TUTORIAL ON BASIC PRINCIPLES OF INTEGRATED WATER RESOURCES MANAGEMENT

The interactive version of the tutorial is on available at www.cap-net.org. You can download it and use it offline or adapt it for your own use. The tutorial is also available on CD-ROM on request to info@cap-net.org.

In collaboration with

Table of Contents

WHY IS WATER RESOURCES MANAGEMENT IMPORTANT TO YOU?

We can virtually take it for granted these days that any international conference or ministerial meeting involved with sustainable development will result in recommendations for more and better “integrated water resources management” (IWRM). Governments are repeatedly urged to introduce or extend IWRM, as a vital component of their sustainable development agenda.

So, what is meant by integrated water resources management? Why is it so important? What are we losing without it? What are the gains to be made from introducing it? If it is so good, why isn’t everybody doing it already? What are the obstacles that prevent IWRM from becoming universal? What do we need to do to spread its application and reap the benefits?

This brief introductory tutorial is aimed at policy makers, water managers, trainers and educators who want a basic understanding of IWRM principles. It provides the case for IWRM and the arguments against those who may oppose it on institutional or sectoral grounds. More detailed courses are available for those who will be directly involved in practical implementation of IWRM (information on these courses may be found on www.cap-net.org). If you come at IWRM from a sectoral perspective, the tutorial provides the opportunity to look at the specific implications of IWRM in your own field, or, equally importantly, to recognise the key issues in the other sectors (environment, agriculture, domestic/municipal water supply and wastewater treatment).

IWRM Tutorial - structure

CORE IWRM flow			
1. What is IWRM?	**Environment**	**Food/ Agriculture**	**Water Supply and Sanitation**
2. Why IWRM? Water resource problems in general	A1. How does the environment use water?	B1. How does agriculture use water?	C1. How does the WSS sector use water?
3. Water management principles	A2. Why is the environment important?	B2. Why is agriculture important?	C2. Why is the WSS sector important?
4. The water users - good and bad points	A3. How is the environment affected by water use in other sectors?	B3. How is agriculture affected by water use in other sectors?	C3. How is the WSS sector affected by water use in other sectors?
5. Implementing IWRM	A4 Impact of the environment on water use by other sectors	B4. Impact of agriculture on water use by other sectors	C4. Impact of water supply and sanitation on water use by other sectors
6. Policy and legal framework	A5. Benefits of IWRM to the environmental sector	B5. Benefits of IWRM to the agricultural sector	C5. Benefits of IWRM to WSS
7. Institutional framework	A6. Barriers to implementing IWRM in the environmental sector.	B6. Barriers to implementing IWRM in agricultural sector	C6. Barriers to implementing IWRM in WSS sector
8. References and links	A7. Implications for change within the environmental sector: legal, institutional, HRD	B7. Implications for change within the agricultural sector: legal, institutional, HRD	C7. Implications for change within WSS sector: legal, institutional, human resources HRD

1. What is Integrated Water Resources Management?

At its simplest, integrated water resources management is a logical and intuitively appealing concept. Its basis is that the many different uses of water resources are interdependent. That is evident to us all. High irrigation demands and polluted drainage flows from agriculture mean less freshwater for drinking or industrial use; contaminated municipal and industrial wastewater pollutes rivers and threatens ecosystems; if water has to be left in a river to protect fisheries and ecosystems, less can be diverted to grow crops. There are plenty more examples of the basic theme that unregulated use of scarce water resources is wasteful and inherently unsustainable.

Integrated management means that all the different uses of water resources are considered together. Water allocations and management decisions consider the effects of each use on the others. They are able to take account of overall social and economic goals, including the achievement of sustainable development. As we shall see, the basic IWRM concept has been extended to incorporate participatory decision-making. Different user groups (farmers, communities, environmentalists, …) can influence strategies for water resource development and management. That brings additional benefits, as informed users apply local self-regulation in relation to issues such as water conservation and catchment protection far more effectively than central regulation and surveillance can achieve.

Management is used in its broadest sense. It emphasises that we must not only focus on development of water resources but that we must consciously manage water development in a way that ensures long term sustainable use for future generations.

Integrated water resources management is therefore a systematic process for the sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental objectives. It contrasts with the sectoral approach that applies in many countries. When responsibility for drinking water rests with one agency, for irrigation water with another and for the environment with yet another, lack of cross-sectoral linkages leads to uncoordinated water resource development and management, resulting in conflict, waste and unsustainable systems.

2. Why IWRM? Key issues in water management

<u>Facts</u>

- Global water: 97% seawater, 3% freshwater. Of the freshwater 87% not accessible, 13% accessible (0.4% of total).
- Today more than 2 billion people are affected by water shortages in over 40 countries.
- 263 river basins are shared by two or more nations;
- 2 million tonnes per day of human waste are deposited in water courses
- Half the population of the developing world are exposed to polluted sources of water that increase disease incidence.
- 90% of natural disasters in the 1990s were water related.
- The increase in numbers of people from 6 billion to 9 billion will be the main driver of water resources management for the next 50 years.

<u>Urgency of action</u>

Water is vital for human survival, health and dignity and a fundamental resource for human development. The world's freshwater resources are under increasing pressure. Growth in population, increased economic activity and improved standards of living lead to increased competition for, and conflicts over, the limited freshwater resource. A combination of social inequity and economic marginalisation forces people living in extreme poverty to overexploit soil and forestry resources, with damaging impacts on water resources. Here are a few reasons why many people argue that the world faces an impending water crisis:

- Water resources are increasingly under pressure from population growth, economic activity and intensifying competition for the water among users;

- Water withdrawals have increased more than twice as fast as population growth and currently one third of the world's population live in countries that experience medium to high water stress;
- Pollution is further enhancing water scarcity by reducing water usability downstream;
- Shortcomings in the management of water, a focus on developing new sources rather than managing existing ones better, and top-down sector approaches to water management result in uncoordinated development and management of the resource.
- More and more development means greater impacts on the environment.
- Current concerns about climate variability and climate change demand improved management of water resources to cope with more intense floods and droughts.

Water governance crisis

Sectoral approaches to water resources management have dominated in the past and are still prevailing. This leads to fragmented and uncoordinated development and management of the resource. Moreover, water management is usually in the hands of top-down institutions, the legitimacy and effectiveness of which have increasingly been questioned. Thus, increased competition for the finite resource is aggravated by inefficient governance. IWRM brings coordination and collaboration among the individual sectors, plus a fostering of stakeholder participation, transparency and cost-effective local management.

Securing water for people

Although most countries give first priority to satisfying basic human needs for water, one fifth of the world's population is without access to safe drinking water and half of the population is without access to adequate sanitation. These service deficiencies primarily affect the poorest segments of the population in developing countries. In these countries, meeting water supply and sanitation needs for urban and rural areas represents one of the most serious challenges in the years ahead. Halving the proportion of the population lacking water and sanitation services by 2015 is one of the Millennium Development Goals[1]. Doing so will require a substantial re-orientation of investment priorities, which will be very much more readily achieved in those countries that are also implementing IWRM. **(Read more in C2. Why is the water supply and sanitation sector important?)**

Securing water for food production

Population projections indicate that over the next 25 years food will be required for another 2-3 billion people. Water is increasingly seen as a key constraint on food production, equivalent to if not more crucial than land scarcity. Irrigated agriculture is already responsible for more than 70% of all water withdrawals (more than 90% of all consumptive use of water). Even with an estimated need for an additional 15-20% of irrigation water over the next 25 years - which is probably on the low side – serious conflicts are likely to arise between water for irrigated agriculture and water for other human and ecosystem uses. IWRM offers the prospect of greater efficiencies, water conservation and demand management equitably shared among water users, and of increased recycling and reuse of wastewater to supplement new resource development. **(Read more in section B2. Why is the agricultural sector important)**

Protecting vital ecosystems

Terrestrial ecosystems in the upstream areas of a basin are important for rainwater infiltration, groundwater recharge and river flow regimes. Aquatic ecosystems produce a range of economic benefits, including such products as timber, fuel wood and medicinal plants, and they also provide wildlife habitats and spawning grounds. The ecosystems depend on water flows, seasonality and water-table fluctuations and are threatened by poor water quality. Land and water resources management must ensure that vital ecosystems are maintained and that adverse effects on other natural resources are considered and where possible reduced when development and management decisions are made. IWRM can help to safeguard an "environmental reserve" of water commensurate with the value of ecosystems to human development. **(Read more in section A2. Why is the environment important?)**

[1] The Millennium Development Goals are an ambitious agenda for reducing poverty and improving lives that world leaders agreed on at the Millennium Summit in September 2000. For each goal one or more targets have been set, most for 2015, using 1990 as a benchmark. More information can be found on the UNDP website at http://www.undp.org/mdg/.

