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Fondation 2iE

TECHNICAL MANUAL FOR THE INTEGRATED WATER RESOURCES MANAGEMENT

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List of Abbreviations and Acronyms

NBA: Niger Bassin Authority

ABFN: River Niger Basin Agency (Mali)

ACMAD: African Centre of Meteorological Applications for Development

ACP: Africa Caribbean Pacific - European Union

CFC: Chlorofluorocarbons

CIDA: Canadian International Development Agency

CILSS: Permanent Interstate Committee for Drought Control in the Sahel

DWS: Drinking Water Supply

DWSS: Drinking Water Supply and Sanitation

ECOWAS: Economic Community of West African States

EIA: Environmental Impact Assessment

EU: European Union

FAO: Food and Agriculture Organisation

GCM: Global Climate Model

GHG: Greenhouse Gases

GTZ: German Development Cooperation

GWP: Global Water Partnership

INBO: International Network of Basin Organizations

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for the Conservation of Nature

IWRM: Integrated Water Resources Management

LFA: Logical Framework Approach

MDGs: Millennium Development Goals

MV: Means of Verification

NAPA: National Action Plans for Adaptation

NBA: Niger Basin Authority

NGO: Non-Governmental Organization

ODA: Official Development Assistance

OECD: Organization for Economic Co-operation and Development

OMVS: Organization for the Development of Senegal River

ONEA: National Water and Sanitation Office (Burkina Faso)

OVI: Objectively Verifiable Indicators

SADC: Southern African Development Community

SAGE: Water Development and Management Plan

SDAGE: Water Development and Management Master Plan

SIDA: Swedish International Development Cooperation Agency

SSO: The Sahara and Sahel Observatory

TdE : Togolaise des Eaux

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

UNESCO: United Nations Educational, Scientific and Cultural Organization

UNFCCC: United Nations Framework Convention on Climate Change

UNICEF: United Nations Children's Fund

UNO: United Nations Organization

USAID: United States Agency for International Development

WHO: World Health Organization

WMO: World Metrological Organization

WWC: World Water Council

Foreword

2iE Foundation received funding from the European Commission through the ACP-EU Water Facility. A major focus of the project is the building of the capacity of the human resources of companies, central governments or local authorities, basin agencies, NGOs and associations.

The project "Capacity Building of communities, civil society, public and private sectors in sub-Saharan African countries ", has as main objective, the strengthening of the capacity of basin agencies, central and decentralized technical services, companies and civil society involved in the management and development of water resources in the area of integrated water resources management (IWRM). In this framework, training sessions were held in Benin, Burkina Faso, Cameroon, Mali and Senegal between 2008 and 2010. Training modules were developed by the managers of the project and by external facilitators; they were used as support during the training sessions.

Following these activities, it was planned to build on the achievements of all seminars organized in this project by producing a technical manual and a learning kit to be made available to those responsible for capacity building in IWRM:

- Media to conduct short term training sessions on IWRM concepts, principles and tools
- Tools for the development of approaches to use in the activities of management and development of water resources.

This handbook, designed for staff and professionals of communities, civil society, public and private sectors in sub-Saharan African countries, aims to:

- Allow to understand of the situation of water resources in the world and in sub-Saharan Africa, and to grasp the major issues in the development of these resources
- develop the capacity of the sector staff on the principles of IWRM, and as well as equipping them with management and planning tools in the framework of a watershed
- develop the knowledge of professionals on the economic and financial aspects of IWRM, but also on legal issues related to shared river basins, on gender aspects and on the involvement of the stakeholders
- understand the problems of climate change, its impacts on water resources and coping strategies in the IWRM approach
- Empower the sector staff on the implementation of project and on the management of the project cycles.

The manual is therefore a support of the learning kit, consisting mainly of training modules in PowerPoint format. It is designed as a guide for future facilitators; it is in a coherent form and structure and deals with eight major thematic areas making up 8 chapters. It relies mainly on

the resources developed through training sessions, but also on bibliographic supports of other institutions involved in capacity building in IWRM and offering training materials; these include Cap-Net and GWP.

General introduction

Water is a limited natural resource, necessary for life and ecological systems, and essential for the economic and social development. This statement has been understood in its full extent by Chapter 18 of Agenda 21 of the Rio Summit in 1992. The overall goal was "to ensure that the entire population of the planet always have water in quantity and quality, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities to the limited capacity of nature and fighting against vectors of water related diseases"

Indeed water is an indispensable resource for many uses: agriculture uses 67% of the water withdrawn, against 23% for industry and 10% for urban and domestic uses. The use of agricultural water increases more and more in a context, first of competition with the domestic uses which trend increases following the increase in population, second in a context of climate change which impacts on water resources are becoming more apparent.

Drinking water is essential for health, survival, growth and it there is no development without water, without sanitation and without hygiene. Besides, the global community is committed to halve the number of people without sustainable access to safe drinking water and basic sanitation. Achieving the MDGs remains a major challenge of our states. The supply of drinking water and access to adequate sanitation are included in the major strategic axes identified for poverty reduction.

But the quantity of water on this planet is limited and it can neither diminish nor increase, water being in a constant recirculation following the hydrological cycle. Fresh water represents only 2.5% of the total stock of water on the planet (the remaining 97.5% being salty), or 2/3 of global fresh water is concentrated in glaciers and snow cover, 1/3 in groundwater. There is only 0.3% of fresh water (or 0.007% of the total water on the planet) in rivers, streams, reservoirs and lakes.

Today water resources generally face major constraints such as climate variability and change, increasing demand, deteriorating water quality, competing uses and internal tensions (upstream / downstream) or international (shared watercourses) for the sharing of the resource. To address these concerns a better management of water resources must be considered. This requires an integrated water resources management, which will aim to:

- protect the resource and improve its knowledge;
- plan the use of the resource, and practice a water saving policy;
- involve men and women equally, then prevent and manage conflicts related to water uses;
- satisfy in a comprehensive way the legitimate and reasonable demands (agriculture, electricity, domestic uses, transport, industry, recreation, aquaculture, fishing ...);
- preserve ecosystems and prevent risks (erosion, drought, floods).

This integrated approach is necessary since most uses of water generate benefits (economic and social) in society, but they can also have negative impacts (namely environmental). This situation may worsen because of inadequate management procedures, the lack of regulation or lack of motivation caused by the regimes of water governance in force.

To understand all the issues relating to the current status of water resources and meet the challenges for a sustainable management of water resources, both surface and groundwater, stakeholders must have the required capabilities to know and master the management and planning tools. Capacity building is therefore a vital link in the system of implementation of IWRM. Besides, this manual can be viewed in this light, as a contribution of 2iE in training the stakeholders so as to enable them acquire the knowledge and skills needed for the development and management of water resources.

The Technical Manual is made up of eight thematic chapters. Chapter I describes the current status of water resources in the world in general and in Sub-Saharan Africa in particular. It discusses their importance in economic development and in the preservation of ecosystems, and shows the threats of degradation and stress placed on them. A new integrated approach to replace the existing sectoral approach in force so far is highlighted by presenting all the benefits linked to this new approach as well as the current issues that implementation of IWRM should address. This is covered in chapter II with a presentation explaining the guidelines that are the basis of IWRM, and on the tools available. The international context that led to its emergence is also discussed with the history of various international meetings where the process matured.

The implementation of these principles and tools is another challenge which the actors of water are facing. Chapter III addresses this issue in terms of planning at catchment level, perfect unit of implementation of IWRM. In this context, the legal aspects of rivers (especially shared) are of great importance in promoting cooperation at basin level.

In the face of the scarcity of water resources, their economic value increases. In this context, the economic and financial aspects become essential for a better allocation, since its use or consumption by competitive sectors or groups also grows. Chapter IV helps to better understand the economic and financial instruments and to assess the financing of the sector, which needs financial resources to initiate and develop the process.

Chapter V is dedicated to the involvement of the actors of IWRM, highlighting the characteristics, types and mechanisms by which participation is made effective. Women play a major role in the collection and preservation of water for domestic and agricultural use, but they have a much less influential role than men in the management, problem analysis and decisions making regarding water resources. Some other vulnerable groups are lagging behind as far as access to safe water and sanitation is concerned, and deserves fairer treatment. The importance of Gender mainstreaming in IWRM is one of the points discussed in this chapter. It also takes into account the conflicting problem of competing uses of water, and the mechanisms to manage these unavoidable conflicts.

One of the concerns of our States and of the international community is to ensure a sustainable and equitable access to safe and adequate water for the populations. Similarly, food security is also an important challenge for the economic and social development of developing countries. The management DWSS services and of agricultural water is therefore

of great interest and requires its inclusion in Chapter VI of the manual. Emphasis is laid on the management methods of water supply services and the efficient management of water in agriculture.

Climate change and the natural variability of the distribution and presence of water further complicate the sustainability of our water resources. Awareness raising at this level is timely, for a better understanding of the phenomena and of their consequences on water resources. Chapter VII is devoted to this issue in its entirety, highlighting the adaptation measures and coping strategies needed to mitigate the impacts.

The final chapter VIII addresses the important issue of managing the project cycle. It focuses on the various phases of the project life cycle and the implementation techniques of the logical framework.

Each chapter ends with proposed references mainly available on the web. They allow users (facilitators, participants) to have a bibliography on the topics covered in the manual, to have more detailed elements on the issues, to deepen their knowledge on the issues raised. Similarly, exercises are proposed to the working groups during training sessions, and also aim at developing interactivity and exchanges between participants. Discussion questions are raised in some cases to encourage brainstorming sessions on practical concerns in the management of water resources. Some exercises, however, need to be adjusted / adapted to the context of the time, or to the place or nature of the targets.

CHAPTER I. Status of water resources in the world and in Africa

Educational Objectives

- understand the current issues around water resources
- have a more comprehensive view of the status and distribution of water resources
- understand the need to adopt an integrated approach in the management and development of water resources

1. Importance and issues around water resources

In most developing countries like those in Africa, access to water is linked to development. In fact water is the source of life in the broadest sense, since it allows developing production functions that underlie the development of populations. It is a limited resource necessary to life and ecological systems, and essential for economic and social development. People need water in quality and quantity to be healthy; they need water to sustain their economic activities, agriculture ... etc.

1.1 Multiple functions and dimensions of water

Water is the basis of any form of life, it is habitat, food, means of production, of transport and indirectly a market commodity. It builds a huge network of connections: it is intimately linked to natural resources (land, forests, biodiversity ...).

Different interest groups use it to meet their needs; water is international, national, regional and local, it occupies varied time and space scales. This complex network does not facilitate the establishment of appropriate management.

