGOs, based on local indigenous knowledge and scientific expertise; for example, appropriate new techniques to reduce water demand and treat wastewater. Many existing techniques require substantial maintenance that often is not carried out in a large number of countries. Companies and NGOs, together with communities, resource-user groups and research institutes, should give priority to investing in the research and development of these techniques, and to applying and testing them. Likewise, these groups should make considerable progress in the application of artificial wetland technologies for effluent treatment, especially for tropical conditions. Further development and testing of appropriate dry-sanitation technologies is also needed.

In 2025, integrated knowledge is applied to ecosystem management…

GOAL Scientific and indigenous information, knowledge, know-how and technologies are developed and used to improve the management of freshwater and related ecosystems.

TARGET 2025 In most countries, integrated networks produce synthesised knowledge and expertise, directly contributing to efforts to conserve freshwater ecosystems and biodiversity.

ACTIONS

- NGOs, UN and national agencies to set up and manage networks of field managers, scientists and decision-makers to compile and develop experiences on management and conservation of freshwater ecosystems within river or drainage basins;
- NGOs, UN agencies, developers and technical institutions to establish global/regional network(s) to review, develop, test and apply approaches to determine and allocate ecosystem water requirements;
- Research institutes and NGOs to develop freshwater species and ecosystem inventories, and set ecosystem and species benchmarks to evaluate change and define intervention priorities on the basis of rational and defensible limits to ecosystem and species loss;
- Governments to maintain and finance, and UN agencies to assist in maintaining, hydrometeorological networks that provide information in appropriate formats to water resources planners, managers and the general public;
- Companies and NGOs to develop and use soft-engineering methods to manage water resources and rehabilitate degraded freshwater ecosystems including, for example, artificial wetlands for effluent and runoff treatment, and floodplain restoration for flood attenuation;
- Communities, resource-user groups and research institutes to develop, test and improve small-scale appropriate methods to sustainably manage, conserve and rehabilitate rivers, wetlands, groundwater, lakes and coastal areas.

Acronyms

CAMPFIRE	Communal Areas Management Programme for Indigenous Resources (Zimbabwe)
CBD	Convention on Biological Diversity (UN)
CBO	Community-based Organization
EIA	Environmental Impact Assessment
EMAAP-Q	Quito Municipal Sewage and Water Agency (Ecuador)
ENGO	Environmental Non-governmental Organisation
EPA	Environmental Protection Agency (USA)
FAO	Food and Agriculture Organisation (UN)
HCCPR	Hadley Centre for Climate Predictions and Research (U.K.)
INEFAN	Forest and Natural Areas Institute (Ecuador)
LHWP	Lesotho Highlands Water Project
MDB	Murray Darling Basin (Australia)
NGO	Non-governmental Organisation
OECD	Organisation for Economic Cooperation and Development
POP	Persistent Organic Pollutant
SAWEG	Sahel Wetlands Expert Group
SDC	Swiss Development Cooperation
SHG	Self-help Credit Management Groups
TNC	The Nature Conservancy (USA)
UNEP	United Nations Environment Programme
WB	World Bank
WCMC	World Conservation Monitoring Centre (U.K.)
WWF	World Wide Fund for Nature
WRI	World Resources Institute (USA)
WTO	World Trade Organisation
YAB	Youth Advisory Board

Glossary

Accessibility: the proportion of the total potential goods and services that is available for use.

Aquifer: underground rock or sediment layer containing water.

Biological diversity or biodiversity: the variety of life in all its forms, levels and combinations, including ecosystem diversity, species diversity and genetic diversity (IUCN, UNEP and WWF 1991).

Carrying capacity: capacity of an ecosystem to support healthy organisms while maintaining its productivity, adaptability, and capability for renewal.

Catchment: unit of land from which water flows downhill to a specified point on a watercourse, as determined by topographical features, and bordered by the divide (e.g. watershed, river basin, drainage basin).

Civil society: sphere of autonomous institutions, protected by the rule of law, in which men and women may conduct their business freely and independently of the state.

Community: the social groupings that the individual household lives within.

Connectivity: measure of the degree of cohesiveness of a system; systems with strong interaction have a high connectivity, as have systems with a large number of the parts interlinked.

(Nature) conservation: protection against irreversible destruction and other undesirable changes, including the management of human use of organisms or ecosystems to ensure such use is sustainable.

Coping strategies: sets of activities that people adopt in the face of threats such as resource degradation, market collapse, conflict or other forces that affect the viability of their livelihoods.

Ecological evaluation: determining the value of something; for example, the value of ecosystem functions provided by natural ecosystems to human society.

Economic security: means of resolving conflicts between economic activities while providing for the maintenance of the natural services.

Ecosystem: any unit limited in space that is made up of a biotic community interacting with the physical environment so that a flow of energy leads to a clearly defined trophic structure (food chain) and material cycles within the system. Ecosystems may be small and simple, such as a small isolated pond, or large and complex, such as a specific tropical rain forest or a coral reef in tropical seas.

Ecosystem functions: capacity of natural processes and components to provide goods and services that could be used or are being used to improve the quality of human life.