Gender disparities

Water management is male dominated. Though their numbers are starting to grow, the representation of women in water sector institutions is still very low. That is important because the way that water resources are managed affects women and men differently. In the agriculture sector, for example, dams and canals can deliver large amounts of vital irrigation water to rich, predominantly male, farmers. At the same time, they block or divert the precious silt that has historically enriched the fertility of floodplains where poorer, mainly women, subsistence farmers earn just enough to live on. As custodians of family health and hygiene and providers of domestic water and food, women are the primary stakeholders in household water and sanitation. Yet, decisions on water supply and sanitation technologies, locations of water points and operation and maintenance systems are mostly made by men. The Gender and Water Alliance cites the example of a well meaning NGO that helped villagers to install pour-flush latrines to improve their sanitation and hygiene, without first asking the women about the extra two litres of water they would have to carry from distant sources for every flush. A crucial element of the IWRM philosophy is that water users, rich and poor, male and female, are able to influence decisions that affect their daily lives. (www.genderandwateralliance.org)

3. Water Management Principles

A meeting in Dublin in 1992[2] gave rise to four principles that have been the basis for much of the subsequent water sector reform (see panel).

- Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
  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.
- Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels.
  The participatory approach involves raising awareness of the importance of water among policy-makers and the general public. It means that decisions are taken at the lowest appropriate level, with full public consultation and involvement of users in the planning and implementation of water projects.
- Women play a central part in the provision, management and safeguarding of water. This pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources. Acceptance and implementation of this principle requires positive policies to address women's specific needs and to equip and empower women to participate at all levels in water resources programmes, including decision-making and implementation, in ways defined by them.
- Water has an economic value in all its competing uses and should be recognised as an economic good.
  Within this principle, it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognise the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

Finite resource

The notion that freshwater is a finite resource arises as the hydrological cycle on average yields a fixed quantity of water per time period. This overall quantity cannot yet be altered significantly by human actions, though it can be, and frequently is, depleted by man-made pollution. The freshwater resource is a natural asset that needs to be maintained to ensure that the desired services it provides are sustained.

[2] The International Conference on Water and Environment, Dublin, Ireland, January 1992.

This principle recognises that water is required for many different purposes, functions and services; management therefore, has to be holistic (integrated) and involve consideration of the demands placed on the resource and the threats to it.
The integrated approach to management of water resources necessitates co-ordination of the range of human activities which create the demands for water, determine land uses and generate waterborne waste products. The principle also recognises the catchment area or river basin as the logical unit for water resources management.

Participatory approach
Water is a subject in which everyone is a stakeholder. Real participation only takes place when stakeholders are part of the decision-making process. The type of participation will depend upon the spatial scale relevant to particular water management and investment decisions. It will be affected too by the nature of the political environment in which such decisions take place.
A participatory approach is the best means for achieving long-lasting consensus and common agreement. Participation is about taking responsibility, recognizing the effect of sectoral actions on other water users and aquatic ecosystems and accepting the need for change to improve the efficiency of water use and allow the sustainable development of the resource. Participation does not always achieve consensus, arbitration processes or other conflict resolution mechanisms also need to be put in place.
Governments have to help create the opportunity and capacity to participate, particularly among women and other marginalised social groups. It has to be recognised that simply creating participatory opportunities will do nothing for currently disadvantaged groups unless their capacity to participate is enhanced.

Important role of women
It is widely acknowledged that women play a key role in the collection and safeguarding of water for domestic and – in many cases – agricultural use, but that they have a much less influential role than men in management, problem analysis and the decision-making processes related to water resources. The fact that social and cultural circumstances vary between societies suggests that the need exists to explore different mechanisms for increasing women's access to decision-making and widening the spectrum of activities through which women can participate in IWRM.
IWRM requires gender awareness**.** In developing the full and effective participation of women at all levels of decision-making, consideration has to be given to the way different societies assign particular social, economic and cultural roles to men and women. There is an important synergy between gender equity and sustainable water management. Involving men and women in influential roles at all levels of water management can speed up the achievement of sustainability; and managing water in an integrated and sustainable way contributes significantly to gender equity by improving the access of women and men to water and water-related services to meet their essential needs

Economic good
Water has a value as an economic good as well as a social good. Many past failures in water resources management are attributable to the fact that the full value of water has not been recognised. In order to extract maximum benefits from available water resources, there is a need to change perceptions about the value of water.
Value and charges are two different things and we have to distinguish clearly between *valuing* and *charging* for water.
The *value* of water in alternative uses is important for the rational allocation of water as a scarce resource, whether by regulatory or economic means.
Charging (or not charging) for water is applying an economic instrument to support disadvantaged groups, affect behaviour towards conservation and efficient water usage, provide incentives for demand management, ensure cost recovery and signal consumers' willingness to pay for additional investments in water services.
Treating water as an economic good is an important means for decision making on the allocation of water between different water use sectors and between different uses within a sector. This is particularly important when extending supply is no longer a feasible option.
In IWRM, economic valuation of alternative water uses gives decision makers important guides to investment priorities but it should not be the only consideration. Social goals are

important too. In a water-scarce environment, would it be right, for example, that the next water resource developed should be assigned to a steel-manufacturing plant because the manufacturer can afford to pay more for the water than the thousands of poor people who have no access to safe water? Social, economic and environmental goals all play a part in IWRM decision-making.

4. The water users, good and bad points

- Agriculture
- Water supply & wastewater
- Mining, industry
- Environment
- Fisheries
- Tourism
- Energy
- Transport

Each of the water uses identified above has valuable positive impacts. Most also have negative impacts which may be made worse by poor management practices, lack of regulation or lack of motivation due to the water governance regimes in place. Water management within government structures is distributed across many agencies and tends to be dominated by sectoral interests.
Each country has its priority developmental and economic goals set according to environmental, social and political realities. Problems and constraints arise in each water use area, but the willingness and ability to address these issues in a coordinated way is affected by the governance structure of water. Recognising the inter-related nature of different sources of water and thus also the inter-related nature and impacts of the differing water uses is a major step to the introduction of IWRM.

Table. Impacts of the water use sectors on water resources

	Positive impacts	**Negative impacts**
Environment **Read more** in section A4. Impact of the environment on water use by other sectors	Purification Storage Hydrological cycle	
Agriculture **Read more** in section B4. Impact of agriculture on water use by other sectors	Return flows Increased infiltration Decreased erosion Groundwater recharge Nutrient recycling	Depletion Pollution Salinisation Water logging Erosion
Water supply & sanitation **Read more** in section C4. Impact of water supply and sanitation on water use by other sectors	Nutrient recycling	High level of water security required Surface and groundwater pollution

What do you think? Add your own ideas in the table cells (remember we are recording only impacts on water resources, not health, nutrition or socio-economic impacts).

Social and economic benefits from water use sectors
These are generally obvious in terms of food production, energy production, drinking water, jobs, recreation, etc, but the relative value of these benefits is more difficult to assess. When there is competition for water resources it brings into the open the need to justify the allocation of water to one user rather than to another. This value assessment should take into account both the benefits and the negative impacts. The input from users, politicians and society in general is necessary as the allocation may not be most efficient when valued in economic terms alone or acceptable when made only on political grounds.

Table. Benefits of IWRM to the sectors

Sector	Benefits
Environment (**Read more** in section A5. Benefits of IWRM to the environmental sector)	- A voice for environmental needs in water allocation - Raising awareness among other users of the needs of ecosystems - More attention to an ecosystem approach to water management - Protecting upper catchments, pollution control, and environmental flows - Safeguarding common resources such as forests, wetlands and fishing grounds on which communities depend
Agriculture (**Read more** in section B5. Benefits of IWRM to the agricultural sector)	- Implications for agriculture of water use by other sectors considered in the management process - Rational decision making on water use in which costs and benefits are considered - More effective use of water within the sector and hence increased returns - Multi-purpose water resource development and cross-sectoral recycling (e.g. use of reclaimed municipal wastewater for irrigation)
Water supply & sanitation (**Read more** in section C5. Benefits of IWRM to the water supply and sanitation sector)	- Increased security of domestic water supplies - Reduced conflicts between water users - Increasing recognition of the economic value of water leading to more efficient use - Increased use of water demand management - Improved waste management considering environmental effects and human health and hygiene - Reduced costs of providing domestic water services

5. Implementing IWRM

The case for IWRM is strong – many would say uncontestable. The problem for most countries is the long history of unisectoral development. As the Global Water Partnership puts it:

> "IWRM is a challenge to conventional practices, attitudes and professional certainties. It confronts entrenched sectoral interests and requires that the water resource is managed holistically for the benefits of all. No one pretends that meeting the IWRM challenge will be easy but it is vital that a start is made now to avert the burgeoning crisis."