In addition water as a natural resource can be:

- **threatened** by a combined population growth and urbanization, which cause a greater demand for water and consequently the ecosystems, the producing and regenerating environment of the resource are threatened, polluted and destroyed;
- source of **competition and conflict;** as a matter of fact, when water resources are limited and that different interest groups express at the same time their needs of these resources, competing and conflicting reactions occur;
- **threatening**, when heavy and erratic rains cause floods, landslides, extended droughts, climate change, in a context where governments lack the capacity and financial resources to implement effective methods of preparation to the effects of disasters and their mitigation.

1.2 Water in economic and social development

Water is, in the one hand, essential to human, animal and plant life. For instance, it supports productive activities, agriculture, hydro-electricity, industry, fisheries, tourism, and transport. Water may, on the other hand, cause extreme devastation; it may be a carrier of

diseases and floods large areas. A lack of water or a prolonged drought may cause many casualties and a recession. Water can also cause or exacerbate conflicts between riparian communities of a local, national or transboundary basin.

Factors such as growth and demographic change, economic development and climate change clearly have a very significant impact on water resources. Similarly, water resources have a significant impact on production and economic growth, health and livelihoods and national security.

Economic growth, the efforts to reduce poverty and social and demographic changes increase the demands for water infrastructure to meet the needs in food or energy, the production of goods and services. Such developments have a significant impact on water resources. The construction of irrigation systems, hydroelectric dams, waterways and water supply systems for residents, tourism and industry have significantly improved the lives of millions of people, however, these developments have also profoundly changed the hydrological regimes, and aquatic ecosystems and the hydromorphology of most rivers, lakes and aquifers in the world.

1.3 Water in the preservation of environment

The way society uses and pollutes water, or impairs the Hydromorphology of rivers has changed the quantity and quality of water in ecosystems which, in addition to their intrinsic value, provide essential and valuable 'natural services' for the well-being of man. Many developing countries are facing a deterioration of freshwater resources, in terms of quantity and quality, and of aquatic ecosystems. This situation has resulted in a reduction of benefits and services provided by water resources, and increased risks and dangers associated with water.

The expansion of cities over the banks of rivers and lakes increases water pollution caused by discharges from households and industries. Agricultural progress is accompanied by greater use of fertilizers and pesticides by farmers, thereby increasing pollution. Biological and chemical pollution, the alteration of the flow of rivers and lakes as well as the decline of groundwater levels can have serious consequences. Rivers become too rich in nutrients, causing algal blooms and eutrophication. The destruction or degradation of ecosystems threatens many communities that depend on natural resources and causes a loss of biodiversity.

1.4 Current issues around water resources

All these problems are aggravated by the sectoral organization of institutions which is in contradiction with the multifunctional and multidimensional nature of water. It is therefore urgent to adapt new concepts and methods of management. The objective is to achieve a balance between water use as the basis for the livelihoods of a growing world population, and its protection and conservation to ensure the sustainability of its functions and features. In this context a number of issues deserve to be highlighted:

- Ensure water for people;
- Ensure water for food production;

- Cover water needs for other employment generating activities;
- Protect vital ecosystems;
- Manage the spatiotemporal variability of water;
- Manage risks.

2. The Water Cycle: Water Resources in the World

2.1 Water cycle and water distribution on the planet

Water cycle or hydrologic cycle (Figure I-1) is the set of paths that a particle of water can follow. These movements, with changes of state, can take place in the atmosphere, at the surface and underground. Water is found in its three forms (liquid, gaseous and solid) in the earth atmosphere. The importance of these changes makes of water the main transport agent of physical, chemical and biological elements.

Water cycle takes place through the Earth system that includes:

- the atmosphere: gaseous envelope above the earth,
- the hydrosphere: all water bodies at the surface of the earth,
- the lithosphere: rock cover covering the earth,
- the cryosphere: all ice caps on the surface of the earth,

The main natural components of this cycle are rainfalls, seepage into the soil, surface runoff, the inflow of groundwater into surface waters and oceans, and the evapotranspiration of surface water, soil and plants.

We distinguish "blue water" (water from rivers, lakes and aquifers), from "green water", which feeds the plants and crops and which is then released into the atmosphere. This distinction can help those responsible for their management to focus on areas crossed and fed by green, such as farms, forests and wetlands. It should be noted that these definitions are not unanimously accepted at the international level, and thus should be used with caution.

Knowing how water circulates in the environment can help us assess the quantity of water available in different regions of the world. The planet's water is naturally present in various forms in the atmosphere, on and under the surface of the earth and in oceans.

Fresh water constitutes only 2.5% of the global water and most is found in frozen form in glaciers and ice caps. In fact, about three quarters of the world's fresh water is frozen in ice caps and glaciers in the Arctic, Antarctica or Groenland. About 96% of fresh water in liquid form is stored in aquifers, and the small remaining part is at the surface and the atmosphere.

The river basins are a "natural unit" very useful for the management of water resources, although they often extend over more than one country. The drainage areas of international river basins cover about 45% of the Earth's surface (excluding polar regions).

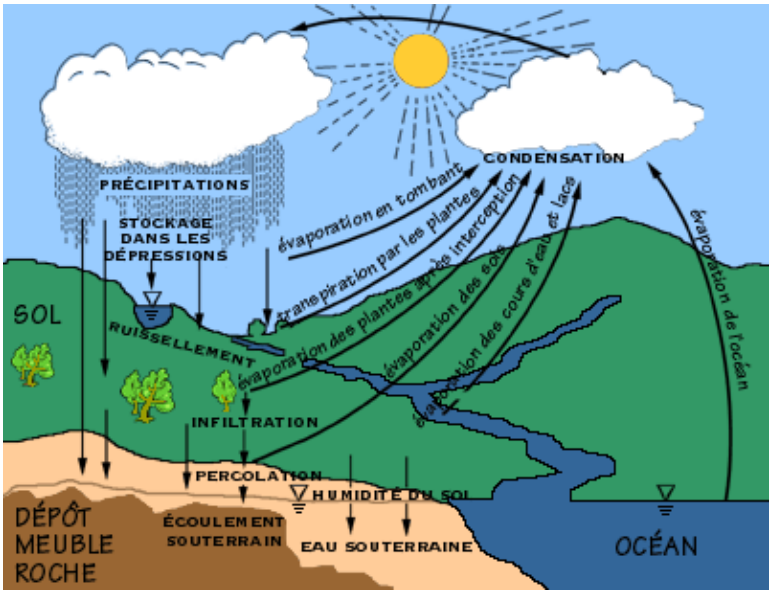


Figure 0-1: Water cycle

Among the biggest basins one can mention that of the Amazon, which provides 15% of all water flowing into the oceans, and that of the Congo, which carries one third of all the waters of African rivers. Wetlands, including swamps, bogs, marshes and lagoons, cover 6% of the land surface of the Earth and play a vital role in conserving water resources.

Box 1.2 Shortage assessments indices: It allows scientists to measure the degree of scarcity of a country. It also indicates that disparities in the distribution of water masses:
• Between 1,000 and 1,700 m^3/year/inhbt, a country may suffer locally or occasionally from water problems;
• 1,000m^3 / year / inhbt= poverty line. Between 1,000 and 500m^3 / year / inhbt: situation of relative scarcity;
• 500m^3 / year / inhbt= stress threshold; below 500m^3 / year / inhbt: absolute shortage-

2.2 Current status of water in the world

Access to safe water and adequate sanitation barely match the rate of population growth over the last decade: 1.1 billion people still lack access to clean water; a third of the world's population lacks access to safe drinking water and almost 2.5 billion lack adequate sanitation.

Water availability in the world (Table I-1) cannot overshadow the difficulties associated with the uneven distribution and problems of demand, pollution increase, and water use.

Water demand

It is estimated that over the next two decades, consumption of water per person will increase by 40% and that 17% of more water will be needed to produce food for people in developing countries. One third of countries located in arid regions would face serious water shortages during the current century. India, Central Asia, part of Eastern Europe and of United States

and Mexico are already experiencing serious difficulties. Between 1950 and 1990 the growth rate of water withdrawal was more than double than that of the population. It has been multiplied by six since the beginning of the century. Correspondingly, the amount of renewable fresh water available per capita shifted from 17,000 m^3 in 1950 to 7,500 m^3 in 1995 and is expected to fall to 5,100 m^3 in 2025.

Water pollution

The Commission on Sustainable Development of the United Nations reports that it is estimated that more than half the rivers in the world are seriously polluted and depleted. The proportion of available but polluted water is increasing, especially because of the changing modes of production in industry and agriculture, and of the increasing urbanization. In developed countries, some groundwater is polluted by chemicals. The situation is even more dramatic in developing countries.

Inefficient use of water

Water consumption rises between 2, 500 and 3, 000 km^3 per year across the world, which is much less than the quantity abstracted, now estimated between 4,000 and 5,000 km^3. To natural losses due to evaporation but that can be exacerbated by certain infrastructures (man-made reservoirs) as well as some irrigation schemes should, be added wastage and leakage: illegal connections can affect 40% of the network like in Latin America.

Agriculture currently consumes five times more than at the beginning of the century, against 18 for cities and 26 for industry. Regarding irrigation specifically, many developing countries spend twice more per hectare than the developed countries with ultimately yields being three times lower.

Table 0-1 : **Availability of fresh water - internal renewable water resources (LRSPs)**

Continent /Region	**Internal renewable water resources**		
	Volume per year (km^3 or 10^9 m^3)	**In % of world fresh water resources**	**Per Inhabitant in 2003 (m^3)**
World	43, 659	100.0	6, 900
Africa	3, 936	9.0	4, 600

Asia	11, 594	26.6	3, 000
Latin America	13, 477	30.9	26, 700
Caribbean	93	0.2	2, 400
Northern America	6, 253	14.3	19, 300
Oceania	1, 703	3.9	54, 800
Europe	6, 603	15.1	9, 100

Source : FAO. 2006 AQUATAT data base. http://www.fao.org/ag/aquatat

3- A new approach to water management

The perilous situation of the environment in general and of water resources in particular that may be regarded as a crisis led the international community to review its strategy of approach to the development of the resources.

3.1 The elements of the crisis

Water has always been considered as a gift of God, ever pure and infinite.

Is it **infinite?** No, because the volume of the Earth's renewable fresh water resource is constant. As the world population grows steadily, the average volume of fresh water per capita can only decrease.
Is it **ever pure?** Surely not, in spite of its sometimes apparent clarity: water is very fragile, it is easily polluted. These pollutants are of anthropogenic origin (illegal or tolerated, domestic, industrial and agricultural discharges) and natural (volcanic eruptions, the presence of arsenic, excessive rainfall ...).