Ecosystem integrity: continuity and completeness of a complex system, including its ability to perform all essential functions over its entire geographic range; the concept of integrity within a managed system implies the maintenance of key components and processes over time.

Ecosystem management or ecosystem approach: deliberate and conscious manipulation of ecosystem structure and/or function, or regulation of human uses of ecological systems, so as to retain defined and desired features and processes, and to meet human needs in an optimal and sustainable way.

Efficiency: making best use of the total package of resource potentials or endowments.

Entitlement: set of commodities that can be acquired by a person or group on the basis of rights, opportunities, ownership or social custom.

Environmental assessment: estimation of the magnitude or quality of the natural environment (air, water, soil) or investigation of the way in which one function or activity affects another function or activity.

Environmental security: a means of achieving long-term social, economic and ethical security through: i) sustainable utilisation of renewable resources and ecosystem functions; ii) protection from natural hazards; and iii) conservation of other species.

Equitability: activities which enhance equity, giving priority to the poverty and gender dimensions of development and resources management in a sustainable way through meeting the needs of all stakeholders.

Equity: a way of resource distribution by which one user does not harm other users, now or in the future, and that is based on fulfilling the greatest need instead being driven by economic or other forms of power.

Flood recession agriculture: a form of usually small-scale or artisanal agriculture, practiced mostly in Africa and Asia, whereby the farmers retreat from the fields during the flood season but then take full advantage of the silt and nutrients left behind by the floods by planting crops in the floodplains. Little or no artificial fertilisation or irrigation is required.

Freshwater resources: fresh water, in all different parts of the hydrological cycle, all the living beings existing in these waters, and all the goods and services provided by them.

Good governance: a democratic way of governing a country or institution, taking into full account the needs and aspirations of all citizens and stakeholders.

Institutions: processes and structures that lead to regularised patterns of decision-making and behaviour.

Integrated catchment management (ICM): coordinated planning and management of the water resources of a river basin, considering its interaction with land, water and other environmental resources for their equitable, efficient and sustainable use at a range of scales from local to catchment level.

Intrinsic value: the worth of an attribute in and of itself, regardless of whether it serves as an instrument for satisfying individuals' needs and preferences.

Legitimate: open, fair and accepted by all concerned, requiring an institutional framework for decision-making that is representative of all interests.

Livelihood: capabilities, assets (including both material and social resources) and activities required for a means of living; a livelihood is sustainable when it can cope with and recover from stresses and shocks, and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.

Livelihoods assets: the means of production available to a given individual, household or group that can be used in their livelihood activities, including natural capital, social capital, human capital, physical capital and financial capital.

Overexploitation or overharvesting: the use or extraction of a resource to the point of depletion or extinction, or the decimation of a population to a level below the minimum needed for a sustainable yield.

Perverse subsidies: financial arrangements or mechanisms that act against the common good; for example, a subsidy to support water extraction for irrigation that ultimately leads to conflict with other valid requirements for water.

Precautionary Principle the idea that, where serious uncertainties exist, potentially damaging resource exploitation should not take place until it can be demonstrated that the risks are within acceptable limits.

Protected area: an area dedicated primarily to protection and enjoyment of natural or cultural heritage, to maintenance of biodiversity, and/or to maintenance of life-support systems.

Rehabilitation: conversion of a degraded ecosystem to an alternative state or use, designed to meet a particular management objective, mostly related to biodiversity conservation.

Resilience: buffering capacity of a system to changing conditions.

Resource degradation: resource utilisation that diminishes the total actual or potential resource endowment, now or in the future.

Resource endowment: total existing and potential package of goods and services that can be extracted from a given resource base.

Restoration: conversion of an ecosystem to the condition it was in prior to anthropogenic disturbance.

Robustness: the property of remaining unchanged even under the influence of new forces, new data or new perspectives of observation.

Sanitation: the safe disposal or reuse of excreta and other effluents from urban, industrial and agricultural use.

Scarcity: for water resources, the limited availability of, or limited access to, the many different services water resources provide. Scarcity can mean that there is simply not enough water available (leading to questions about how to allocate what is available) but, for many, the issue is the quality of the water resources, the consequences of different, incompatible uses competing for the same resources, or the social, economic or institutional barriers which limit access to resources which are abundant in an absolute sense.

Social security: means of achieving material and non-material manifestations to meet basic needs in a secure manner and enjoy freedom from threats of violence, prejudice, oppression and environmental risks.

Subsidiarity: the process of institutional change that devolves decision-making authority to the lowest appropriate level, ensuring that the power and resources to make such decisions meaningful ones are similarly devolved.

Sustainable development: a change of living conditions that meets the needs of the present without comprising the ability of future generations to meet their own needs.

Sustainable management: management that makes best use of present resource potentials and does not diminish the availability of these resources in the future or the integrity of the ecosystems through which these resources are provided.

Sustainable use: use of an organism, ecosystem or other renewable resource at a rate within its capacity for renewal.

Vulnerability: extent to which livelihoods are at risk from factors, trends and shocks beyond their control.