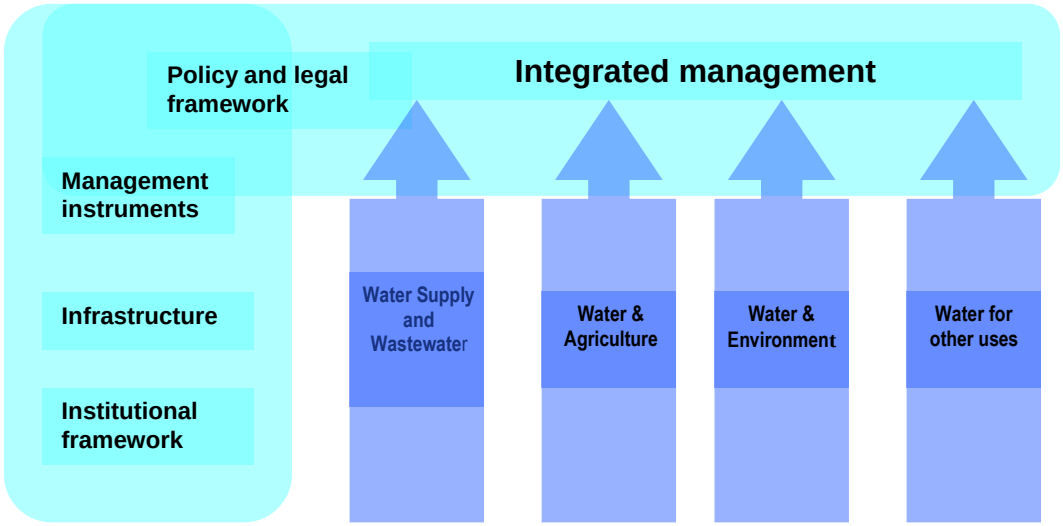
IWRM is, above all, a philosophy. As such it offers a guiding conceptual framework with a goal of sustainable management and development of water resources. What it does demand is that people try to change their working practices to look at the bigger picture that surrounds their actions and to realise that these do not occur independently of the actions of others. It also seeks to introduce an element of decentralised democracy into how water is managed, with its emphasis on stakeholder participation and decision making at the lowest appropriate level.

All of this implies change, which brings threats as well as opportunities, There are threats to people's power and position; and threats to their sense of themselves as professionals. IWRM requires that platforms be developed to allow very different stakeholders, often with

apparently irreconcilable differences to somehow work together.

Because of the existing institutional and legislative frameworks, implementing IWRM is likely to require reform at all stages in the water planning and management cycle.
An overall plan is required to envisage how the transformation can be achieved and this is likely to begin with a new water policy to reflect the principles of sustainable management of water resources. To put the policy into practice is likely to require the reform of water law and water institutions. This can be a long process and needs to involve extensive consultations with affected agencies and the public.
Implementation of IWRM is best done in a step-by-step process, with some changes taking place immediately and others requiring several years of planning and capacity building.

Figure. IWRM and its linkage to the sub-sectors (GWP)



6. Policy and legal framework

Bringing some of the principles of IWRM into a water sector policy and achieving political support may be challenging, as hard decisions have to be made. It is therefore not surprising that major legal and institutional reforms are unlikely to take place until serious water management problems have been experienced.

In some cases, IWRM may be seen as a threat to donor-supported capital investment programmes. Some developing countries tend to be more concerned with increasing supplies through new infrastructure rather than with water efficiency or managing water demand. Indeed they fear that the new agenda of IWRM will lead to a reduction in capital investment for such projects. Attitudes are changing though. Officials are becoming more aware of the need to manage resources efficiently. They see too that the construction of new infrastructure has to take into account environmental and social impacts and the fundamental need for systems to be economically viable for maintenance purposes. However, they may still be inhibited by the political implications of such a change. The process of revising water policy is therefore a key step, requiring extensive consultation and demanding political commitment.

Read more about the potential barriers to implementing IWRM in each sector:

A6. Barriers to implementing IWRM in the environmental sector
B6. Barriers to implementing IWRM in the agricultural sector
C6. Barriers to implementing IWRM in the water supply and sanitation sector

Water legislation converts policy into law and should:

- Clarify the entitlement and responsibilities of users and water providers;
- Clarify the roles of the state in relation to other stakeholders;
- Formalise the transfer of water allocations;
- Provide legal status for water management institutions of government and water user groups;
- Ensure sustainable use of the resource.

7. Institutional framework

For many reasons, developing country governments consider water resources planning and management to be a central part of government responsibility. This view is consistent with the international consensus that promotes the concept of government as a facilitator and regulator, rather than an implementor of projects. The challenge is to reach mutual agreement about the level at which, in any specific instance, government responsibility should cease, or be partnered by autonomous water services management bodies and/or community-based organisations.

The concept of integrated water resources management has been accompanied by promotion of the river basin as the logical geographical unit for its practical realisation. The river basin offers many advantages for strategic planning, particularly at higher levels of government, though difficulties should not be underestimated. Groundwater aquifers frequently cross catchment boundaries, and more problematically, river basins rarely conform to existing administrative entities or structures.

In order to bring IWRM into effect, institutional arrangements are needed to enable:

- The functioning of a consortium of stakeholders involved in decision making, with representation of all sections of society, and a good gender balance;
- Water resources management based on hydrological boundaries;
- Organisational structures at basin and sub-basin levels to enable decision making at the lowest appropriate level;
- Government to co-ordinate the national management of water resources across water use sectors.

Think About It

Having gone through the Main section of this tutorial you will probably be able to assess the situation in your own country when it comes to implementation of IWRM. Some of the questions you may want to answer are:

- What are the main sectors involved in the exploitation of water resources in my country and what are the interactions between these sectors?
- Is there an urgency to manage water resources in an integrated manner and how is this best done? What will be the benefits for the different sectors?
- How are men and women affected differently by changes in water resources management?
- Considering the government structures in my country, what institutional and legal reforms are needed to implement IWRM and what are the requirements to make it effective?
- What is the general attitude towards integrated water management in my country and what sectoral barriers have to be taken before IWRM can be implemented?

A. Environment

A1. How does the environment use water?

- Terrestrial and aquatic ecosystems need water to maintain their functioning: plants evaporate and transpire water; animals drink water; fish and amphibians need water to live in. Water is also used by upper-watershed ecosystems, like forests, shrublands and woodlands.

- Downstream, wetlands, floodplains, and mangroves need freshwater inputs. This water is used to maintain a (semi)-natural dynamic, often of a seasonal nature. To prevent degradation and destruction of ecosystems, it is important to have enough water of the right quality and with the right seasonal variability.

A2. Why is the environment important?

- Ecosystems provide goods and services (functions) (see Table 1) that benefit people and their livelihoods. These benefits are often not fully recognised in planning and managing water resources. The total benefits are estimated to be USD 8.8 billion per year (IUCN).

- Destruction of ecosystems penalises the poor most. They are the ones who benefit from the “free” common resources (fuel wood, water, fisheries, fruits). They can also contribute to ecosystem degradation through over-exploitation. That is why it is important that user communities are involved in water management decisions.

Table 1 Natural ecosystems provide many goods and services to humankind that are often neglected in planning and decision making.

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

A3. How is the environment affected by water use in other sectors?

The needs of water for nature, or the environment, are too easily neglected in considerations of water allocations. But if too much water is allocated for other sectors, the impacts on ecosystems can be devastating.

- The agriculture sector is most important as a user of water and impacts most heavily on ecosystems' "water share". Abstraction of water for agriculture is leading to dried up rivers, falling ground water tables, salinated soil and polluted waterways. Carefully considered multipurpose projects can combine irrigation with aquifer recharge, land drainage and ecosystem sustenance.

- Urban water uses, in particular wastewater effluents, pollute downstream ecosystems if not sufficiently treated. The treatment of effluents is often costly and, especially in developing countries, not considered a high priority given other needs. When due consideration is given to the value of ecosystems, effluent recycling and reuse are often seen to be cost-effective conservation measures.

- The hydropower sector affects downstream ecosystems by changing the water and sediment regime and blocking migratory movements of fish and amphibians. In some cases reservoirs have provided new habitats for animals and investments have been made in environmental protection upstream. Combining considerations of power generation, flood control and ecosystem protection can mean new operational rules for reservoir releases.

- Industry often has substantial impacts on ecosystems downstream through water use and pollution. Mining, for example, has affected many waterways in Latin America. In Western Europe industrial pollution has taken its toll on aquatic ecosystems during the last century. Transfer of recycling technologies to developing countries could help to pre-empt ecosystem damage from industrial development.

A4. Impact of the environment on water use by other sectors

- Water assigned for ecosystem protection is not available for other uses. In this sense the environment can be seen as a competitor by other users. It is true to say that a proportion of the total water available needs to be assigned to ecosystems, but the synergies with other uses can also boost the total resource by encouraging multiple use and reuse.