Here are some reasons why many people think that the world is facing a looming water crisis:

Box 1.3: Reasons for concern:
• 50% of the world rivers and lakes are polluted.
• 50% of wetlands have disappeared during the last 100 years
• The freshwater biodiversity has declined by 50% during the past 30 years

- Water resources are under increasing pressure from population growth, economic activity and competition between different users;
- Water withdrawals have increased at a rate of two times faster than the population growth and currently one third of the world's population lives in countries experiencing water stress from medium to high;
- Pollution further increases water shortage by reducing the usefulness of water downstream;

- Weaknesses in water management, sectoral approaches to water management from top to bottom lead to an uncoordinated development and management of the resource.
- Increased development means greater impacts on environment.

These findings have resulted in:

- a shrinking and drying up of water resources
- a degradation of water quality, ecosystems and in biodiversity loss
- an increase of poverty and food insecurity
- A competing use and international tensions for water sharing
- etc ...

3.2 The ways forward or ways of recovery from the crisis

Concerns about the situation of water resources are real and technical solutions exist. However, the problems are primarily institutional and related to:

• Sectoral approaches to development of water resources in a context of centralization and bureaucracy with insufficient means of the administrations and of local authorities
• Lack of legal, regulatory and standardization frameworks to which must be added the non-involvement of all water stakeholders
• a poor knowledge of the resources, uses and pollution, with a deficit of basic training and capacity building of professionals, but also a lack of an education policy for the various types of audiences.

All these concerns added to those related to climate variability and climate change require improved management of water resources. This requires **an integrated approach** to water resources management, which objective is to:

• protect the resource and improve its knowledge
• plan the use of the resource, and practice a water saving policy;
• involve men and women equally, then prevent and manage conflicts over water use
• meet comprehensively the legitimate and rational demands (agriculture, electricity, domestic uses, transport, industry, recreation, aquaculture, fishing ...)
• preserve ecosystems and reduce risks (erosion, drought, floods).

Box 1.4: Functions and services of the ecosystems

- *production of products and goods (wood, fishing products ...)*
- *habitat of fauna and flora*
- *aesthetics and recreation*
- *environmental regulation*

The driving force that can lead to an effective implementation of this approach is the manifestation of a strong political will at the level of national and local institutions. It is essential to provide an education policy for various types of target population to empower individuals, promote changes in lifestyles, facilitate dialogue, facilitate participation, promote consultation, impose new rules of life, an ethic of water (protection, solidarity, sharing,

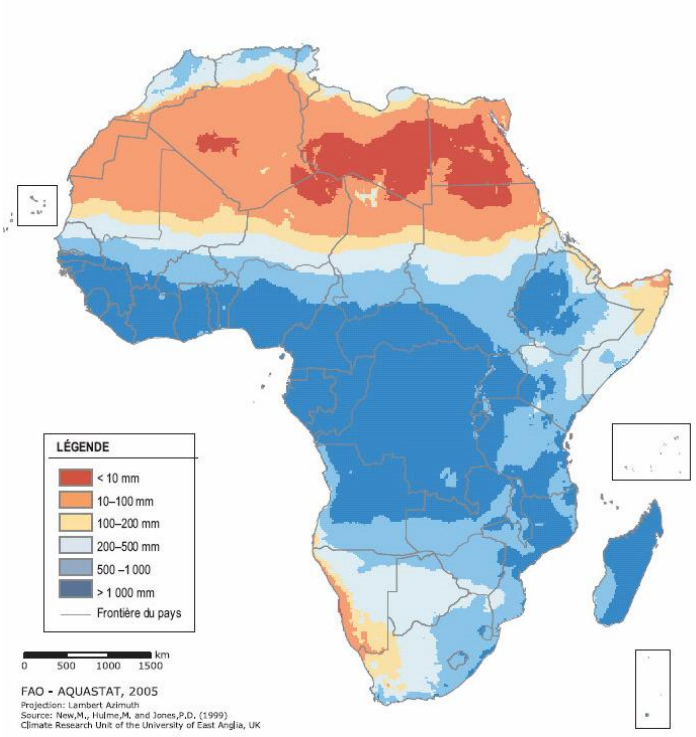
respect). It is equally important to define national policies with the necessary tools (tariffs, laws and application decrees, incentives, constraints, cost, financing, interdepartmental consultations, public education) based on social consultation.

4. Status of Water Resources in Africa

4.1 Overview of the hydro-climatic framework

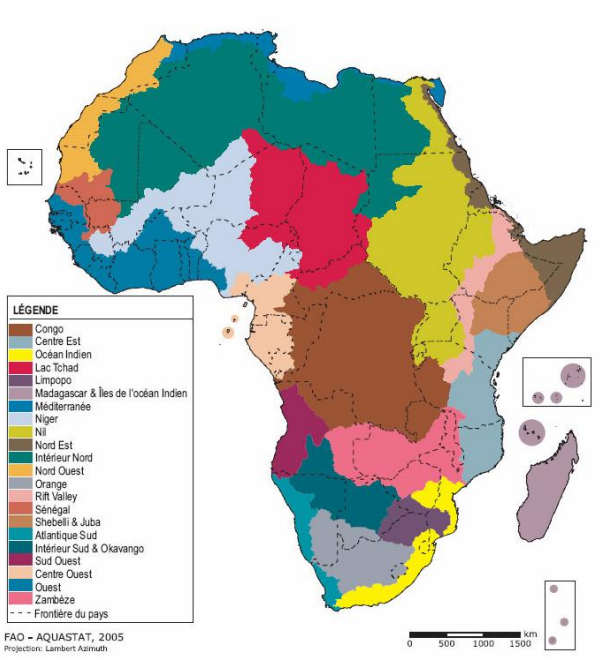
African countries can be grouped into regions with climate and geographical coherence: North Africa, Sudano-Sahelian region, Gulf of Guinea, Central Africa, East Africa, South Africa. However we can note a disparity and a latitudinal variation in rainfall which is illustrated in Figure I-2 of annual average rainfall. It varies from less than 200 mm / year in arid areas to 3,000 mm / year in wetter parts of the continent.

Climate variability observed in the majority of African countries leads to a significant change in flows. In 60 shared rivers in Africa (Figure I.3), it is imperative to provide solutions for the entire basin and to resolve upstream / downstream conflicts (in the case of a River). A basin approach allows understanding the hydrological system as a whole (Figure I.4). In other words, national policies and international agreements and regional agreements on transboundary waters can be applied in the basins.



Source: FAO – Aquastat
http://www.fao.org/nr/water/aquastat/regions/africa/Picturescontinentfra.pdf#fig6

Figure 0-2 : Average of annual rainfalls



Source : FAO Aquastat
http://www.fao.org/nr/water/aquastat/regions/africa/Picturescontinentfra.pdf#fig6

Figure 0-3 : Shared watershed in Africa

For reasons of convenience, the hydro-climatic framework will be described by region with a certain climatic and geographical coherence:

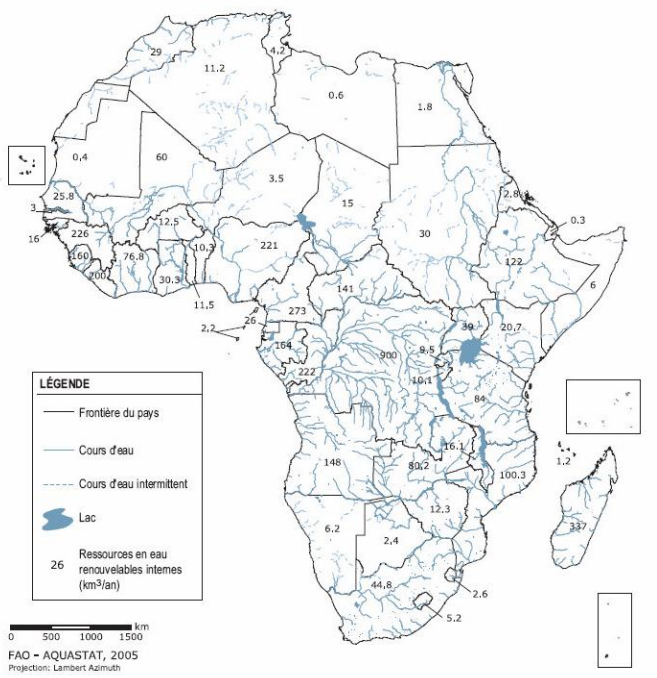
North African Zone: It is a region with a Mediterranean to arid climate with a rainy season that starts in autumn - spring and a dry season in summer. In North Africa there is a North-South climate zonation marked by a fragmented and sparse hydrologic network. Water resources are low and entirely internal. In Egypt the climate is dry everywhere and hydrography is reduced to a single river Nile which resources are almost entirely external.

That zone is the region in Africa with the poorest water resources, with less than 2% of total external resources (Table I.2). On the other hand, significant reserves of non-renewable groundwater are observed: Northern Sahara, Nubian Sandstone...

Sudano-Sahelian Zone: The North – South climatic zonation is very pronounced with an arid tropical climate. The rainy season is in summer and its duration increases from North to South. The hydrographical network is very dense and structured in large river basins which are all transboundary (Nile, Niger, Senegal ...).

The important endorheism of Chad Basin, of Niger and Nile inland deltas determine heavy flow losses. The inputs are external and generated by rivers: Senegal, Niger, Chari, and Nile.

That zone is a sub-region in Africa second in water scarcity, with a little more than 4% of total internal resources. But many sedimentary basins are present with important non-renewable groundwater resources (lowly assessed): Chad basin, Iullemeden basin, Senegalo-Mauritanian basin.



Source : FAO aquastat (http://www.fao.org/nr/water/aquastat/regions/africa/Picturescontinentfra.pdf#fig6)

Figure 0-4 : Africa hydrographic network

Gulf of Guinea Zone: In this area there is a tropical climate with a rainy season in summer. The hydrographic system is dense and rather fragmented, the main river basin is the Niger, shared with the Sudano-Sahelian zone and secondarily with "Central Africa" zone. Internal water resources are abundant; in fact they represent 24% of the total resources of Africa, to which must be added the contributions from the external basins of Niger and Volta. The portion of infiltration in the total flow is high (30-50%).

Central Africa Zone: It has a wet equatorial to tropical humid climate in the South, and prolonged rainy seasons. The hydrographic system is dense and concentrated, the most representative are the Congo and the Ogooue. The internal water resources are abundant and account for almost 50% of the total resources of Africa. The portion of groundwater in the total flow is rather important in this area that export water to neighbouring zones.

Southern Africa Zone: The climate is very diverse, from subtropical humid to arid with a rainy season in winter. Several major river basins are noted, they are all transboundary: Zambezi, Limpopo, Orange. There is, however an endorheism area, the Okavango located in Botswana. Water resources are modest (7% of Africa total resources), moreover, there

are significant external inputs from the Central Africa zone (Contributions to the Zambezi basin).