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- Annex 1 -
The Current State of Affairs

A1. ECOSYSTEM FUNCTIONS AND THEIR VALUES

A1.1 Ecosystem functions

Healthy freshwater and coastal ecosystems perform a number of functions, as detailed in Table A.1. A number of such functions are obvious to people: we use water to drink, grow and prepare food, provide for domestic and industrial needs (including waste disposal), generate power and transport people and goods. However, other less obvious goods and services are also provided by ecosystems, and the appropriations made for one single use often compromise the functioning of these other services.

The ability of healthy ecosystems to perform these functions can be considered the very basis of security for individuals and societies. A loss of these functions can often be directly linked with a loss in security of some individuals or society as a whole. A clean and healthy wetland, for example, has a certain purification capacity that depends on the plants and organisms and the environmental processes it sustains. Contamination of a wetland, and subsequent loss of key species and processes, will degrade this regulation function once a certain threshold is reached. To sustain ecosystem functions requires the conservation of the integrity of the ecosystem; that is, the full range of interactions between the water cycle, individual species and biophysical, chemical, and ecological processes.

A1.2 Monetary value of freshwater and wetland functions

Many functions of freshwater ecosystems and wetlands have direct and indirect economic importance. Entire communities and countries depend on the functions provided by freshwater ecosystems and, as such, ecosystems have enormous value. It is still difficult to translate this value into monetary terms, leading to the continuing loss and degradation of water systems due to undervaluation and neglect in economic accounting procedures. In Nigeria, for example, after pouring US$ 3 billion over two decades into the construction of dams for irrigated agriculture in the Hadajia-Nguru river basins, the government realized in the early 1990s that the net economic benefits of the floodplain are much larger than those from irrigated land: US$ 32 versus US$ 0.15 per 1,000m^3 of water, not including benefits of floodplains inundations for groundwater recharge and water supply to Lake Chad (Adams 1992).

A first attempt to synthesise existing knowledge on the monetary benefits of the services of ecosystems on a global scale was published in 1997 (Costanza et al. 1997). Table A.1 gives a summary of the main functions, and monetary values, of freshwater and wetland ecosystems.

Table A.1 Global monetary values of freshwater and wetland functions (in US$ billion, 1994) (functions based on de Groot 1997; values based on Costanza et al. 1997).

Ecosystem functions (goods & services)	**ACTIVE** or **DIRECT USE VALUES** (mainly market prices)	**PASSIVE** or **INDIRECT USE VALUES** (mainly shadow price)	**Per cent of Global Total** (for a particular function)
1**. REGULATION FUNCTIONS**			
1.1 Climate regulation & biogeochemical cycling (e.g. CO2)	?	44	3 %
1.2 Water buffering (e.g. flood prevention)	?	350 (a)	40 %
1.3 Waste treatment	?	5,300	31 %
1.4 Biological control	?	14	3 %
2. HABITAT FUNCTIONS			
2.1 Refugium function	?	(c)	(c)
2.2 Nursery function	62	62 (a)	100 %
3. PRODUCTION FUNCTIONS			
3.1 Water	840	840 (a)	99 %
3.2 Food (mainly fish)	186	(b)	13 %
3.3 Raw materials & energy	40	(b)	6 %
3.4 Genetic material & medicines	(d)	(d)	(d)
4. INFORMATION FUNCTIONS			
4.1 Aesthetic information (e.g. views)	?	5	2 %
4.2 Recreation and tourism	304	(b)	37 %
4.3 Cultural values (e.g. art, science)	(d)	(d)	(d)
Total (in US$ billion/year)	**1,782**	**+ 6,905**	**Average 26%**

Notes:
(a) The total value of the flood prevention, nursery function and water supply given in Costanza et al. (1997) was based on a combination of market and shadow prices. For simplicity, it has been estimated that 50% of the calculated value is included in market prices.
(b) The values given for food, raw materials and tourism are based only on market prices. However, these resources also have an unknown (direct) consumptive use value (many people depend on freshwater systems for these resources directly, without market intervention).
(c) In addition to active and passive use values, many ecosystem functions have so-called non-use or intrinsic value. In this study it is not attempted to place a monetary value on the intrinsic importance of nature but it could, in part, be derived from the money people are willing to spend to maintain the refugium function of natural ecosystems.
(d) Freshwater and wetland systems are important sources of genetic material, medicines and cultural values but little or no information is available on the monetary value of these ecosystem functions.

Table A.1 shows that, worldwide, freshwater and wetland systems account for approximately 26% of the total economic value of all ecosystem services (which vary substantially by function, as the last column shows). It can be concluded that still only about 20% (US$ 1,782 billion) of the economic value of coastal and freshwater systems is accounted for in market pricing mechanisms. All other values, which mainly relate to regulation and habitat functions, are not (properly) accounted for. Damage to these functions is seen as “externalities” (e.g. climate regulation, waste treatment, biological control and nursery habitat) and the costs associated with these function losses, such as health damage, costs of water purification and rehabilitation of freshwater systems, are (often) burdened upon poor people and future generations. A World Bank study, for example, shows that approximately 20% of families affected by dam projects in Latin America earn less than the minimum wage (Cernea 1999).