- Well functioning ecosystems provide benefits downstream, for example, flood attenuation by a floodplain wetland, or the cleansing of limited amounts of pollution. Protection of upper-catchments is also known to provide benefits for flood peak reduction, especially at local scales.

- Ecosystems maintained in a healthy state can provide good quality water that can be used by any other user. Clean rivers, non-polluted groundwater sources, fresh mountain springs are easily disrupted by inappropriate water and land-use.

A5. Benefits of IWRM to the environmental sector

- Ecosystems can benefit from applying an integrated approach to water management by giving environmental needs a voice in the water allocation debate. At present these needs are often not represented at the negotiating table.

- IWRM can assist the sector by raising awareness among other users of the needs of ecosystems and the benefits these generate for them. Often these are undervalued and not incorporated into planning and decision-making.

- The ecosystem approach provides a new framework for IWRM that focuses more attention on a system approach to water management. It provides an alternative to a sub-sector competition perspective, with more emphasis on maintaining the underlying ecosystem as a factor that can join stakeholders in developing a shared view and joint action.

- An ecosystem approach to water management focuses on several field level interventions: protecting upper catchments (e.g. reforestation, good land husbandry, soil erosion control), pollution control (e.g. point source reduction, non-point source incentives, groundwater protection) and environmental flows (e.g. through reducing abstractions, special releases from reservoirs, river restoration).

- Most importantly, the IWRM concept can bring together communities, industrialists, water managers and opinion formers (teachers, religious leaders, media representatives) in a common cause to achieve sustainability by conserving both water and ecosystems.

A6. Barriers to implementing IWRM in the environmental sector

Of all the sectors, the environment is probably the one with most to gain from implementation of IWRM. Usually at the end of the queue (if not missing altogether) when water allocations are made, it is suffering the consequences of water scarcity and poor awareness. The desire for an IWRM approach is therefore very strong in the environment sector, but there are some stumbling blocks to be overcome:

- Lack of awareness among all water users is the biggest obstacle to change. Especially in the developing world, the impacts of poor water management are only just starting to be noted. Floods, pollution and depleted rivers are beginning to get a bit more public attention, but freshwater biodiversity is still outside the sphere of interest of most people.

- Lack of political will to combat vested interests is also an important barrier. Fishes have no voice, farmers do. Often the interest of farmers and other water users prevail over the water needs of ecosystems.

- Lack of human and financial resources causes ecosystems not to be taken into account in planning and development. A lack of capacity in government agencies and an overall lack of financial resources to invest in sustainable practices, e.g. in upper catchments, causes ecosystems to be degraded. Though the effects are then felt in lost supplies from springs and in declining fish stocks, the chain of command is often ephemeral and it is no-one's responsibility to take action.

A7. Implications for change within the environmental sector: legal, institutional, human resources

From the environmental perspective, a major requirement of water sector reform is to provide recognition of ecosystem needs alongside the demands of domestic, industrial and agricultural water users. In many countries, that involves significant strengthening of the status, human and financial resources and political representation of environment agencies, not just at national level, but regionally and locally too – and, particularly in the context of IWRM, at river basin level.

- National legislation often needs to be harmonised and strengthened to include an environmental perspective into water management and other relevant sectoral policies and legal arrangements. At present many conflicting arrangements exist.

- Water departments need to function more and more as brokers between various other departments and stakeholders, rather than stand-alone units. They will have a major role in facilitating negotiations between various water users. There is also an important regulation and monitoring function in relation to environmental standards. Participatory decision-making is a crucial part of IWRM, but it has to be in a framework that protects common interest from self interest. It is the role of government (local or national as appropriate) to set and maintain standards that prevent upstream users from depleting or degrading the water resources of downstream users.

- The above requires a substantive capacity building in facilitation, mediation, negotiation and surveillance. At present, staff are often not well equipped to take on these responsibilities as they require knowledge and skills beyond those traditionally taught to an engineer or hydrologist.

Think About it

Consider the situation in your own country. You can probably readily identify the agencies responsible for providing people with drinking water and dealing with wastewater. Similarly, it is likely to be apparent which organisations are responsible for estimating and meeting demand for irrigation water.

But, who computes and delivers the river water needed to preserve ecosystems?
And, if you can identify them, what powers and resources do they have in comparison with other sectors?
If water is short, who makes the environmental case?

B. Food/Agriculture

B1. How does the agricultural sector use water?

Without water there is no food production. Water is used for crop production, livestock husbandry and aquaculture.

Crops

- Crops grow best and produce most when they have an adequate supply of water available to them. Water is mainly used for transpiration and smaller amounts are stored in plant tissues.

- Sources of water for crop production are rainfall, shallow groundwater and irrigation water, which is water diverted from surface flows or groundwater. Often in marginal rainfall areas, irrigation supplements rainfall.

- A special form of crop production takes place under recession farming. This is a hybrid form of rainfed and irrigated agriculture. Crops are planted following the recession line after high water peaks in a river or lake.

- Crops rely on residual moisture stored in the soil. As well as the usual irrigation water sources, water harvesting (capture of rainfall runoff)is increasingly becoming an important source of water for agriculture.

Table 1. Total amount of water needed to produce a kilogramme of some staple crops and soybean oil.

Production of 1 kg of:	Amount of water required (m^3)
Wheat	1.3
Rice	3.0
Soybean oil	22

Source: FAO (1997), Waterhouse (1982) – note this is not the amount transpired, but the total required for production

Livestock

- Like humans, animals need water for their metabolic processes. Livestock water requirements are mainly provided by direct water intake and partly by the moisture content of their forage. Livestock production requires large quantities of forage.

- Where livestock does not have access to grazing pastures or where forage cannot be grown under rainfed conditions, fodder is often grown under irrigation. The production of forage requires substantial amounts of water.

Table 2: Estimates of livestock water requirements

Type of Animal	Water Consumption (litres/day/animal)
Dairy cows (drinking only)	40 – 50
Beef cattle and steers	45 – 55
Horses in pasture	28
Horses at work	45 – 55
Pigs	14 – 18
Goats	10
Sheep	6 – 9
Chickens	0.25 – 0.5

Source: Waterhouse, J. (1982)

Aquaculture

- In aquaculture, fish or other marine organisms are grown for human consumption. Water requirements are small in quantitative terms but the produce are extremely sensitive to the reliability and quality of the water supply. As aquaculture sites are usually close to agricultural land, agricultural runoff largely determines the quality of incoming water.

- Integration of aquaculture, agriculture and animal husbandry on farms in Asia creates systems that closely resemble the nutrient recycling pathways of natural ecosystems. However, concerns have been raised about more intensive aquaculture operations that divert water from rivers and produce nutrient pollution.

B2. Why is the agricultural sector important

Agriculture is important because it provides food, and is a major part of the world economy. Access to food is a basic human right. Undernourished people never reach full physical and mental potential and succumb more easily to disease. Globally, agriculture has been remarkably successful in its capacity to keep pace with human food and fibre demands. Over the last century, as the human population has risen, tremendous efforts have been made to ensure that enough food is produced to feed people. As the global population will continue to expand, from 6 billion today to 8.1 billion by 2030, the demand for food will increase.

- It is estimated that 40% of world food supplies are grown on irrigated land. Irrigation is therefore extremely important for global food security. To meet the future food needs of a rapidly increasing population, irrigated agriculture will need to grow at a rate of about 4% per year. In this respect, providing food for the growing population is a major challenge, as agriculture is already by far the largest consumer of water withdrawn in most regions in the world, except North America and Europe. On a global basis, agriculture accounts for more than 70 percent of all water withdrawals.

- Improved food security remains a major target for nearly all developing countries and in many places it is unreliability of water resources that is the primary (though not only) constraint to food security. The productive use of water both in irrigated and rainfed agriculture is a key factor in achieving food and water security.

- Agriculture is particularly important in developing countries because over 70% of the population in these countries live in rural areas and derive their livelihoods directly from agriculture and related activities. For this reason, growth in the agricultural sector is perceived by many as a pre-requisite for economic development. Although water is one of many inputs in agricultural production, it is, perhaps together with land resources, the most critical input. Agricultural water management is thus also a key factor in poverty alleviation.

- Agriculture has the potential to contribute enormously to improving the situation of women in developing countries. Some 70% of agricultural workers are women, and women's small-scale agriculture feeds the vast majority of the world's poorest people. Regrettably, current irrigation and land-management practices strongly favour men. Land tenure, water rights and credit systems are all biased towards males and the institutional framework of irrigation water management means that the small-scale, predominantly women, farmers are at the end of the line.

B3. How is the agricultural sector affected by water use in other sectors?

There is competition for water between agriculture and other sectors such as domestic water use, industry and mining. Although in the developing world agriculture consumes far more water than other sectors, in the developed world industry consumes more water than agriculture.

- Industrial effluents and untreated domestic waste flowing into rivers, lakes and aquifers can pollute the water to such an extent that it becomes unsuitable for agricultural purposes.