Eastern Africa Zone: The climate is varied, from tropical humid type to semi-arid with two rainy seasons: autumn and spring. The hydrographical network is sparse and fragmented. This is the area of the region of the Great Lakes which includes the largest lake in Africa (Victoria) and shares with the other zones of South Africa and Central Africa. Water resources are low (6-7% of total Africa resources) and are primarily internal. The zone provides the bulk of the Nile flow for the benefit of Sudan and Egypt.

Table I.2: internal renewable water resources in Africa

Region	Surface-area	Rainfall	Internal Renewable Resources			
	(1000 km^2)	(km^3/year)	(km^3/ year)	(mm/ year)	% of total	% of rain
North	5,753	411	50	8.7	1.2	12.2
Soudano-sahelian region	8,591	2,878	170	19.8	4.3	5.9
Gulf of Guinea	2,106	2,965	952	452.0	23.8	32.1
Centre	5,329	7,621	1946	365.2	48.8	25.5
East	2,916	2,364	259	88.8	6.5	11.0
Islands of Indian Ocean	591	1,005	340	575.3	8.5	33.8
South	4,739	2,967	274	57.8	6.9	9.2
Total	30,025	20,211	3,991	132.9	100.0	19.7

Source : FAO, AQUASTAT
http://www.fao.org/nr/water/aquastat/regions/africa/tablestextfra.pdf#tab4

4.2 Some river basins in Africa

Africa has several international rivers and has an extreme variation in rainfall, which presents real challenges for the management of water resources as well as real opportunities for mutual gains through collaborative management of shared water resources.

Collaborative management and development of international rivers in Africa offer very promising prospects for an increased sustainability and productivity of the continent's water resources, which are becoming increasingly rare, and for its precarious environment. In addition, the potential benefits of collaborative management of water resources can serve as

a catalyst for expanding regional cooperation, integration and economic development, even for conflict prevention.

Rivers and wetlands in Africa play important economic, social and environmental roles. They provide water for domestic, agriculture, livestock and beverage industry uses, and are largely used for transportation. The use of water resources for flood recession agriculture, livestock watering and wildlife and flora during long dry seasons and for fishing has long been a sustainable livelihood, with fresh water fish, which remains an important source of protein for people in Africa. Rivers in Africa are also fuelling environmental systems and promote biodiversity. With their wetlands they are important habitats for fauna and flora as well as for migratory birds.

Niger Basin

With a length of 4200 km, the Niger River with its tributaries drain a theoretical surface-area of approximately 2.1 million km². Approximately 1.5 million km² of active portion is allocated to member countries of the Niger Basin Authority: Guinea (6%), Côte d'Ivoire (1%), Mali (26%), Niger (23%), Burkina Faso (4%), Benin (2%), Cameroon (4%), Chad (1.0%) and Nigeria (33%).

Like the other basins of the West African sub-region, the Niger basin has generally been characterized by a rainfall deficit of 20-30% for more than thirty years. This deficit combined with the anthropogenic effects resulted in the following impacts: the reduction of surface runoff between 20% and 55% mainly at the expense of ecosystems, the appearing and / or worsening of certain environmental phenomena tending to be a threat to human existence such as:

- Pollution from various sources;
- (Water and Wind).Erosions

The socio-economic context of the basin is characterized by:

- A population of approximately 110 million inhabitants (in 2000) with an average annual growth rate of 3%;
- The Basin's hydropower potential is estimated at 30,000 GWh / year. The hydropower sites currently equipped produce 21% of the potential of the basin with 91% produced by Nigeria.
- Navigation: The course of the Niger River is navigable all year round on some sections.
- Livestock, fisheries, tourism, mining and industries are other potential areas likely to experience a greater development.

In the Niger basin, multifaceted uses of available water resources, the objectives and priorities of various users (public or private) are different and variable in time and space in a context of climate change with clearly visible effects on our environment. It is because of this situation and for the sake of an equitable sharing of the benefits related to water in the whole basin and for the strengthening of the cooperation between the countries that the

Heads of State and Government of the NBA, during their 7th Summit in February 2002 in Abuja (Nigeria), decided that a CLEAR and SHARED VISION should be developed.

In the case of Mali, the Niger River Basin Agency (ABFN) is the public management body entirely dedicated to the preservation of the Niger River. It was created in 2002, but its activities actually started in 2004. ABFN's primary mission is to ensure the protection of the Niger river as a vital entity in the country, to protect its banks and watersheds against erosion and siltation and to preserve land and aquatic ecosystems. The agency operates in four major subsectors of the Niger River: the Upper Niger, the inland delta, the loop of Niger and Bani tributary, through its regional offices. It also plays a role on the international level. The Niger flows across 9 countries in West Africa, and it is ABFN that represents Mali within the Niger Basin Authority (NBA), responsible for the cross-border coordination of the river management.

Senegal Basin

The Senegal River Basin covers an area of 300,000 km^2 distributed between Guinea 11%, Mali 53%, Mauritania 26% and Senegal 10%.

The basin of the river is fed by a hydraulic system consisting of the Senegal River and its major tributaries (Bafing, Bakoye and Falémé which originate from the Fouta Djallon Mountains in Guinea, and which provide over 80% of the River flow). Bafing alone contributes for nearly half of the mobilization of the Bakel flow. Major tributaries downstream of Bakel are: Gorgol and Gharfa Oued that account for about 3% of contributions.

The rural population within the catchment was estimated in 2001 to nearly 3.9 million. It should also be noted that 85% of the population live near the river and that the population growth rate is quite high because estimated at about 3.1%).

The area of the upper basin is primarily an agricultural region. But this is still subsistence and / or itinerant agriculture. As for the valley and delta area, it is characterized by the coexistence of traditional production systems (flood recession cropping, animal farming, and fishing) and modern agriculture (**irrigation**). Irrigated crops are grown on the two banks in Senegal and Mauritania.

Flood recession cropping (walo) is also practiced on both sides. It is practised on the floodplain when the water withdrawal permits. The cropped area for this activity represents approximately 44,000 ha on the left bank (Senegal) and 35,130 ha on the right bank (Mauritania). It still represents a substantial means of survival for the poorest populations in the river valley, who have no access to the practice of irrigated agriculture.

Despite drought, the basin is still an **animal farming area** by excellence. The animal farming method is based on the extensive type of internal and external transhumance. It seems that the number of animals (cattle and sheep) is about **8 millions**. The improvement of conditions for livestock development has contributed to increase the concentration of livestock in the basin with real threats of overgrazing, unless initiatives are taken to reverse the current trend.

Fishing activities in recent years have experienced some disruptions related to changes in the functioning of the river-sea ecosystem with the building of Manantali and Diama dams.

Indeed it is noted, first at the level of the fishery resources, the loss of sea-river species and the appearing of new freshwater species, secondly at the level of the valley, especially in the delta, some behavioural changes of people with fishermen and farmers becoming farmers in irrigated agriculture and finally around the Manantali reservoir (11.5 billion m^3), the creation of a new fishing area with the arrival of fishermen (mostly from Mali) from the Niger river delta which was until then the fishing zone by excellence in Mali.

At the headwaters of the Senegal River between Kayes region in Mali and Mamou region in Guinea, several sites having important **hydropower potential** have been identified. The OMVS has already built Manantali in Mali on one of these sites. In the next 2 years the dams (over water) of Félou and Gouina will be built still in Mali. Feasibility studies are underway for the construction of the Gourbassi dam on the Falémé in Mali while Bourreya and Balassa will be built very soon in Guinea to mark the definite return of this country into the OMVS family in early 2006.

OMVS which was created in 1972, following a drought cycle, had as an essential objective through its program to develop the Senegal River in regulating most of the hydrological inputs:

- to significantly improve the incomes and food security of riparian and neighbouring populations confronted with the continuing deterioration of weather conditions;
- to maintain the ecological balance in the sub region and particularly in the basin;
- to make the economies of the three states less vulnerable to weather conditions and external factors;
- to promote the economic development of member countries that should be backed by a political will for cooperation, for an integrated regional development.

Achieving this goal required the implementation of a regional infrastructure program and the integrated development of the three sectors which are irrigated agriculture, hydropower and navigation.

The Volta Basin

The Volta River is 1,850 km long and drains a watershed of 400,000 km2 nearly 20 million people live there. Six countries share the basin: Benin (3.4%), Burkina Faso (43%), Cote d'Ivoire (2.5%), Ghana (42%), Mali (3%), and Togo (6.4%).

The Volta has several original features. While the upper Niger, the Logone and Chari, for example, flow from south to north in humid tropical zones towards the edge of the Sahara, the Volta offers an opposite aspect: several lean formations appear in the Sahel below 1,000 mm annual rainfalls and flow after many detours towards the wetter south, where they swell and develop considerably.

The length of the river is over 1,850 km with a catchment area of 400,000 km^2 which discharges into the Atlantic Ocean. It covers almost the entire southern part of Burkina Faso and almost the entire northern part of Togo, and most of Ghana. Some smaller portions are found in the fringes of Benin, Côte d'Ivoire and Mali. The flow of the Volta becomes important only at the centre of Ghana in its lower reach after having received large contributions from its main tributary, the Oti. This is where the Akosombo dam created in 1964 with over 60

billion m^3 of usable reserves and a storage capacity of 148 billion m^3, stores more than one and a half times the module. The Volta Lake has become a pole of development of Ghana.

The 400,000 km² of the Volta basin are drained by a hydrographical system that develops around three main branches which are: the Mouhoun (Black Volta), then the Nakambe (White Volta) and its tributary the Nazinon (Red Volta). The main tributary of the Volta is the Oti, which flows from Togo and Benin.

4.3 Some large transboundary aquifers in Africa

Hydrogeological environments

Groundwater is stored in the spaces and fractures of rocks. Porosity measures the proportion of voids in the formation, the property of the reservoir to store or release groundwater. When the pores communicate among themselves they allow the movement of water particles. However all the voids are not occupied by the flow, that is why we talk of effective porosity, which measures the percentage of voids where gravitational water flows. Gravitational water is the fraction of groundwater discharged by the action of gravity; it is some water that can be mobilized.

When the pores and fractures are interconnected, we can say that the formation is permeable. The essential feature of a hydrogeological formation is the degree of permeability. The permeability is the ability of a reservoir to direct water flow in imposed hydrodynamic conditions. An aquifer has two main functions: storage and directing ability. The characteristics of the rock determine the storage capacity of the aquifer and its ability to direct the flow. Some formations have better hydrogeological characteristics (hydraulic conductivity, storage coefficient and transmissivity): gravel, sand....