Externalities

As mentioned above, an important cause of the loss of freshwater systems is the (over-) use of the marketable functions, like water extraction, food harvesting or recreation, which are depleted at the expense of all, or most, other functions of the ecosystem in conventional market economics. These damages are still seen as "externalities" and are therefore not included in (traditional) cost-benefit analysis. As a result, large development schemes, like dam construction and canalisation of riverbeds, have very high "hidden" environmental and social costs that only become visible after construction and often lead to grave "side effects" and even disasters (e.g. flooding, diseases due to still water). In a properly managed system of water resource planning and allocation, users from all sectors must be held responsible for bearing their part in the costs of maintaining the freshwater ecosystem.

Perverse incentives

Due to the vital importance of some functions (e.g. water provision and fish production), over the years a system of subsidies has developed which is now stimulating the overuse of these resources, often at the expense of most other functions of the system. Groundwater overexploitation is an illustrative example of this practice. Low water tariffs and water-intensive crop subsidies lead to irresponsible short-term rent-seeking behaviour of agribusinesses, which causes water levels to drop in many areas of the world. These perverse subsidies lead not only to unnecessary environmental problems, but also to inequity through unbalanced access to, and ownership of, natural resources.

A2. MAIN CAUSES AND EVIDENCE OF ECOSYSTEM DESTRUCTION

A2.1 Main causes of ecosystem destruction

Although natural disasters such as floods, tidal waves, hurricanes and wild fires may cause temporary ecosystem disruption on a massive scale, the only cause of permanent ecosystem destruction is human activity. The activities that have the most impact on freshwater ecosystems, and the corresponding functions which are put at risk, are summarised in Table A.2.

Table A.2 Threats to freshwater ecosystem functions from human activities (after Daily 1997).

Human activity	Impact on aquatic ecosystem	Functions at risk
Population and consumption growth	Increases pressures to divert more water and acquire more cultivated land (e.g. wetland drainage); increases water pollution, acid rain, and potential for climate change	Virtually all aquatic ecosystem functions
Infrastructure development (e.g. dams, dikes, levees, river diversion)	Loss of ecosystem integrity alters timing and quantity of river flows, water temperature, nutrient and sediment transport and delta replenishment, and block fish migrations	Water quantity and quality, habitats, floodplain fertility, sports, fisheries, maintenance of deltas and their economies
Land conversion and poor land use (e.g. wetland drainage, deforestation)	Eliminates key component of aquatic environment: loss of functions, integrity, habitats and biodiversity, alters runoff patterns, inhibits natural recharge, fills water bodies with silt	Natural flood control, habitat for fisheries and waterfowl, recreation, water supply, water quantity and quality, transport
Overharvesting and overexploitation	Depletes living resources, ecosystem functions and biodiversity (e.g. groundwater depletion, loss of fisheries)	Food production, sport and commercial fisheries, habitats, water supply, water quantity and quality
Introduction of exotic species	Eliminates native species, alters production and nutrient cycling, loss of biodiversity	Water quality, sport and commercial fisheries, fish and wildlife habitat, transport
Release of chemical and biological pollutants to water, land and air	Pollution of water bodies alters chemistry and ecology of rivers, lakes and wetlands	Water supply, habitat, fisheries, recreation
Greenhouse gas emissions inducing climate change	Potential dramatic changes in runoff patterns from increases in temperature and changes in rainfall patterns	Water supply, hydropower, transportation, fish and wildlife habitat, pollution dilution, recreation, fisheries, flood control

A2.2 Indicators and effects of loss of ecosystem functions

The current state of five key indicators are reviewed herein to substantiate the fact that human activities are causing the loss of ecosystem functions; namely: loss of ecosystem integrity, loss of habitats, pollution, resource overexploitation and freshwater biodiversity decline.

Loss of ecosystem integrity – connectivity of freshwater habitats

Ecosystem integrity can be defined as the range of interactions between the water cycle, individual species and biophysical, chemical and ecological processes that support the organisation of an ecosystem. To preserve the integrity of freshwater ecosystems it is essential to maintain the hydrological characteristics of catchments, including the (semi-) natural flow regime, the connection between upstream and downstream sections (including coastal and marine zones), the linkages between groundwater and surface waters, and the close coupling between the rivers and their floodplains. Fragmentation of river systems due to dams forms the greatest threat to the maintenance of ecosystem integrity. In North America, Europe and the former Soviet Union, for example, 77% of the 139 largest river systems are strongly or moderately affected by water regulation resulting from reservoir operation, interbasin transfers or irrigation (Dynesius and Nilsson 1994).

Other important threats to ecosystem integrity include land conversion and development of other infrastructure, such as dikes and levees. Land conversion affects the hydrology of many catchments. Destruction of forests in upper catchment areas, for example, is known to increase peak flows and reduce low flows. This results in severe flooding during some months and severe water shortages for the rest of the year. Upper catchment deforestation during recent decades has been severe in local areas in developing countries, particularly in Central America and Southeast Asia. Recent floodings in Europe and the USA have shown that disconnecting rivers from their floodplains can deprive them from the capacity to store floodwater and attenuate flood peaks, inducing great damage to human property and infrastructure. Total world flood damage between 1987 and 1996 reached up to US$ 250 billion and caused the death of at least 240,000 people.