- The industrial sector may also affect agriculture indirectly through the production of air pollution. Acid rain, or other dissolved pollutants can damage crops directly, or contaminate lakes used as water sources.

- By modifying rainfall, temperature and evaporation anticipated global warming will affect not only water availability and the water demand of rainfed crops but also water resources. In arid and semi-arid areas, relatively small changes in climate could have significant effects on groundwater recharge and river flows so greatly affecting the feasibility of irrigation.

- A problem for the agricultural sector of treating water as an "economic good" is that agricultural products generally have a very low economic value as well as a high water demand. Consequently, when in competition with other sectors for scarce water supplies, the other sectors can often demonstrate a better cost-benefit ratio than agriculture.

  Think about it for a moment. If it takes 3m^3 (3 tonnes) of water to produce 1kg of rice (see Table 1), how much can you charge the farmer for irrigation water?

- In some instances water resource developments for other sectors can provide benefits for agriculture, particularly if the requirements of both sectors are managed in an integrated manner. In other cases, water resource schemes developed primarily for irrigation, are only economically viable because the dams constructed also enable the production of hydropower.

- Wastewater from other sectors can sometimes also be beneficial for agriculture, e.g. using domestic wastewater for irrigation. This practice not only provides water, but also nutrients for the crops or forage. Research has shown that the use of wastewater for irrigation can support livelihoods and generates considerable benefits in urban and peri-urban agriculture if carefully managed to avoid the negative health impacts.

- Degradation of aquatic environments is the greatest direct threat to inland fish production. Water quality degradation also affects crop production in a variety of ways. These range from direct toxicity of certain elements to plant growth, to a more complex situation where irrigation infrastructure is used for multiple purposes. (See the Egypt example in box 1)

BOX 1
Use of agricultural drainage water for irrigation is a policy to augment Egypt's limited fixed freshwater resources and to close the gap between supply and demand. Pollution of the main drains as a result of large-scale urbanisation and industrialisation is a growing concern, as irrigation canals are also a main source of water for: municipal and rural water supply; industrial water supply; nature; fisheries; bathing and washing. Since the 1990s, many re-use mixing stations have been under increasing pressure as a result of water quality deterioration. Indeed, 4 of the 22 main re-use mixing stations have been entirely or periodically closed since 1992. (Kielen, 2002)

B4. Impact of agriculture on water use by other sectors

Unfortunately agricultural water resources are often overused and misused, especially in irrigated agriculture. This has not only resulted in large-scale waterlogging, salinity and overexploitation of groundwater resources, but also in the depriving of downstream users of sufficient water and in the pollution of fresh water resources with contaminated return flows and deep percolation losses.

- Between 30% and 60% of the water abstracted for agriculture is returned to rivers. In many instances this water is polluted with salts, fertilisers and pesticides and so is only of limited, if any, value to other sectors. Leaching of excess nutrients from farms into water sources causes eutrophication, which damages aquatic flora and fauna by producing algal blooms and depressing dissolved oxygen levels. The presence of agro-chemicals in drinking water is a recognised health hazard, requiring sophisticated and expensive treatment processes.

- In some places where irrigation is dependent on groundwater, water is being abstracted faster than the rate of recharge. As well as depriving other sectors of water, such declines can have devastating environmental consequences.

- Agriculture also affects other sectors indirectly through the impacts of land-use change on water resources. Conversion of grassland and forests to pasture and arable land alters the hydrological regime of a catchment by modifying infiltration rates, evaporation and runoff.

- Land-use change may also contribute to climate change, not only by altering radiation balances and evaporation, but also through increasing CO_2 emissions. As with industrial emissions, in the long-term this may bring about changes in water resources that affect all sectors.

- Increased sediment loads in rivers arising from erosion of agricultural land have a negative impact on downstream aquatic ecosystems and also result in increased siltation in downstream channels, reservoirs and other hydraulic infrastructure.

- Water resource development for irrigation can provide benefits for other sectors. In arid and semi-arid countries, there are often large areas where groundwater is brackish and where people have to obtain water from irrigation canals for all domestic uses. Better coordination with other sectors can mean that benefits such as these are more effectively targeted.

- Many types of aquaculture can contribute positively to environmental improvement. Recycling of nutrients and organic matter through integrated farming systems is well recognised.

B5. Benefits of IWRM to the agricultural sector

As the single largest user of water and the major non-point source polluter of surface and groundwater resources, agriculture has a poor image. Taken alongside the low value added in agricultural production, this frequently means that, especially under conditions of water scarcity, water is diverted from agriculture to other water uses. However, indiscriminate reduction in water allocation for agriculture may have far-reaching economic and social consequences (see the California example in Box 2). With IWRM, planners are encouraged to look beyond the sector economics and take account of the implications of water management decisions on employment, the environment and social equity.

- By bringing all sectors and all stakeholders into the decision-making process, IWRM is able to reflect the combined "value" of water to society as a whole in difficult decisions on water allocations. This may mean that the contribution of food production to health, poverty reduction and gender equity, for example, could over-ride strict economic comparisons of rates of return on each cubic metre of water. Equally, IWRM can bring into the equation the reuse potential of agricultural return flows for other sectors and the scope for agricultural reuse of municipal and industrial wastewaters.

- IWRM calls for integrated planning so that water, land and other resources are utilised in a sustainable manner. For the agricultural sector IWRM seeks to increase water productivity (i.e. more crop per drop) within the constraints imposed by the economic, social and ecological context of a particular region or country. A major shift in focus under IWRM is the concept of demand management (i.e. managing water demand rather than simply looking for ways to increase supply).

BOX 2
Successful management
In physical water scarce countries like Israel, Cyprus and Malta, governments have successfully moved their population into other activities, including industry, commerce and tourism. Agriculture is mainly restricted to high value export crops and most food is imported rather than produced within the countries. (GWP, 2000)

Unsuccessful management
In 2001 farmers south of the Sacramento-San Joaquin Delta, California received the lowest amounts of water since 1994 as a result of changing priorities and scant precipitation. Central Valley Project agricultural customers in the region received only 45 percent of the contracted supply. The water shortage has triggered a domino effect of fallow fields, lost jobs and troubled towns dependent on the income that farming provides. The city of Mendota for example thrives when area crops receive adequate water. Virtually every job is tied to agriculture, and the unemployment rate of the city can increase to more than 40 percent when times for agriculture are tough. (Morris, 2001)

B6. Barriers to implementing IWRM in the agricultural sector

Successful IWRM requires consideration of a wide range of social, economic and political issues at a variety of different scales. Barriers to successful implementation of IWRM within the agricultural sector include:

- *Incompleteness in water management policy and legal and regulatory frameworks*. This is particularly the case in developing countries where water policies are often rudimentary, and the regulatory mechanisms for implementing and enforcing them are weak.
- *Demographic pressures*. Population growth, primarily in developing countries, linked to poverty, is in many places driving inappropriate and non-sustainable agricultural practices and associated water utilisation. However, often communities even when they understand the long-term consequences of their actions feel that they have no alternative.
- *Lack of understanding of IWRM principles and practices*. In many instances, only a few people in the hierarchy of water management know and understand IWRM and often there is insufficient technical support to operationalise IWRM within the agricultural sector.
- *Inadequate information and data on how water is used in agriculture*. Despite the recognised need for demand management, in many places the data required for analysing water use patterns in detail (e.g. temporal and spatial variation in quantities of water diverted and return flows) is lacking. Of all the sectors agriculture is most often the one for which there is least quantitative information on exactly how much water is being used.
- *Lack of understanding of the inter-relationships between biophysical and socio-economic aspects of a system*. Successful IWRM requires the integration of environmental, social and economic factors, but in any specific situation the relationships between biophysical and socio-economic systems are even less well understood than the biophysical alone. Consequently, the social implications of management decisions are often impossible to predict.
- *Market-failure*. Despite the wide-spread recognition that water should be treated as an economic good, in many places water is provided to the agricultural sector at very subsidised rates. In part this is because of the perceived need by many governments for nations to be self-sufficient in food production. The result is that there is little economic incentive for farmers to change long established agricultural practices.
- *Entrenched agricultural practices*. Very often farmers, like other groups, are unwilling to change practices, if they believe that others will simply continue doing what they have always done.

B7. Implications for change within agricultural sector: legal, institutional, human resources

IWRM promotes judicious and sustainable use of water resources. As agriculture will always use more water than any other sector, governments need to review carefully their agricultural and food policies. Clearly, in many places there is a need for both time and resources to improve the policy and institutional framework, as well capacity to facilitate management across sectors.

- In regions facing water stress, governments may want to take the political decision to forego domestic self-sufficiency and instead aim for food security through trade, thereby recognising the value of “virtual water”. Policies will also need to focus on increasing the crop productivity per drop of water and per unit of investment. Basically, this means that yields need to be raised in both irrigated and rainfed farming.