The availability of groundwater resources depends on the geological nature of the aquifer. Discontinuous formations are related to fracture systems in the rocks. The hydraulic continuity of water is not ensured, so that the presence of water is more uncertain. Precambrian crystalline rocks (550 AD) include ancient igneous and metamorphic rocks. The upper part that has been altered (tropical countries) may contain significant groundwater. While the fractured base (unaltered) generally contains smaller quantities of water.

Africa's simplified hydrogeology

Most of it is dominated by igneous and metamorphic Precambrian rocks. They are often topped with sediment deposits dating from the Primary to Quaternary. In Sub-Saharan Africa there are four hydrogeological areas:

- The crystalline basement occupies 40% of land surface area; 220 million of persons (rural populations) live in areas where the underlying layers are crystalline basement.
- Volcanic rocks occupy 6% of the land, home to a rural population of 45 million, most of whom live in drought affected areas in the Horn of Africa.
- The consolidated sedimentary rocks occupy 32% of land with a rural population of 110 million. Major water resources are found in sandstone and limestone
- Unconsolidated sediments occupy 22% of land with a rural population of 60 million. The groundwater is contained in sand and gravel formations.

Large sedimentary basins are also present with very large water tables. Some are transboundary aquifers with important "invisible" resources for which collaborative management is as essential as in the case of transboundary rivers, which resources are attracting more public attention. In the northern part of the African continent, there are some major basins with vast groundwater resources.

Nubian sandstone aquifer: The sedimentary sequence ranges from Cambrian to Cretaceous. Its thickness exceeds 3,000 m in the Kufra Basin and in Northwest. It consists of continental formations in the South: sand, sandstone, clay, gradually rising to marine formations towards the North: limestone, sandstone and dolomite with intercalated clay.

Iullemeden aquifer system: It is mainly located in Niger and Mali, it extends in Nigeria across the Sokoto Basin. The main aquifers of this basin are: Continental interlayer / Continental Hamadien, Upper Marine Cretaceous and Paleocene, Continental Terminal)

Lake Chad aquifer system: Lake Chad Basin comprises a multilayer aquifer system consisting of the main following aquifer levels:

- the Plio-Quaternary covering nearly 350, 000 km2 and encompassing several layers located inside fluvial-lacustrine and alluvial sedimentary alternations
- Late Cretaceous with an area of about 300, 000 km2, containing a confined aquifer under a marnoschisteous cap within sands and sandstones of Senonian and Maastrichtian
- The Continental Terminal outcrop extending over nearly 300, 000 km^2 and containing a generalized groundwater located in clayey sands and which is tapped through wells and test drillings.

The aquifer system of the Senegal-Mauritanian basin: This is a shared aquifer system between Mauritania, Senegal, the Gambia and Guinea Bissau. It includes:

- The "maestrichtian sands" aquifer which is tapped only in Senegal with withdrawals concentrated near the region of Dakar. These withdrawals are relatively significant. Many other wells located throughout Senegal, also tap the aquifer.
- The Continental terminal is mainly tapped in Mauritania with important withdrawals at Idini to supply Nouakchott with drinking water.
- The Oligo-Miocene aquifer in the south of Senegal (a few boreholes and wells) and especially in Guinea-Bissau.
- The quaternary sands resources are mainly exploited in the northern coast of Senegal.

The coastal aquifer system of Guinea Gulf: It includes the Tano Basin, which extends from the town of Fresco in the West (Ivory Coast) to Axim (Ghana), and the Keta Basin, which starts from Keta city (Ghana), going through Togo, Benin, until the city of Lagos to the east (Nigeria). It is a highly vulnerable system because of the pressure exerted to fuel coastal cities like Cotonou, Lomé, and of the risks of pollution generated by these cities.

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Exercise : Importance and stakes of water resources

Purpose : to assess on the one hand the links between human activities and water resources, and on the other hand their consequences or impacts on the environment and/or on the socio-economic development.
Duration : 30 – 45 mn

Activities : in taking some examples from your respective countries, list in a table, the impacts of human activities (industry, agriculture, tourism, or other sectors) on (surface and groundwater) water resources: in urban area (group 1) and in rural area (group 2)

List the impacts of the exploitation of water resources on the preservation of land and aquatic ecosystems on the one hand, and on the socio-economic development on the other hand. Illustrate with some examples from your country.(group 3)

CHAPTER II. IWRM: Historical background, concepts, principles and management tools

Educational objectives:

- Understand the historical context, and the process of IWRM adoption at the international level
- Understand the guiding principles, the benefits, the challenges and the tools of IWRM

1. Background and history of IWRM

The situation of water resources in the world (Chapter 1) shows that during the years 1980-2000, water has become a political topic of priority concern at both national and international levels. It is especially noted that while in the 80s, the debate was focused on water and water sanitation in the context of public health, and access in developing countries, from the 90s it expanded dramatically to the management and usage policy, while integrating into a perspective of environmental protection and sustainable development.

These findings illustrate the need for a global policy regarding water. Indeed, it was necessary rethinking approaches that will permit to meet human beings water needs, while maintaining the quality of the natural systems that support the existence of human community. Thus a number of crucial issues are raised in international forums. These issues are:

- the Need for integrated management rather than management by sector;
- the Need for sustainable management of water resources: combining both the needs of man and those of nature;
- Moving away from centralized management model towards a greater involvement of communities.

In this context, some events are held at the international level to show the awareness of the international community about the need for a new approach to the environment and water resources.

1.1 The United Nations Conference on Environment in 1972 (Stockholm)

In 1972 an international conference was held from June 5 to 16 in Stockholm Sweden on the environment under the auspices of the United Nations. A declaration was adopted which stated the need for adopting common concepts and principles which will inspire and guide the efforts of the people worldwide to preserve and improve the environment.

It is subsequent to this conference that the need to create the United Nations Environment Programme **(UNEP**) emerged. Also, a global system of **continuous environment monitoring** called "Global Environment Monitoring System" (**GEMS**) was established in **1974**. Along with these initiatives, the World Health Organization (WHO), the United Nations

Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO) and the UNEP, put in place in **1976**, the GEMS / WATER, a multidisciplinary program in Science, which focuses on freshwater quality in the world. Its main activities include monitoring, assessment and capacity building. One of its objectives is to assess the impact of water pollution by certain dangerous and persistent substances. Thus more than 50 variables related to water are followed to gather information on water quality for both human consumption and for agricultural, commercial and industrial consumption.

1.2 The United Nations Conference on Water in 1977 (Mar del Plata)

The Conference of Mar del Plata in Argentina in 1977 launched the water issues and proposed the organization of an International Decade for Drinking Water and Sanitation (IDWSSD 1980-1990). In addition it recommended systematic assessment of water resources.

Following this in **1983**, the UN General Assembly welcomed the idea of establishing a special commission that would make available a report on the global environment and its problems in the 21st century. This report should contain proposals of strategies for sustainable development and the special commission will be later on named the "**World Commission on Environment and Development".**

In **1987** the Commission published the "**Brundtland Report**", named after its chairman, the Norwegian Prime Minister. The report also titled "Our Common Future", noted that the most serious environmental problems across the world are mainly due to the extreme poverty that prevails in the south and to the unsustainable consumption and production patterns applied in the north.

It shows the concept of **sustainable development (SD)** and defines it as: "development that meets the needs of present generations without compromising the ability of future generations to meet their own needs". Sustainable development, to which must be added "**good governance**", revolves around three major and inter-related pillars:

• The economy: establishing international cooperation with developing countries, fighting against poverty, changing patterns of production and of consumption, promoting fair trade between north and south, incorporating elements of sustainable development in the decision making processes.

• The environment: reducing pollution discharges, fighting against deforestation, desertification and drought, protecting the biodiversity, the forests and the mountains, promoting environmentally friendly agriculture and health, protecting ocean resources, the fisheries, and promoting renewable energy...

• Social issues: ensuring access to health and education, fighting against poverty and hunger, improving living conditions, fighting against the exploitation of children, strengthening social groups through unions, associations and NGOs (local populations, women, children, workers ...).

The Brundtland Report was the subject of debate in 1989 at the United Nations General Assembly which decided to convene a

Box 2.1: Good Governance

"Governance can be considered a the exercise of economic, political and administrative authority to manage the affairs of countries at all levels. Good governance is participatory, transparent and accountable. It is also effective and equitable.

It ensures that political, social and economic relations are based on broad consensus in society and that the voices of the poorest and most vulnerable are at the heart of decision making on the allocation of resources for development."

Source : UNDP

conference on Environment and Development.

1.3 The Dublin Conference in 1992

The concept of sustainable development, as defined by the Brundtland report requires, regarding water resources, that water be managed as an asset, by integrating in all water uses the concept of **solidarity with future generations**. It also recommended taking into account the ecosystem management and the entire living world around, while reinforcing the component “development of the land” in which natural resources and all water in priority would be taken into account. It stressed the need to adopt a prospective approach of the resource before the curative approach to water pollution is taken.

A Global Consultation on Water Supply and Sanitation held in New Delhi in 1990 agreed on the need to implement a safe water supply combined with an adequate means of waste disposal, actions which should be the focus of the **integrated water resources management.**

Four guidelines were identified on this program:

- Protecting the environment and the health through integrated water resources management and the management of solid and liquid wastes;
- Reforming institutions to promote an integrated approach through a change in attitudes and behaviours, and ensuring the full participation of women at all levels of the sectoral institutions;
- Encouraging the management of water services by local communities thanks to measures meant to help local institutions implement sustainable programs of drinking water supply and sanitation;
- Adopting sound financial practices through better management of existing assets and a widespread use of appropriate technology.

It is in this context that the **Conference on Water and Environment** was held in **1992** (January 26 to 31) in Dublin (Ireland)**.** The participants in this conference demanded that the evaluation, the development and the management of water resources be viewed in an entirely drastic new perspective. This would not be possible without the commitment of all political leaders, from the highest state authorities to the smaller communities. This commitment must be shown through significant investments, sensitization campaigns, legislative and institutional changes, together with capacity building. This can be achieved if we first recognize the interdependence of all people and their place in the natural world: **this gives birth to the concept of the integrated water resources management.**

This conference which is a prelude to the summit on "Planet Earth", adopted a declaration called **"Dublin Statement on Water in the perspective of sustainable development"**. It adopted four (04) guiding principles and an action program, formally defining the principles of the Integrated Water Resources Management (IWRM), and proposing the creation of a World Council of Water.

1.4 The Earth Summit in Rio de Janeiro in 1992

From June 3 to 14 in Rio de Janeiro (Brazil) took place the United Nations Conference on Environment and Development, called the **"Earth Summit".** 173 Heads of State and of

Governments decided to intervene to ensure a sustainable development for the planet. Following this conference, the 173 heads of state and of government adopted five texts:

- The Rio Declaration on Environment and Development, consisting of 27 principles that define the rights and responsibilities of all states regarding the matter;
- The Convention on Climate Change;
- The Convention on Biodiversity;
- The declaration of principles pertaining to forests;
- Agenda 21 (Action 21) is a detailed global action plan in all areas of sustainable development, and in which 38 major themes have been identified.