A loss of connection between upper, middle and lower parts of a river basin, and a decoupling of the river from its coastal zone, largely affects their productivity. In addition, floods are not always detrimental; they form an essential element of a healthy, functioning ecosystem. For example, the decline in discharge of the Indus and Brahmaputra rivers due to dam construction is now causing the destruction of very productive mangrove systems in the deltas of these rivers. Continued freshwater inputs are also essential for maintaining coastal fisheries and biological diversity.

Habitat destruction caused by land conversion and infrastructure

Ecosystems provide refugia and reproduction habitat for plants and animals, thereby contributing to the conservation of biological diversity and maintenance of populations of migrating and/or harvestable species. Wetlands, for example, are of a high importance for migratory species and support important levels of biological diversity, including over 10,000 species of fish and over 4,000 species of amphibians. Some of the richest habitats for freshwater species include foothill streams, lowland rapids, peat swamps and ancient lakes. The loss of wetland habitats has been severe in many developed countries during the last century and is caused mainly by conversion to agricultural land (see Table A.3).

Table A.3 The loss of wetlands in various Organisation for Economic Cooperation and Development (OECD) countries (OECD 1999).

Country	Period	% of wetland losses
France	1900-1993	67
Germany	1950-1985	57
Greece	1920-1991	63
Italy	1938-1994	66
Netherlands	1950-1985	55
Spain	1948-1990	60
USA	1970-1985	54
World	1900-1998	50

Pollution of water bodies from industry, agriculture and urban centres

Pollution of water bodies originates from industrial and urban effluents, as well as such diffuse sources as agricultural runoff and atmospheric deposition. Many countries have experienced a series of freshwater pollution problems involving domestic, industrial and agricultural wastes. Water quality is currently improving in some areas, but water contamination continues to pose serious threats to human and environmental health. Persistent Organic Pollutants (POPs)

originating from pesticides and herbicides, for example, continue to be used in large quantities. These chemicals become concentrated in people and other top predators as they pass through the foodweb, causing reproductive and developmental abnormalities in humans and animals. Even more frightening is their propensity to cause genetic mutations, resulting in the potential for a perpetuation of pollution impacts through genetic inheritance.

Non-point agricultural runoff continues to load surface and groundwater with overdoses of nutrients, rendering an increasing number of sources useless for drinking water. In the United States, for example, 22 per cent of wells in agricultural areas contain nitrate levels in excess of the federal limit. In many developing countries, water quality is degrading due to pollution from domestic sources. In industrial areas, wastewater contributes increasingly to poor water quality, which has serious consequences for human and environmental health. Drinking water contaminated with human or animal excreta is the main source of many water-related diseases.

Resource overexploitation

Freshwater abstractions have increased in most parts of the world in an unsustainable manner (see Table A.4). This overexploitation of resources occurs where abstractions or harvests exceed the total renewable amount of a resource (i.e. sustainable yield). In many areas of the world, the abstraction of groundwater for domestic and agricultural use is increasingly leading to falling groundwater levels. In some cases, the decline in groundwater tables is as high as 0.5 to 5 metres per year. The overexploitation of groundwater in coastal areas in causing saltwater intrusions that render many of the remaining freshwater resources useless. Falling water tables also affect wetland areas that often depend on groundwater discharge for their maintenance.

Surface water diversions and groundwater abstractions are primarily used to irrigate land. With the application of undrained water, salts enter into the soil and build up to large quantities. One-fifth of the world’s irrigated land is currently estimated to be damaged by salts (Postel 1999). Upstream saltwater drainage forms a huge threat for downstream users, as they will add more salt to their land when irrigating and need to apply more and more water to flush the excess salt.

Exploitation of freshwater fisheries has sharply increased during recent decades in several regions. Fish constitute a major source of animal protein throughout the world, especially in many tropical and subtropical countries. Figure A.1 shows that between 1961 and 1996 worldwide freshwater fish catches increased fivefold (from 9 to 45 million metric tonnes). The greatest growth has been in developing countries, particularly those in Asia, where over the same period there was nearly an eight-fold increase. The very significant increase in the human exploitation of the natural fish resource in recent decades, and the recent local decrease in catches, indicate that freshwater fishes are being exploited at, or above, sustainable levels (Abramovitz 1996). Production of farmed fish also increased up to an average of 11 million tonnes per annum between 1993 and 1995 (WRI et al. 1998). In many cases, the production methods used in aquaculture are themselves a threat to the wild fish populations in adjacent freshwater and coastal ecosystems, as five times more 'wild' fish is used to feed farmed fish.