- The main institutional challenge in irrigated agriculture is to transform inefficient, supply-driven, central irrigation bureaucracies into vibrant, demand-driven locally based authorities answerable to the farmers. A starting point is to transfer management of irrigation from government agencies to water users associations (WUA) or other private sector organisations. Irrigation management transfer (IMT) may be done managerially and/or hydraulically. In the former, management authority and responsibility is shared between the government and WUAs. In the latter only certain sub-levels are transferred to WUAs. Various forms and examples of IMT exist around the world. It is through WUAs and the institutional reforms that make them effective that governments can strengthen the influence of women in IWRM, with potentially a major impact on water-use efficiency in agriculture.

- The institutional and managerial reforms have far reaching consequences for Human Resources Development. Irrigation agencies need to undertake strategic planning to restructure and identify new roles to take on. To reorient their relationships with farmers into new partnerships, they will require service agreements backed by irrigation management audits. Irrigation managers need to understand the concept of service, and what type of service is desirable and possible within their irrigation system.

- Farmers need extensive training and long-term support to make WUAs sustainable by enhancing local management capacity and creating group orientation.

BOX 3

The Tieshan Irrigation District in China was transformed into the Tieshan General Water Supply Company in 1992 under a World Bank-funded modernisation project. The general company consists of various individual companies including the 1 and 2 Farming Water Supply Companies. These two companies are responsible for the management, operation and maintenance of the 2 main canals up to the branch canal off-takes from where the Water Users Associations (WUAs) take over responsibilities. On a yearly basis, WUAs submit a request for bulk supply of irrigation water to the company. In March of each year an agreement is signed between the WUAs and the company for the delivery of irrigation water. The water price from the company is fixed at 0.032 RMB/m^3. The actual amount paid to the company depends on the actual water consumption. WUAs pay 40 percent of the water fee up-front and the remainder is paid according to the actual use. The WUAs establish their own price to be charged to the individual water users. The water fees include the cost for maintenance, bulk water supply cost, operation and management and occasional pumping from the canals if the supply is insufficient. For larger investments such as the construction of new canals the WUAs depend on government funds. WUAs are members of the board of the company.

Think About it

As is the case in most countries, the agriculture sector in your country may be the most important user of water resources. When you think of agricultural water use in your country you may want to consider the contribution of the sector to the livelihood and food security of the population. But you may also ask yourself:

- Are these water resources used effectively and efficiently or are there alternative means of production?
- What are the impacts of water use for agricultural production on water availability and quality?
- How can IWRM improve the performance of the agricultural sector in my country?
- What institutional arrangements have to be made within agriculture for the implementation of IWRM?

C. Water Supply and Sanitation

C1. How does the water supply and sanitation sector use water?

The water supply and sanitation sector has two main categories of water users: domestic; and industrial/commercial. Domestic water users need dependable supplies of "safe" water for drinking, cooking, bathing, washing and basic household cleaning. They also have to dispose of human waste and washwater in ways which do not create health risks or environmental damage.

Industrial users frequently need large quantities of water for cooling and other processes, but do not "consume" much of it. Their residual water is returned, often in contaminated form to water courses. Some industries (chemicals, fertilisers, coffee processing, …) produce highly toxic or biologically polluting effluents.

In developing countries there are big differences between urban and rural areas in both water use and wastewater disposal. Only better-off urban residents can afford what is seen as the classic domestic water cycle in the industrialised world: house connections to deliver enough high-quality treated water for all their lifestyle needs and sewer connections to take away the wastewater for centralised treatment and return to water courses. In many crowded peri-urban settlements, construction of water mains and conventional sewers is unaffordable and impractical. There, residents depend on communal water points or water vendors, and on a range of often unhygienic ways of disposing of solid and liquid human waste.

In rural areas, water systems are primarily community-based. Hundreds of millions of people are served by handpumps on boreholes or dugwells; others have standposts or yardtaps fed by elevated tanks and distribution networks. Groundwater is a primary source of supply and the daily task of fetching and carrying water remains a major burden for women and girls throughout the developing world. Rural sanitation is very much an individual household responsibility, and one that has historically been a very low priority. Its neglect has meant that millions of people die unnecessary deaths each year from diarrhoeal diseases, and that life is squalid, unhealthy and undignified for vast numbers of the world's poorest people. That situation is changing: one of the Millennium Development Goals that has received high publicity, is the aim to halve by 2015 the proportion of people who lack access to hygienic means of sanitation (2.4 billion people, or almost half the world's population had no such access in the year 2000, according to official WHO/UNICEF statistics).

Another important domestic use of water is for productive purposes around the household. This includes activities such as growing vegetables and fruit trees, giving water to livestock, making bricks, and running a range of small-scale processing and other industrial activities.

The quantities of water used for domestic water supply and sanitation are relatively small compared with water use for industry or agriculture. Box 4 shows one calculation for domestic household needs. Different countries have different norms but most domestic use can be adequately covered by a water supply in the range 25-50 lpd (litres per person per day). If household productive uses are taken into account, this increases to 50-200 lpd .

Industrial water use varies enormously from industry to industry and from country to country. Among the biggest water consumers are the pulp and paper industry and steel manufacture. Environmental pressures and water pricing have stimulated an increasing amount of recycling and reuse by industries in the developed world, but so far there is much less progress in developing countries. Two examples are quoted by the Worldwatch Institute: "In China, the amount of water needed to produce a ton of steel ranges from 23 to 56 cubic metres, whereas in the US, Japan, and Germany, the average is less than 6 cubic metres. Similarly, a ton of paper produced in China requires around 450 cubic metres of water, twice as much as used in European countries."

Box 4. Basic needs: a traditional approach

The traditional approach to 'basic needs' excludes water for productive activities within the household. Typically, it proposes 50 litres per person per day as a recommended minimum based on the following figures.

Purpose	Recommended minimum (litres per person per day)
Drinking water	5
Sanitation services	20
Bathing	15
Cooking and kitchen	10
Total	50

In different countries there are different 'basic needs' targets. Sometimes these are as low as 25 litres per person per day (e.g. rural South Africa), or as high as 55 litres (India's recently revised target). Targets are best reviewed and revised to suit circumstances. For example, South Africa proposed short, medium and long-term targets to pragmatically address water supply backlogs.

Combining projections of demographic and industrial growth, the World Resources Institute estimated in 1997 that demand for municipal water supplies could rise by a factor of five or more in the next four decades.

Two more factors distinguish domestic water supplies from those in other sectors: quality and reliability.

- *Quality:* The quality of drinking water is critical for human health and well-being. Quality is assured by treatment, but also by the quality of the source. The lower the quality of the source, the higher the treatment costs. There is debate about the delivery of unlimited high quality domestic water through house connections, when only about 5% -10% of piped water is actually used for drinking.

- *Reliability of source:* Domestic supplies must be absolutely reliable. Lack of water even for a few days kills people. Failure to keep water supply networks pressurised allows polluted water to force its way into leaky pipes. The source must therefore be reliable to a very high level of certainty (for example 1 in 20 years), both in its inherent ability to supply water and also in terms of any possible competing claims.

Treating wastewater from sewerage systems is expensive and therefore often not done, even in middle-income countries. Typically, it may cost up to $1,500 per household to collect and treat the wastewater of a Third World city. Yet the costs of non-treatment are huge, in terms of both human health and the lost potential for reuse downstream.

C2. Why is the water supply and sanitation sector important?

Water is a basic human right

Without safe and sufficient drinking water and sanitation, people cannot live healthy and productive lives. Water is firstly crucial to keep the human organism alive and healthy. This takes 2-5 litres of *clean* water per person per day (depending on climate and activities). However, having enough water to drink but not enough to wash will lead to ill health or death, less directly but no less certainly than lack of water to drink. Hence the need for water for bathing and personal hygiene (such as hand washing after defecation). Domestic water is also critical for waste disposal – through sewers or into septic tanks or latrines. All of these uses, as well as small quantities for cooking and cleaning/washing are so essential to human well-being that they are universally acknowledged as being both a need and a right. While

planning for access and use has to be integrated with other sectors and users, water for domestic purposes is universally acknowledged as having priority in water resource allocation.

In addition to these critical domestic requirements, there is an increasing recognition of the important role in economic well-being and poverty reduction that a supply of water for productive use can provide at the household level. It has been argued that because of the range of economic and social benefits, including income generation, food security, and improved nutritional status this additional quantity of water should be included with the core domestic requirement as a key priority and right in water resource allocation.

Gender equity

Lack of convenient access to water and sanitation adds enormously to women's domestic burdens. It also disproportionately affects their health and that of their children. The water and sanitation sector has long recognised the major benefits that improved basic services can bring to women's lives and to girls' education when they are freed from the daily chore of fetching water. Gender perspectives are comparatively well developed in the sector and are seen as an entry point for poverty alleviation as well as bringing health and lifestyle benefits.