It was noted at that time that there was no single international institution dealing exclusively with problems related to water resources, although all international organizations should worry about it. Yet, the strengthening of the cooperation, the coordination and integration of sectoral activities with regards to their impact on water, are imperative for a more effective action. Thus this period was marked by the launch of two positive multi-stakeholder dynamics:

World Water Council: The idea of establishing a World Water Council has been first suggested in 1992, during the UN Conference on Environment and Development in Dublin (Ireland) and during the Earth Summit in Rio de Janeiro (Brazil).

The World Water Council is a multilateral platform created in 1996 at the initiative of international organizations and experts from the sectors of water. It aims to raise the awareness of policy makers and to promote solutions for sustainable management of this scarce resource. In terms of activities undertaken, we may in particular, mention the following: the World forum in Marrakech (1997), the Paris Conference (1998), the 2nd World forum in The Hague (2000), the Bonn Conference (December 2001) which contributed to the preparation of Rio + 10 (September 2002) in the water sector, the 3rd World forum in Kyoto (2003), the 4th forum in Mexico (2006), the 5th forum in Istanbul (2009) and the one to be held in Marseille in 2012.

Global Water Partnership (GWP): Created in 1996 by the World Bank, the UNDP, the UN-AIDS, the Swedish International Cooperation Agency, the Global Water Partnership is a partnership between all entities involved in the management of Water (states, governmental agencies, governments, educational institutions, research institutions, public and private enterprises, civil society including NGOs, international and professional organizations and bilateral and multilateral development agencies). Its mission is to support countries in the sustainable management of water resources, in helping develop programs, meet needs, mobilize the skills, establish appropriate alliances and foster information sharing on **integrated water resources management.**

Box 2.2: The Rio Declaration

• States have "the sovereign right to exploit their own resources," according to their environment and development policy, without causing damage to the environment of other States or areas beyond the limits of their jurisdiction;

• It is "indispensable" for sustainable development to eradicate poverty and reduce differences in living standards in the world;

• Full participation of women is essential to achieve sustainable development;

• States should reduce and eliminate patterns of production and of consumption and promote appropriate demographic policies;

• " it is the polluter who should bear in principle the cost of pollution"

• States should discourage or prevent the trans-boundary movement of activities and substances which are harmful to human health or to the environment;

• The lack of full scientific certainty should not be an excuse for postponing the adoption of urgent measures for preventing environmental degradation.

***Agenda 21**:*

***Agenda 21 is an international agenda for the 21st century**. It sets out guidelines for sustainable development that focuses primarily on:*

• The fight against poverty and social exclusion,

• The production of durable goods and services,

• The protection of the environment.

Chapter 18 deals with the protection of freshwater resources and of its quality by integrating approaches regarding their development, their management and their use. The document is built from observations about the situation of water resources, their role in the ecosystems, and the impacts of climate change. Then, it listed the areas of activities to be undertaken, the guiding policies, and also the timeline objectives assigned to governments, for example:

• before 2000, to have designed and initiated action plans with costs and targets. To have set up institutional structures and sound legal instruments;

• before 2025: having reached the objectives of the sub-sectoral program for all activities related to freshwater

2. IWRM guiding principles

The Dublin Conference in 1992 adopted a declaration called "Dublin Statement on Water in the perspective of sustainable development. This statement adopts four (04) guiding principles and a program of action. The Dublin Principles are recognized internationally and are the basis for discussions regarding the management of water resources.

Principle 1*: Water is a finite and vulnerable resource that is essential to life, to development and to environment.*

The idea that freshwater is a finite resource comes out when the hydrologic cycle produces an average amount of fixed water per time interval. The total quantity may not yet be significantly altered by human actions, although it may be, and is often exhausted by human pollution. The freshwater resources are an asset that must be maintained to ensure that the services it provides are sustainable.

This principle recognizes that water is necessary for some purposes, some functions and some various services. Its management must consequently be holistic (integrated) with the taking into account of the requests for this resource and the threats it faces. It also recognizes the catchment area or the river basin as the logical unit for management of water resources. The integrated approach to managing water resources makes it necessary to coordinate the range of human activities that create demands for water, while determining land uses and generating waste products related to water.

Principle 2: *The development and management of water must be participatory in involving users, planners and policy makers at all levels;*

Water is a subject in which everyone is involved. True participation takes place only when stakeholders are part of the process of decision making. The type of participation will depend on the spatial scale decisions on specific management and investment. It will be especially affected by the nature of the political environment in which these decisions take place. The participatory approach is the best way to achieve a consensus and a common and lasting agreement. The participation concerns the taking of responsibility, the identification of the effect of sectoral activities on other water users and on the aquatic ecosystems and the acceptance of the need for change so as to improve the efficient use of water while allowing the sustainable development of the resource.

To this end, policymakers, as well as the rest of the population, must be well- aware of the importance of water resources. Decisions are taken at the lowest appropriate level in accordance with public opinion and involve users in planning and implementing water related projects. Participation does not always lead to consensus, the process of arbitration or other dispute resolution mechanisms should be established.

Similarly, the decentralization of decision making at the lowest appropriate level is a strategy for greater participation. Thus, governments should help create the opportunity and ability to participate, particularly among women and other marginalized social groups. We must also recognize that a mere creation of participatory opportunities will mean nothing for those presently disadvantaged groups, unless their ability to participate is enhanced.

Principle 3: *Women play a key role in the provision, management and preservation of water*

The institutional arrangements on the development and management of water resources rarely consider the role of women users and custodians of the biotope. It is widely acknowledged that women play a major role in the collection and preservation of water for domestic and (in many cases) agricultural use, but they have a much less influential role than men in managing, and analyzing problems and making decisions related to water resources. The adoption and application of this principle requires that we look to the particular needs of women and give them the means and authority to participate at all levels in programs conducted regarding water, including decision-making and implementation, in the manner they would define.

IWRM requires Gender awareness (Chapter V). In developing the full and effective participation of women at all levels of decision making one must take into account how the

various societies share social, economic, and cultural roles among men and women. There is a significant synergy between gender equity and sustainable management of water. Engaging men and women in influential roles at all levels of water management can accelerate the achievement of this sustainability. The water management in an integrated and sustainable way can contribute significantly to gender equity in improving the access of women and men to water and water -related services for the satisfaction of their basic needs.

Principle 4: *Water is used for multiple purposes and it has an economic value and must therefore be recognized as an economic good.*

In principle, it is essential to recognize first the basic right of all human beings to have access to safe water and sanitation at an affordable price. Managing water as an economic good is an important way to achieve social goals such as equitable and efficient use and encourage conservation and protection of water resources. Water has both the value of an economic good as well as a social good. Many past failures in the management of water resources were due to the fact that the full value of water had not been recognized, leading to a waste of the resource and to its exploitation in the defiance of the environment .

Treating water as an economic good and managing it accordingly opens the way to an efficient and equitable allocation of this resource, as well as its preservation and protection. This principle does not ignore the social dimension of water i.e. the fundamental right of man to safe water and sanitation at an affordable price.

Value and price, two concepts which should not be confused: Concerns have been expressed about the social implications of the concept of 'economic good': Treating water as an economic commodity would undermine its access to the neediest people. The Dublin Declaration recognizes the economic importance of water, while Chapter 18 of its Agenda considers water as an economic and social good. To avoid confusion, we must make the distinction between value and price of water.

The total value of water is its use value (or economic value) added to its intrinsic value (Figure II 1).

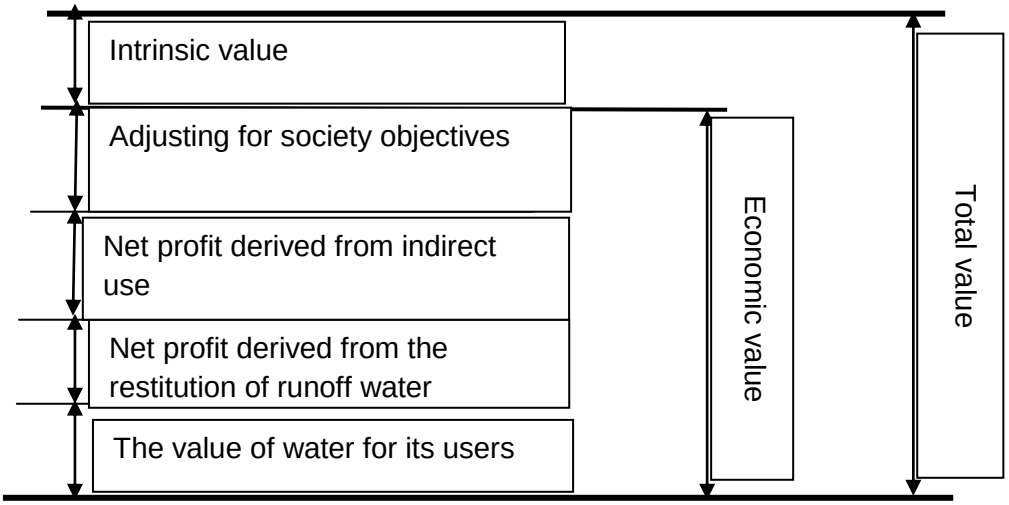

Figure II 1: Value of water

The price of water (Figure II.2) is an economic instrument (Chapter IV) that guides behaviour towards the preservation and rational use of water, promotes demand-based management,

ensures cost recovery, and shows whether consumers are willing to pay for additional investments.

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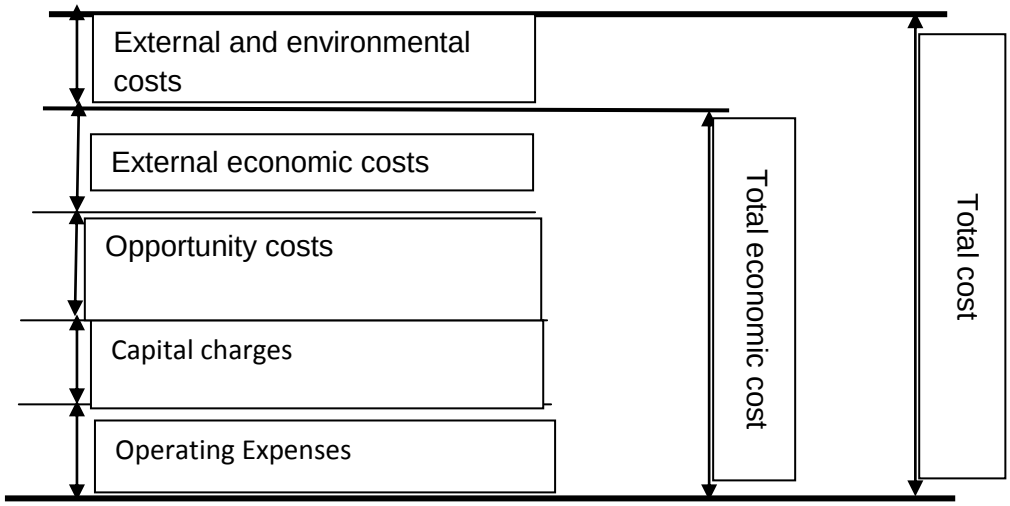

Figure 0-2 : The cost of water

The opportunity cost of an action or an economic decision is the measure of the economic value of each of the other actions or decisions one refuses to do. When you need to arbitrate and make choices, the most rational decision is the one which opportunity cost (subjectively assessed) is the lowest one. The opportunity cost of an action A over action B is the loss of income suffered by A rather than B, it designates a shortfall.