Table A.4 World water abstractions (km^3/year) increased sharply during the last decades; abstraction and consumption for agricultural use continues to predominate. Direct human consumption currently accounts for less than 10% of total abstractions (Shiklomanov 1999).
The first line is water withdrawal; the second line is water consumption:

Sector	Assessment								Forecast
	1900	1940	1950	1960	1970	1980	1990	1995	2000
Population (million)			2542	3029	3603	4410	5285	5735	6181
Irrigated land area (million ha)	47.3	75.9	101.0	142.0	169.0	198.0	243.0	253.0	264.0
Agricultural use	513.0	895.0	1080.0	1481.0	1743.0	2112.0	2425.0	2504.0	2605.0
	321.0	586.0	722.0	1005.0	1186.0	1445.0	1691.0	1753.0	1834.0
Industrial use	21.5	58.9	86.7	118.0	160.0	219.0	305.0	344.0	384.0
	4.6	12.5	16.7	20.6	28.5	38.3	45.0	49.8	52.8
Municipal use	43.7	127.0	204.0	339.0	547.0	713.0	735.0	752.0	776.0
	4.8	11.9	19.1	30.6	51.0	70.9	78.8	82.6	87.9
Reservoirs	0.3	7.0	11.1	30.2	76.1	131.0	167.0	188.0	208.0
Total (rounded)	579.0	1088.0	1382.0	1968.0	2526.0	3175.0	3633.0	3788.0	3973.0
	331.0	617.0	768.0	1086.0	1341.0	1686.0	1982.0	2074.0	2182.0

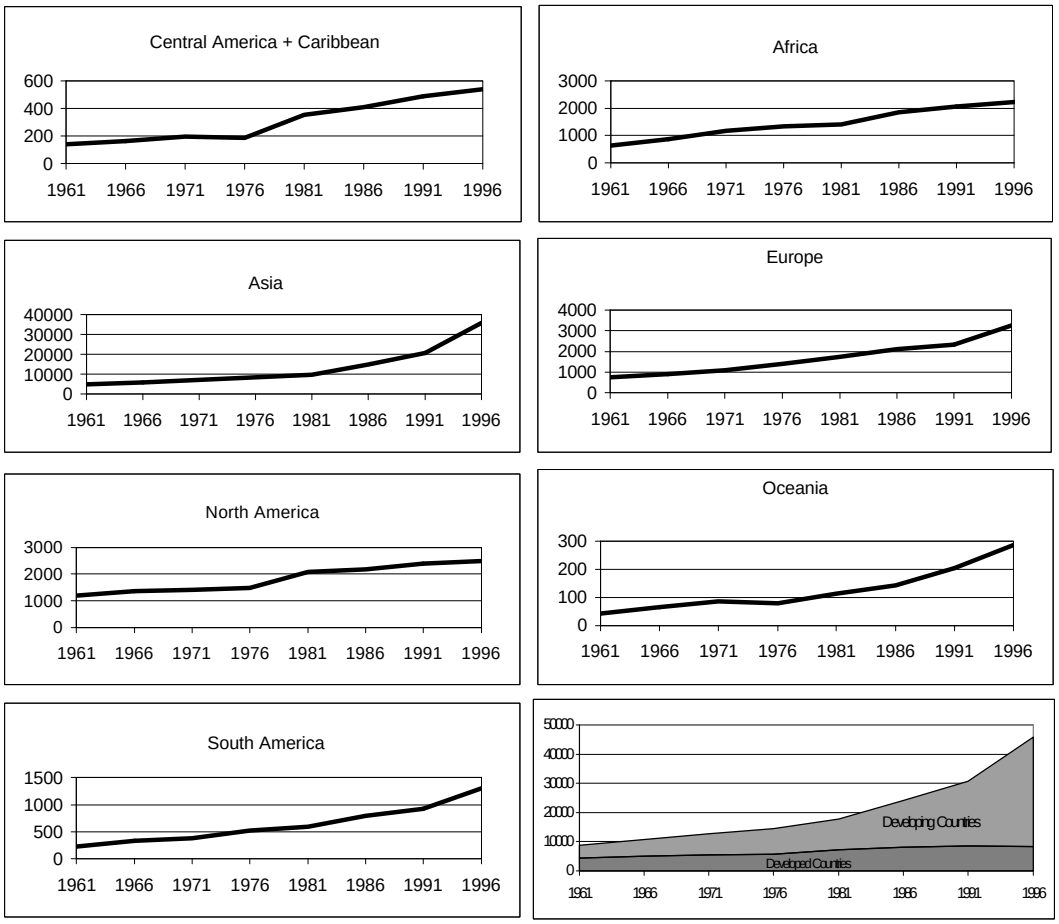

Figure A.1 Freshwater fish catches between 1961 and 1996 indicate a sharp rise in catches in Asia that currently is responsible for 76% of the total world freshwater fish catches (McCartney et al. 1999 based on data from FAO 1999).

Loss of freshwater biological diversity

Biological diversity relates to the indigenous diversity that exists at various trophic levels, ranging from ecosystems and species to genes. Freshwater biological diversity is relatively high in relation to the very limited portion of the earth's surface covered by freshwater. Freshwater fish, for example, comprise 40% of all fishes (Abramovitz 1996) and freshwater molluscs comprise 25% of all molluscs (IUCN 1996). Freshwater biodiversity tends to be greatest in tropical regions with a high number of species, such as in northern South America, Central Africa and Southeast Asia. Worldwide, the total number of freshwater species is estimated to be between 9,000 and 25,000.