C3. How is the water supply and sanitation sector affected by water use in other sectors?

The WATSAN (Water Supply and Sanitation) sector is most critically affected by other water uses in terms of competing or conflicting use and pollution. The first affects the quantity and reliability of domestic water supplies, the second the quality and associated costs of treatment.

Competition

Water is a critical economic resource and hence often in great demand. As a result competition exists on many levels within and between sectors. Most of the examples of conflicting water use impacting on domestic water supply needs come from the agricultural sector (water for irrigation). From California to India, cases of competition between irrigated agriculture and domestic water supply are becoming increasingly common and well known. The example in Box 5 from Andhra Pradesh is typical. It illustrates competition at a basin scale – perhaps the most widely reported. However competition occurs at a local scale too, for example when over-use of groundwater for irrigated agriculture leads to rapidly falling groundwater tables that in turn lead to domestic supply wells failing – as is the case in much of India.

Box 5

Farmers storm Kurnool ZP office

KURNOOL, APRIL 15. Farmers under the Gajuladinne Project canal stormed the Zilla Parishad office here on Monday, demanding release of water beyond the scheduled closure to save the standing crops. A large contingent of farmers arrived at the Zilla Parishad and a few of them barged into the hall as the meeting was in progress. Their supporters outside created a noisy scene by banging the windows and doors. Some of the leaders picked up an argument with the Collector and others. The Collector told the farmers that the Irrigation Advisory Board had formally decided to close the canal by April 9. Any decision to reopen the canal had to be taken by the Government, he said.

The farmers got angry with the argument of the officials saying that they were more concerned about supplying drinking water to Kurnool town rather than saving the crops. They said the crops required watering for 20 days more and demanded supply of 100 cusecs. The farmers' leaders argued that priority be given to farmers under the project and the drinking water requirement of Kurnool should come next. One of the farmers threatened to poison the GDP water to make it unfit for consumption.

adapted from THE HINDU, Tuesday April 16, 2002

Pollution

Pollution of sources from which domestic supplies are derived is a critical issue, leading in the worst case to serious health problems and in the best to increased water treatment costs. Pollution is a problem for water from both surface and sub-surface sources, although it is the former where the problem is more widely recognised. The quality of river water can be negatively affected by pollution from either agriculture or industries (pesticide or fertiliser runoff, discharges of hazardous materials etc.), or indeed untreated human effluent. Equally, aquifers can be polluted by excess fertiliser application, or improper disposal of hazardous materials from industry or from municipal dumping or poorly constructed septic tanks. Groundwater pollution problems can be particularly difficult to identify and then to remedy, as much industrial pollution calls for very costly treatment. Finally, the environment itself can be an important source of pollution in water sources, with the example of arsenic contamination of groundwater in Bangladesh being perhaps the most widely known recent example.

The fact that the water supply sector is itself most often responsible for polluting drinking water sources, especially for downstream users, highlights an internal management problem or discontinuity in management structures.

C4. Impact of water supply and sanitation on water use by other sectors

Allocation issues

It is frequently wrongly assumed that because allocations for domestic water resources are 'small' they will have little impact on those for other uses. However, because of the critical importance of an uninterrupted supply, the need to safeguard adequate buffers in the catchment or aquifer systems to ensure this supply at all times, and the seasonal nature of much water demand (particularly for irrigation), serious conflict can and does occur between allocation for domestic and other needs.

This competition for allocation and the priority normally given to domestic use can result in conflict, especially when urban piped systems are accused of "losing" as much as 50% of the piped water and using water wastefully.

Pollution

Improperly treated human waste is a major source of environmental pollution, leading to problems for both other humans and the environment as a whole. Pollution of rivers and streams by untreated or inadequately treated municipal and industrial effluents can render the watercourses unsuitable for use as sources of irrigation water and damage aquatic ecosystems.

The reuse of municipal wastewater for irrigation, carried out in the peri-urban zones of many developing country cities has both positive and negative impacts. The recycled water and nutrients are important for water conservation, but the health risks are significant unless there are tight controls. Not only are the farmers themselves exposed to high risk from pathogens, but their produce is then exported to a wider public who may also suffer.

C5. Benefits of IWRM to the water supply and sanitation sector

Water Security

Above all, properly applied IWRM would lead to the water security of the world's poor and unserved being assured. The implementation of IWRM based policies should mean increased security of domestic water supplies, as well as reduced costs of treatment as pollution is tackled more effectively. Conflict between water users is reduced.

Participatory IWRM, especially at basin or catchment level, can include and empower previously disadvantaged, poor and voiceless people, and provide opportunities for further development, in the form of jobs, newly acquired skills, etc.

Recognizing the rights of people, and particularly women and the poor, to a fair share of water

resources for both domestic and household-based productive uses, leads inevitably to the need to ensure proper representation of these groups on the bodies that make water resource allocation decisions. This is one of the great challenges for the next years – to change institutions that have until now typically existed to serve the interests of relatively small, powerful and effectively organised groups, to serve a large, diffuse, group of often poor users.

Efficient use

An increasing recognition of the economic value of water is in part behind current moves to more efficient use. Greater integration in management of water resources will help to reduce conflict between water users by ensuring agreed efficiency of use in competing sectors. For the domestic water supply sector the costs of delivering the small quantities of water required greatly outweigh the actual cost of the resource itself, the increased use of demand management and other measures aimed at more efficient use typically have more to do with the ever increasing costs of developing new sources and removing pollution. The focus on integrated management and efficient use should also be a stimulus to the sector to push for recycling, reuse and waste reduction by industrial users. High pollution charges backed by rigid enforcement have led to impressive improvements in industrial water-use efficiencies in the industrialised countries, with benefits for domestic water supplies and the environment.

Improved waste management

Major blind spots exist due to failure to coordinate effectively with other sectors. The issue of wastewater disposal provides a good example. Here, rather than working together with other sectors to exploit a potentially important economic resource, the attitude tends to be one of out of sight, out of mind.

Past sanitation systems often focused on removing the waste problem from the areas of human occupation, thus keeping the human territories clean and healthy, but merely replacing the waste problem, with often detrimental environmental effects elsewhere. Introduction of IWRM will improve the opportunity for introduction of sustainable sanitation solutions that aim to minimise waste-generating inputs, and reduction of waste outputs, and to solve sanitation problems as close as possible to where they occur.

Economic and coverage benefits

At a practical local level, improved integration of water resource management could lead to greatly reduced costs of providing domestic water services, if for instance more irrigation schemes were designed with a domestic water component explicitly involved from the start. The irrigation sector will be encouraged to recognise that improving people's wealth and nutrition status through irrigation will not have the desired impact on poverty if people are constantly sick due to lack of domestic water and sanitation facilities.

Participation and gender equity

Social inclusivity and women's influence in decision-making have been seen as desirable for some time in the water and sanitation sector. However, because of the community-based nature of this sector, the adoption of inclusive approaches has had only local effect and local impact. The basin-wide approaches of IWRM will be able to build on these local successes and extend successful participatory approaches to higher levels of decision-making. Communities will thus be made more aware of the implications of their activities on others and be able to work together on unified plans for catchment protection, water conservation and demand management.

C6. Barriers to implementing IWRM in the water supply and sanitation sector

Willingness to change

Domestic water, sanitation and hygiene are often divided over a number of government departments, such as water affairs, health, local government, and / or public works, and over the last two decades much experience has been gained in practical ways to work together effectively across departmental lines. Equally, the WATSAN sector has been focusing on grassroots led development for decades, and has been at the forefront of decentralisation efforts. More than the other sectors, water and sanitation are local issues requiring local

solutions by local people.
WATSAN professionals are perhaps more removed than any other water sub-sector from IWRM as it is currently practised. Typically they focus on the management of the supply system (reticulation) rather than the resource base itself, which tends to be taken for granted. Equally they are already involved in trying to work together effectively with a range of actors from different backgrounds – many of whom have nothing to do with water at all. A focus on health has led to a number of failures, perhaps most important the stubborn blind spot that persist as far as productive uses at the household level are concerned. Starting to work with other water sub-sectors environment, food / agriculture or other sectors, who are equally often divided over the departments presents a considerable challenge.

Lack of tools and systems for integration
The core of this challenge is finding effective tools and processes to achieve greater coordination and cooperation without incurring such high transaction costs that the entire process becomes wasteful. IWRM could on the one hand increase co-operation and improve coordination between the various departments (i.e. through introduction of inter-departmental, or regional task teams), but on the other hand could disrupt systems that have been in existence for a long time, and therefore meet with a lot of frustration and negativity of the officials within the various departments. Furthermore, institutional reforms are often very costly – costs that have to be won back through improved efficiency and effectiveness of the new IWRM-based system.