Box 2.3: Definitions of IWRM

Global Water Partnership (2000) *"The IWRM is a process which encourages the development and coordinated management of water, land and of related resources so as to fairly maximize the resulting economic and social wellbeing in an equitable way without compromising the sustainability of vital ecosystems (GWP)"*

Hofwegen and Jaspers, 1999 "*The IWRM is a process of allocation of functions to water systems, it must establish standards, regarding the implementation (monitoring) and management. It includes data collection, analysis of physical and socio-economic consideration of different interests and making decisions regarding the availability, use and development of water resources".*

Calder, 1999 « *The IWRM is a tool for planning and coordinating the management of land, of water and of other natural resources for their equitable efficient and sustainable use*"

CE, 1998 « *The IWRM expresses the idea that water resources should be managed in a holistic way, while coordinating and integrating all aspects and functions of water sampling, of water monitoring and of the provision of services related to water, in a way that those who depend on these resources benefit sustainably and equitably from them".*

RIOB (workshop of March 2000)

The IWRM is "a tool for sustainable use of water to meet the different needs, and which permits to:

- *Fight against natural disasters and risks of erosion, flooding or drought, taking into account water and space management;*
- *Reliably meet the needs of urban and rural communities regarding quality drinking water so as to improve hygiene and health, and prevent major epidemics;*
- *Ensure food sufficiency through the sanitation of farming land and irrigation;*
- *Develop harmoniously industry, energy production, the practice of leisure and of transport by water;*
- *Prevent and fight pollution from all sources and all kinds, so as to preserve aquatic ecosystems, in particular to protect wildlife and maximize fish production for food, to meet the needs of various uses and more generally to preserve the biodiversity of the aquatic environments."*

3. The benefits of IWRM

3.1 The objectives of IWRM

The main objective of IWRM is to achieve a balance between on the one hand the use of water as a foundation for the subsistence of a growing global population, and secondly its protection and conservation so as to ensure the sustainability of its functions and features. Under Chapter 18 of Agenda 21 it about:

- Promoting a dynamic, interactive, iterative and multi-sectoral approach to water resources management;
- Planning the use, protection, conservation and sustainable management and rational utilization of water resources based on the needs and priorities of communities, within the framework of the national economic development policies;
- Developing, implementing and evaluating projects and programs that are both socially appropriate and economically viable in the context of clearly defined strategies, based on full public participation;
- Defining, strengthening or establishing or, as appropriate, institutional, legal and financial mechanisms, particularly in developing countries which will ensure that water policy and its implementation are catalyst for social progress and sustainable economic growth.

The World Water Council (WWC) set three major objectives as regards the integrated water resources management:

- Empowering women, men and communities to decide at their level how to obtain safe water and hygienic living conditions, and choose the type of suitable economic activities which require the use of water and organizing to achieve it;
- Producing more food, developing sustainable livelihoods per unit of water used, (increasing agricultural yield and jobs obtained per drop of water used) and ensuring that all people can get the food they need to live a healthy and productive life;
- Managing the use of water so as to keep the number and quality of earth and fresh water ecosystems which are useful to both human beings and the other living organisms.

To achieve these objectives, the World Water vision provides five key levers:

- Involvement of all stakeholders in the integrated management.
- Establishment of pricing for all water services based on the total costs.

- Increasing public funding for research and innovation in the interest of the community
- Recognizing the need to cooperate in the Integrated Water Resources Management as far as the international river basins are concerned
- Massively increasing investments in water (WEC, 2000, p. 2 and 3)

Integrated management means that all the various uses of water resources are considered together. The functions and decisions of water management take into account the effects of each use on all the others. They are able to take into account the overall economic and social objectives, including the achievement of sustainable development.

Also, the political decision-making logic is related to all sectors: the basic concept of IWRM has been expanded to incorporate participatory decision-making. Different users groups (farmers, communities, environmentalists ...) can influence the management strategies and development of water resources. This brings additional benefits, as knowledgeable users apply a local self-advised regulation in relation to issues such as water conservation and watershed protection much more efficiently than centralized regulation and supervision can achieve.

3.2 The impacts of water use:

Most uses of water provides benefits to the society but they also have negative impacts (Table II 1) which may worsen because of inadequate management procedures, the lack of regulation or the lack of motivation caused by the systems of water governance in place.

Each country has its development goals and economic priorities set in line with the realities of the environmental, the social and political contexts. Problems and constraints are arising in each area of water use, but the willingness and ability to address these issues in a coordinated manner is that of the department in charge of the governance of water. The identification of the interdependent nature of the various sources of water and, therefore, the interdependent nature of the various impacts and water use is an important step towards the introduction of an IWRM.

Table II 1: Impacts of the sectors of water use on the water resources

	Positive Impacts	**Negative Impacts**
Environment	▪ Purification ▪ Storage ▪ Hydrological Cycle	
Agriculture	back tides - Increased seepage - reduced erosion - groundwater recharge - Nutritional	▪ Depletion ▪ Pollution ▪ Salinization ▪ Water exploitation erosion

	Re-use	
Water supply and sanitation	Nutritional re-use	High level of water security required Pollution of surface and ground water

3.3 The environmental benefits of IWRM

- Ecosystems can benefit from the application of the integrated approach to water management to have a say regarding the environmental needs in the debate on the allocation of water. At present, these needs do not always appear in the negotiation table.

- IWRM can help the industry by educating the other users about the needs of the ecosystems and the benefits these ecosystems generate for them. Often these people are underestimated and are not incorporated in planning and decision making.

- The ecosystem approach provides a new framework for IWRM to focus more attention on a system- approach to water management: - protection of upper basins (e.g., reforestation, animal husbandry, and the soil erosion control), the fight against pollution (e.g., the reduction of pollution sources, and motivating in the absence of sources of pollution, protecting the aquifer) and environmental flows. It offers an alternative solution to the prospect of inter-sectoral competition which can involve stakeholders in the development of a new shared vision and joint action.

3.4 The agricultural benefits of IWRM

As a single user of water and the main polluter of the main resource of groundwater resources and surface water, agriculture has a poor image. Added to the poor performance in terms of agricultural production, this means that frequently, especially when there is water scarcity, water is diverted from agriculture towards other uses. However, an indiscriminate reduction in the allocation of water for agriculture could have unthinkable economic and social consequences. With IWRM, planners are encouraged to go beyond the economic sector and take into account the consequences of the decisions pertaining to water management on employments, environment, and social equity.

By bringing together all stakeholders and all sectors in the decision making process, IWRM may reflect the combined "value" of water to the society on the whole when time comes to make difficult decisions on water allocation. This may mean that the contribution to food production, to health, to poverty reduction and gender equity, for example, could exceed the stringent economic comparisons of rates of return on each cubic meter of water. Also, IWRM can put in equation the potential for re-use of waste water from irrigation and from other

sectors and the impact of agricultural re-use of municipal and industrial wastewater.

IWRM calls for an integrated planning so as to use the land, the water and other resources in a sustainable manner. For the agricultural sector, IWRM aims to increase water productivity (i.e. more crop per drop) in the constraints imposed by the economic and social development of a given region or country.

3.5 The benefits of DWSS in IWRM

A properly applied IWRM will result in a guaranteed water security for the world's poor and un-served communities. The implementation of IWRM-based policies should mean greater security of domestic water supplies, as well as a reduction in the treatment costs when pollution is addressed more effectively.

The recognition of the people's rights, particularly those of the women and the poor, to a fair sharing of water resources for both production and domestic use at the household level, leads inevitably to the need to ensure proper representation of these groups in the agencies involved in the allocation of water resources.

Focusing on the integrated management and efficient use should be a stimulus for the sector, as it will incite to a re-use, a recycling and a reduction of the waste. High pollution taxes reinforced by a rigid enforcement have yielded significant improvements in efficiencies of industrial use of water in the developed countries with benefits on domestic water supplies and the environment

The past sanitation mechanisms often focused on the elimination of waste problems in areas occupied by human beings, then keeping clean and healthy human living environment, while simply moving the waste problem with its catastrophic environmental effects elsewhere. The introduction of IWRM will improve the timely introduction of sustainable sanitation solutions meant to minimize the sources of waste production, and the reduction of the direct effects of waste. It also solved the sanitation problems as closest as possible to its source.

Almost at a local level, the integration of improved management of water resources could lead to significantly reduced costs in the provision of domestic water service, if for example more irrigation works were designed with a component of domestic water involved clearly from the beginning.

Box 2.4: A few points of reflections derived from IWRM principles

• The premise of Integrated Water Resources Management (IWRM) is that the various uses of water resources are interdependent;

• Integrated means that all the various uses of water resources are considered together. The functions and decisions on water management takes into account the effects of each use on the others;

• Different users- groups (farmers, communities, environmentalists ...) can influence the management strategies and development of water resources;

• The management is understood in its most "primary" definition. It stresses that we must not only focus on the exploitation of water resources, but rather carefully manage the exploitation of water reserves, so as to ensure long term sustained and (continuous use) for future generations;

• IWRM is a systematic approach to sustainable exploitation, allocation and monitoring of the use of water resources based on the social, the economic and the environmental objectives. It is opposed to the current sectoral approach used in many countries.

4. Current issues around IWRM

4.1 Securing water for people and production activities

Although the human beings' basic needs in water are of top priority for most countries, one fifth of the world's population is deprived of drinking water and half do not have decent sanitation. This lack of services primarily affects the poorest populations in developing countries, where water supply and sanitation in urban and rural areas will be the most alarming challenges for the years to come.

According to demographic projections, the world will feed 2 to 3 billion people over the next quarter of century. But increasingly, water is considered a major constraint for food production, combined with the shortage of arable land. Irrigated agriculture already represents over 70% of total water abstractions (that is over 90% of the absolute consumption).