The loss of freshwater biodiversity is poorly monitored except for some larger, commercial species. Available data suggest that between 20 and 35% of freshwater fish are vulnerable or endangered. In addition, of the more than 3,500 species currently threatened worldwide, 25% are fish and amphibians (UNEP 1999). Table A.5 indicates that extinction rates increased rapidly during the eighties (from 8 in the 1970s to 53 in the 1980s), whereas during the 1990s freshwater fish species loss was reduced to three species. Habitat destruction, particularly that caused by water infrastructure development (e.g. dams, dikes), is a major cause of freshwater biodiversity loss. Other factors include pollution, invasive species and overharvesting. The loss of freshwater biological diversity affects the benefits derived by humankind, especially as many freshwater ecosystem functions are based on the presence of a range of species (e.g. plants, fishes, molluscs, insects, bacteria) that are essential for their performance.

It is estimated that half the fish stocks endemic to the Pacific coast of the USA have been wiped out in the past century, often because of dam construction (Chaterjee 1998). Serious negative environmental impacts are associated with the construction of large infrastructure such as dams. Reservoirs flood the river upstream and disrupt the natural hydrological regime of downstream freshwater ecosystems. These changes can have severe implications for downstream users, as well as flora and fauna.

Table A.5 Freshwater fish extinctions globally: Number of known species extinctions by decade (WCMC 1998).

	1890s	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	1990s
Number of extinct species by decade	2	1	0	4	2	3	4	1	8	53	3
Cumula-tive total		3	3	7	9	12	16	17	25	78	81

Note: Ninety-one fish species were listed as extinct in the wild in 1996. This table includes 50 Lake Victoria cichlids, all treated here as becoming extinct during the 1980s, and 31 other species for which estimated extinction times are available. A further 10 species could not be assigned to a decade.

A3. WATER RESOURCES DEGRADATION JEOPARDISES SOCIAL SECURITY

Freshwater ecosystem functions provide the basis for social security, which can be seen as the extent to which people are able to meet their most basic needs (water, food, shelter, health) in a secure manner, and the freedom people enjoy in the absence of violence, prejudice, oppression and environmental risks. As such, the prevention and mediation of conflicts is a key element of social security.

Because water forms the most important basic human need, social security is intimately linked to the sustainable use of freshwater ecosystem functions, as detailed above. Maintaining these functions provides direct and indirect benefits to people and their security.

Considering the vital importance of freshwater ecosystems, their many functions and uses, and the degradation they are facing, it is not surprising that there is increasing conflict and social disruption related to freshwater systems. The absence of fair and effective social structures is the root of both ecosystem degradation and social insecurity. As such, the analysis of the relationship between social security and the use of freshwater ecosystems must focus on issues of conflict, power and empowerment, in relation to water resource access and distribution at all levels.

Conflicts over water resources at the livelihood level often centre around allocations between different user groups and individuals. This is directly related to the conditions of life-support systems, as they provide the means through which people secure a ‘living’; that is, the ecosystem functions that allow them to survive and, for some, prosper. Allocation of land and water for irrigated agriculture, for example, is in many cases in conflict with fully fulfilling stream water requirements for ecosystem maintenance, fisheries and tourism. Without adequate mechanisms to resolve conflicts, no secure livelihood base can be provided.

At national levels, destruction and degradation of ecosystems is often the result of conflicting interests. In many cases, this leads to a water resource base being developed with a single purpose in mind, which seeks to maximise supply to a few with little regard for the impacts on equity, social security and ecosystems. Rarely do these institutions provide a forum for representative consensus-building and local empowerment, both of which are crucial to avoiding and solving conflicts between users. Such platforms for collaboration, coordination and exchange are also often absent at the ministerial level, with technical institutions being poorly linked and the division of responsibility poorly defined. The current top-down management structures tend to neglect traditional systems and, by focusing on large-scale water engineering, erode the social security of populations, often forcing them to become environmental refugees.

Conflicts over water resources also appear at international levels. Recent analysis has shown that, worldwide, over 300 zones of potential conflict over water resources exist. These conflicts are mostly related to appropriation of water by upstream countries or overabstractions of groundwater. International water conflicts are all related to potential or actual resource destruction or degradation, with one or more countries involved. The result of upstream overabstraction is that countries downstream, or those without enough resources to dig deeper wells, are faced with rivers and wells drying up. Pollution of rivers and aquifers is another important area for international conflict. This goes to show that, at all levels, there exists a close relationship between water resource degradation and security for people and nations.

- Annex 2 -
Selected International Agreements and Texts Related to Environmental Aspects of Water Resources Management

Convention on Wetlands (Ramsar) (1971)

The Convention on Wetlands is the first of the modern global intergovernmental treaties on conservation and wise use of natural resources, and today covers all aspects of wetland conservation and wise use. It recognizes wetlands as ecosystems that are extremely important for biodiversity conservation and for the well-being of human communities. The Convention on Wetlands entered into force in 1975 and now has more than 110 Contracting Parties in all parts of the world. Under Article 3.1 of the Convention, Contracting Parties agree to: "formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory."