Summary of barriers
There is much good-will surrounding the concept of IWRM, but formidable barriers remain. These include:

- A failure on the behalf of the WATSAN sector to engage meaningfully with the other sectors involved in IWRM
- A lack of models of how to go about integration.
- A critical lack of both policy and the personnel to implement it. Conflict between decentralisation and the desire to maintain central power and influence.
- The difficulty of getting the large, diffuse group represented by the WATSAN sector to interact meaningfully with the small, well-organised lobbies of big agriculture and industry.
- An unwillingness to deal with the implications of the critical need for reliability (and hence often large reserves and buffers) in domestic supplies, and the implications this has on the availability of water for other sectors

C7. Implications for change within the water supply and sanitation sector: legal, institutional, human resources

The changes will be greatest for those who currently work most narrowly within a sectoral remit. NGOs for example, who have for years worked in a holistic and multidisciplinary manner to address poverty and human development will have little difficulty adapting to the concepts of IWRM. On the other hand highly centralised line ministries will need huge adjustments and may not in the end manage the change of mindset and working style that IWRM implies.

While for some organisations and institutions the above implications for change will be very real and substantial, many sector organisations have already adopted IWRM as the best option for sustainability, and have opened up to look for opportunities to work with sector role-players from the other water sectors.

To start with the current ‘water and sanitation sector’ should cease to be considered as a separate autonomous sector. The focus should shift to one of scale and type of supply, with those working in the current WATSAN sectors teaming up with others involved in efforts to tackle poverty through the effective use of water resources. The rights of the poor (and indeed all people) to an equitable share of available resources will require both legislation and

new models of stakeholder involvement, as well as concerted advocacy. Only when this right has been satisfied to an acceptable level of certainty should excess resources be made available for other uses.

In addition a completely new approach to dealing with wastewater will be required – one that focuses on waste as a resource, and that seeks to maximise the value of the resource to the community as a whole.

The requirement of IWRM to allow stakeholder representation will require wholesale reorientation in many existing organisations used to seeing themselves as 'experts' and 'managers'. They will need to change to being facilitators, enablers, and regulators. This will require a shift in the skills base, with a particular focus on the use of participatory techniques.

Finally, IWRM can only be built on experimentation. There are no blue prints, regionally, national, or even sub-nationally. People must be given the freedom to experiment and find solutions that suit them and their environment.

Think About it

In many countries urban water supply is the first priority when it comes to water allocation. How is the situation in your country? And more specifically you may want to consider the following questions:

- What is the water security situation in my country and how can it be improved through IWRM?
- How is water supply being affected by use of water resources by other sectors?
- How is our wastewater being managed and is there room for improvement?
- What is the relation between water availability and people's livelihood and well-being?
- What are we doing at home to make wise use of the water resources?

8. References and links

References

Asian Development Bank. 2000. Water For All. The Water Policy of Asian Development Bank. www.adb.org/Documents/Policies/Water/default.asp?p=policies

Beck, U. 1992. Risk Society: Towards a new modernity. Sage Publications, London, 306 pp.

Boubecar, B., Crosby, C. and Touchains, E. 2002. Intensifying rainfed agriculture: South African country profile. IWMI

European Commission, 1998. Guidelines for Water Resources Development Cooperation. Brussels.

European Commission. 1998. Towards sustainable water resources management - a strategic approach. Guidelines for water resources cooperation. European Commission, Brussels, 351 pp.

FAO. 1995. Irrigation in Africa in Figures. Water Reports #7. FAO, Rome, Italy.

FAO. 1997: Food Production; The critical role of water. Technical Document #7. FAO, Rome, Italy.

Gleick, P.H. 1993. *Water in crisis: a guide to the world's freshwater resources.* Oxford University Press, Oxford.

Global Water Partnership. 2000. Integrated Water Resources Management. TAC Background Papers, no 4, 67 pp. www.gwpforum.org/gwp/library/Tacno4.pdf

Global Water Partnership, 2002. ToolBox, Integrated Water Resources Management. http://www.gwp.ihe.nl

Groot, R.S. de. 1992. Functions of Nature: Evaluation of Nature in Environmental Planning, Management and Decision-making. The Netherlands: Wolters Noordhoff B.V. Groningen, 345 pp.

Gumbo B. and P. van der Zaag. 2001: Principles of Integrated Water Resources Management. Global Water Partnership Southern Africa, Southern Africa Youth Forum, 24-25 September 2001, Harare, Zimbabwe.

ICID. 2000. Strategy to implement ICID's concerns emanating from the Vision for Water, Food and Rural Development. ICID, Cape Town. www.icid.org/index_e.html

ICOLD. 1997. *Dams and the Environment*. ICOLD Position Paper. http://genepi.louis-jean.com/cigb/chartean.html

ICWE. 1992. Dublin Statement and report of the conference, 26-31 January 1992.

IHA. 2001. IHA Comments on the Final Report of the WCD - February 2001.

IPCC. 2000. Intergovernmental Panel on Climate Change. *Land use, land-use change and forestry*. Cambridge University Press, Cambridge.

IUCN 2000. Vision for Water and Nature. A world strategy for conservation and sustainable management of water resources in the 21st century. Gland, Switzerland, 52 pp. www.iucn.org/webfiles/doc/WWRP/Publications/Vision/VisionWaterNature.pdf

Jaeger, 2001. Risk, Uncertainty, and Rational Action.

Knight, 1971. Meaning of Risk and Uncertainty

Perreira, L. S., I. Cordery and I. Iacovides. 2002: Coping with water scarcity. IHP-VI Technical Documents in Hydrology, No. 58. UNESCO, Paris.

Postel, S.L., Daily, G.C. and Ehrlich, P.R. 1996. Human appropriation of renewable fresh water. *Science*, 271, 785-788.

Rees, J.A. 2002. Risk and Integrated Water Management. TAC Background Papers, Global Water Partnership, Stockholm.

Resiner, M. 2001. *Cadillac Desert: the American west and its disappearing water.* Pimlico, London.

Rosegrant, M. and Ringler, C. 1997. World Food markets into the 21st century: environmental and resource constraints and policies. *The Australian Journal of Agriculture and Resource Economics* 41.

Savenije, H. 2002. Management arrangements; IHE Lecture Notes – Water Law and Institutions. UNESCO-IHE, Delft, the Netherlands.

Szöllosi-Nagy, A., Najlis, P. and Björklund, G. 1998. Assessing the world's freshwater resources. *Nature and Resources*, 34, 8-18.

Truffer, B., Cebon, P., Dürrenberger, G., Jaeger, C., Rudel, R., S. Rothen 1998. Innovative social responses in the face of global climate change. In: Views from the Alps. Regional Perspectives on Climate Change, edited by Cebon, P., Dahinden, U., Davies, H., Imboden, D., Jaeger, C. Boston, MIT Press. p.351-434.

United Nations, 2003. World Water Development Report. UNESCO. www.unesco.org/water/wwap

UN-ESA 1992. Chapter 18 - Agenda 21. http://www.un.org/esa/sustdev/agenda21chapter18.htm

Waterhouse, J. 1982. Water Engineering for Agriculture. Publ. Batsford, London, UK.

WCD. 2000. Dams and development - a new framework for decision-making. Earthscan, London, 404 pp.

Wolff, P. and Stein, T.M. 1998. Water efficiency and conservation in agriculture – opportunities and limitations. *Agriculture and Rural Development* 17-20.

Wood, S., Sebastian, K., Scherr, S.J. 2000. *Pilot analysis of global ecosystems: agroecosystems.* World Resources Institute, Washington D.C.,USA.

World Bank. 1993. Water Resources Management - A World Bank Policy Paper. The World Bank, Washington DC, 140pp.

World Bank Institute, 2003. Integrated Water Resources Management: An Introduction.

Links

Cap-Net - International Network for Capacity Building in Integrated Water Resources Management – www.cap-net.org

HR Wallingford Ltd. – www.hrwallingford.co.uk

IRC – International Water and Sanitation Centre – www.irc.nl

IUCN – The World Conservation Union – www.iucn.org

IWMI – International Water Management Institute – www.lk.iwmi.org

WSSCC – Water Supply and Sanitation Collaborative Council – www.wsscc.org

Acknowledgements

Cap-Net wishes to express its gratitude to all of those who contributed to the preparation of this tutorial. Thanks are directed in particular to Patrick Moriarty of IRC for coordinating the module on water supply and wastewater, Tom Brabben of HR Wallingford for organising the module on agriculture, and Ger Bergkamp of IUCN for his inputs for the module on environment. The contributions of Darren Saywell of WSSCC in the module on water supply and wastewater, and Doug Merrey, Matthew McCartney, Hilmy Sally and Aidan Senzaje of IWMI in the module on water and food are highly appreciated. Ton Schouten is thanked for reviewing the draft version thoroughly.