UN Water Conference (Mar del Plata) (1977)

This was a 'historic conference' and the first, and so far the only, UN conference entirely focusing on water. In the Mar del Plata action plan, recommendations are discussed in detail. In retrospect, the implementation of the action plan has been far from satisfactory. It did, however, urge for the launching of the International Drinking Water and Sanitation Decade, stating:

> *It is necessary to evaluate the consequences which the various uses of water have on the environment, to support measures aimed at controlling water-related diseases, and to protect ecosystems (35). …take into account the need for improvement of catchment areas of the national hydrological basins which generate the water resources to be used, in keeping with their degree of degradation and provide for the costs of such measures (36c). …recognize that freshwater and coastal wetlands are among the most vital and productive of ecological systems (36m).*

UN World Charter for Nature (1982)

The World Charter for Nature was adopted by consensus by the UN General Assembly in 1982. It provides the high-level guiding principles that should govern humankind's responsibility for nature conservation and management. In its preamble, it states that:

> *Every form of life is unique, warranting respect regardless of its worth to man (sic), and, to accord other organisms such recognition, man must be guided by a moral code of action and that man can alter nature and exhaust natural resources by his action or its consequences and, therefore, must fully recognise the urgency of maintaining the stability and quality of nature and of conserving natural resources.*

The general principles of the World Charter for Nature are:

- Nature shall be respected and its essential processes shall not be impaired.
- The genetic viability on the earth shall not be compromised; the population levels of all life forms, wild and domesticated, must be at least sufficient for their survival, and to this end necessary habitats shall be safeguarded.
- All areas of the earth, both land and sea, shall be subject to these principles of conservation; special attention shall be given to unique areas, to representative samples of all the different types of ecosystems and to the habitats of rare or endangered species.

- Ecosystems and organisms, as well as the land, marine and atmospheric resources that are utilised by man, shall be managed to achieve and maintain optimum sustainable productivity, but not in such a way as to endanger the integrity of those ecosystems or species with which they coexist.
- Nature should always be secured against degradation by warfare or other hostile activities.

Activities which might have an impact on nature shall be controlled, and the best available technologies that minimize significant risks to nature or other adverse effects shall be used; in particular:

- *Activities which are likely to cause irreversible damage to nature should be avoided;*
- *Activities which are likely to pose a significant risk to nature shall be preceded by an exhaustive examination; their proponents shall demonstrate that expected benefits outweigh potential damage to nature, and where potential adverse effects are not fully understood, the activities should not proceed;*
- *Activities which may disturb nature shall be preceded by assessment of their consequences, and environmental impact studies of development projects shall be constructed in advance, and if they are to be undertaken, such activities shall be planned and carried out so as to minimize potential adverse impacts.*

These guiding principles have been reaffirmed in a succession of formal intergovernmental agreements.

International Conference on Water and Environment (Dublin) (1992)

Five hundred participants endorsed four guiding principles in the Dublin Statement:

1) Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2) Water development and management should be participatory, involving planners and policy makers at all levels.
3) Women play a central role in the provision, management and safeguarding of water.
4) Water has an economic value in all its competing uses and should be recognised as an economic good.

Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or groundwater aquifer.

UN Conference on Environment and Development (1992)

Links between the environment and development were recognised at the highest political level during the formulation of Agenda 21, consisting of 40 chapters. Freshwater resources is dealt with in Chapter 18 and lists seven programme areas. Most of the seven programmes cover the same issues as the eight recommendations in Mar del Plata, with the exception of urban issues and climate change.

> Agenda 21, Chapter 18 – Integrated Water Resources Management, states:
> *18.8 Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilization. To this end, water resources have to be protected, taking into account the functioning of aquatic ecosystems*

and the perenniality of the resource, in order to satisfy and reconcile needs of water in human activities. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however, water users should be charged appropriately.

Agenda 21, Chapter 15 – Conservation of Biological Diversity, states:
…processes and activities with significant impacts upon biological diversity [should be identified;…] *action* [should be taken] *where necessary for the conservation of biological diversity through the in situ conservation of ecosystems and natural habitats*[;…and] *the rehabilitation and restoration of damaged ecosystems and the recovery of threatened and endangered species* [should be promoted.]

The Convention on Biological Diversity (CBD) was signed by 156 States in June 1992, and by September 1999, 175 countries had ratified the Convention.

UN Expert Meeting on Water Management (Harare, Zimbabwe) (1998)

The Expert Group Meeting recalled Agenda 21, Chapter 18, to be a basis for action concerning freshwater and states:

III.D.I. Ecosystem integration. The conservation of freshwater and related ecosystems is vital to sustainable development. These ecosystems are themselves users, water regulators and providers of freshwater-based resources (including fisheries). It is therefore necessary to promote an ecosystem approach in integrated water resources planning, development and management within the framework of river basin and aquifer systems.