The need for irrigated agriculture and those of human beings and the ecosystems will certainly cause serious conflicts. The difficulties will even worsen as countries suffering from water shortages will strive to reach food self-sufficiency, rather than targeting food security through trade. As a matter of fact, when importing food, countries may import water from regions that are better off (the concept of "virtual water").

All human activities result in water consumption and waste production. But some consume more water and produce more waste per job than others. It is therefore necessary to take this into account when developing strategies for economic development, particularly in regions experiencing water shortage.

4.2 Protecting vital ecosystems

Terrestrial ecosystems from the upstream river basins play important roles regarding the infiltration of rain water, the recharge of groundwater and the flows in rivers. In turn, aquatic ecosystems generate a range of economic benefits, thanks to products such as lumber, firewood and medicinal plants. They also contain specific habitats of flora and fauna, as well as spawning grounds. These ecosystems are dependent on the flow, the seasonal patterns of the rivers and the fluctuation of the groundwater. Whether terrestrial and aquatic, ecosystems are intrinsically determined by the quality of the water.

As regards the development and management of land and water, decisions should ensure the preservation of these vital ecosystems and take into account the possible negative impact on other natural resources, or even neutralize them if necessary.

Box 2.5: Ecological Flow or compensation water of a river

Low-flow (minimum) required to maintain an acceptable level, fish habitats where there is human intervention. The environmental flow is to simulate and predict aquatic biological responses in situations of altered flow in a river considerably modified.

Guidelines:

- *No net loss of fish habitat or productivity of receiving waters;*
- *Maintenance of the free movement of fish in rivers;*
- *Contribution to protection of biodiversity in aquatic ecosystems.*

4.3 Managing spatio-temporal variability and risks

Almost all the usable fresh water for human usage purposes is from rainfalls. But they vary considerably in time and space. Most tropical and subtropical regions are characterized by significant seasonal and annual variations in rainfall, often aggravated by short-term irregular variations. This variability is reflected by an increase in demand for the development of infrastructure and the increased need to manage demands and water supply. It is clear that to cope with this variability the task is even more acute for the poorest countries, who have limited financial and human resources. In addition, the climate change currently faced by our planet could aggravate the situation.

Changes in river flows and groundwater recharge, due either to weather or to a poor land management can exacerbate droughts and floods. These events are likely to have catastrophic consequences causing heavy human beings' deaths and economic, social and ecological damage. Water pollution shows another set of risks in affecting human health, the economic development and the functions of various ecosystems. Other risks to consider regarding the management and development of water resources, the economic risks are far from being negligible considering the type of large-scale and long term investment needed.

Finally, political instability and changes of government are also important risk factors. So far, there has not been any concern regarding the systematic evaluation of the costs and benefits of risk mitigation for all water users or the comparative evaluation with other options.

4.4 Raising public awareness and stimulating the political will

There is the need to sensitize public opinion so as to mobilize effective support for a sustainable management of water resources and encourage changes in behaviour while generating actions necessary to support the idea. In addition, the awareness raising of public opinion and the calls for actions deriving from it may be essential to stimulate the political will to act. The historical development of the ecological movement called «Greens" shows how awareness of public opinion and pressure groups have led to the birth of a commitment and political will to act.

In these times of scarce resources, whether they are financial or natural, both attention and political commitment are essential to ensure sound decision making and make the necessary investments in the development and management of water. We have no choice but to bring the water issue at the forefront of the political agenda if we are to ensure a successful long-term sustainable management of water resources.

In the management of water resources, the traditional approach, which was both sectoral and frequently fragmented, pushed the governing body to represent conflicting interests. Too

often, policy objectives have been defined without taking into account their implications for other water users and without consultation beyond sectoral and institutional boundaries. Accordingly, financial resources and physical resources (including water) have not been used to improve the welfare of the society as a whole. It is necessary to identify appropriate ways to coordinate the development, the planning and the implementation of policies in an integrated manner, and beyond the sectoral, institutional and professional, boundaries, while taking into account the more complex problems of how to coordinate the management of rivers crossing several countries.

5. The implementation of IWRM

5.1 The enabling policy and legal framework

The implementation of IWRM calls for changes (Table II 2) which require political support and which can be a challenge, since we must make difficult decisions. This requires an approach based on the Dublin principles and building on its three fundamental elements such as: the economic efficiency, the environmental sustainability and the social equity (Figure II-3). In this connection, one needs to focus the required changes on the following three areas of action:

- An enabling environment that includes water policy, legislation and regulation;
- A definition of institutional roles;
- An introduction of management tools

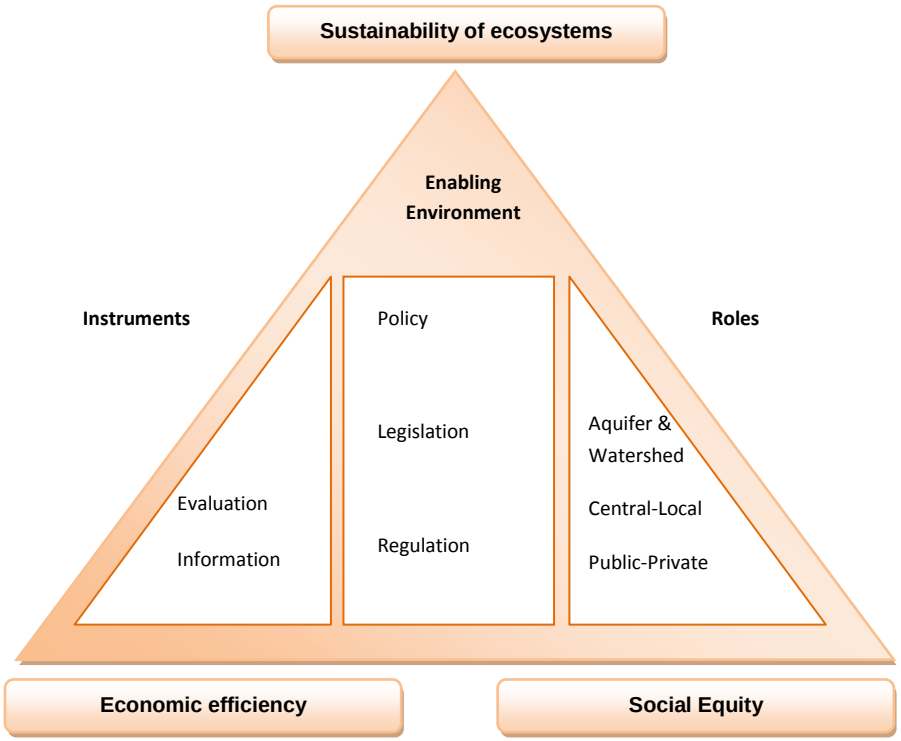

Figure II-3: IWRM implementation Triangle

The political authorities must set targets for the use, the protection and the conservation of water. The process of updating the water policy is a major step, which requires extensive consultation and requires a political commitment. They should also set rules to follow in the implementation of the policies so as to meet the objectives. For example, the law on water changes the policy into a law and therefore, should:

- Clarify the rights and responsibilities of water users and suppliers
- Clarify the roles of the state in relation with the other stakeholders;
- Formalize the transfer of water allocations;
- Provide legal status to the institutions of water management from the government and from groups of water users;
- Ensure a sustainable use of the resource
- Promote the creation of financing structures and offer incentives permitting to provide financial resources which meet population's need of water.

5.2 The institutional framework

It defines the roles, in creating an organizational framework, which includes the formal and the functional aspects while strengthening institutional capacity jointly with the development of human resources. To this end, institutional arrangements are necessary to enable:

- The operation of a consortium of stakeholders involved in decision-making with representation from all sections of society, and a good gender-balance,
- The management of water resources based on the hydrological boundaries (watershed, aquifer) but not the administrative ones;
- The establishment of organizational structures at basins and sub basins level so that decisions would be taken at the lowest appropriate level;
- The coordination by the government of the national management of water resources through the sectors in which water is used. Moreover, they must facilitate, regulate and encourage the private sector to support in the financing and the provision of water services, Irrigation ...).

5.3 The management tools:

The political and legislative frameworks sets the "rules of the game" while the institutional framework identifies the "stakeholders" and defines their respective roles. As for the management tools, they represent the "stakeholders" with their skills and expertise necessary for a quality game, which will be both effective and in harmony with the social and economic context. The main objectives of these management tools are to put in place:

- A service of evaluation and monitoring of water resources to understand the availability and the needs;
- IWRM plans by combining development options, the use of resources and human interaction;
- A mechanism of demand management which allows regulation and water allocation so that it will be used more efficiently by setting limits in the distribution and use of water;
- Instruments of social change to promote a civil society turned toward water and

conflict resolution mechanisms to handle disputes by ensuring the sharing of water.
• Economic instruments in order to use the value and price of water efficiently and with equity. Information management mechanisms must be set up to improve knowledge for better water management.

Table II 2: Main areas of change prior to the implementation of an IWRM

Areas of intervention	Target Areas	Actions to undertake
Target Areas - Actions to undertake	Political Framework	Setting the objectives regarding the use, the protection and the conservation of water
	Legislative Framework	Voting laws to enforce in the implementation of the policies and which will permit to reach the objectives
	Funding organizations	Allocating the financial resources to satisfy the needs in water
Institutional Roles	Organisational Framework	Setting up an organization which will coordinate the formal and operational components
	Development of the institutional capacities	Human resource capacity building
Management tools	Evaluation of the water resources	Knowing about the availability and the needs
	Designing plans for IWRM	Combining the development choices with the use of resources and human inter-actions
	Demand management	Using water more effectively
	Social changing instrument	Encouraging a civil society turned toward water
	Conflicts resolutions	Managing disputes in guaranteeing a sharing of water
	Regulatory instruments	Limiting the distribution and sharing of water
	Economic instruments	Using the value and price for efficiency and equity
	Information sharing and	Improving the knowledge for a better

	management	management of water

5.4 Watershed: The relevant level for IWRM implementation

We can define a **watershed** as a geographical area in which all rain water converge towards a river, a pond, a lake or other water points. All uses from urban, rural and industrial lands can influence the quality and quantity of surface and groundwater in a watershed or, conversely, be influenced by the quality and quantity available in that area.

The watershed is a relevant area for IWRM, regardless of national boundaries or administrative divisions: it is in this area that problems are raised and must be solved by consensus among the stakeholders of water and land, in application of the principle of subsidiarity of governance at the level that closest to the area.

IWRM promotes the emergence of institutions which are meant to ensure the dialogue and arbitration between essential actors in the management of water and land resources of the basin. It is based on technical tools (measuring networks, data banks) which are essential to the knowledge of the resource and on the decision-making tools, especially in the planning of activities to be carried out in the basin.

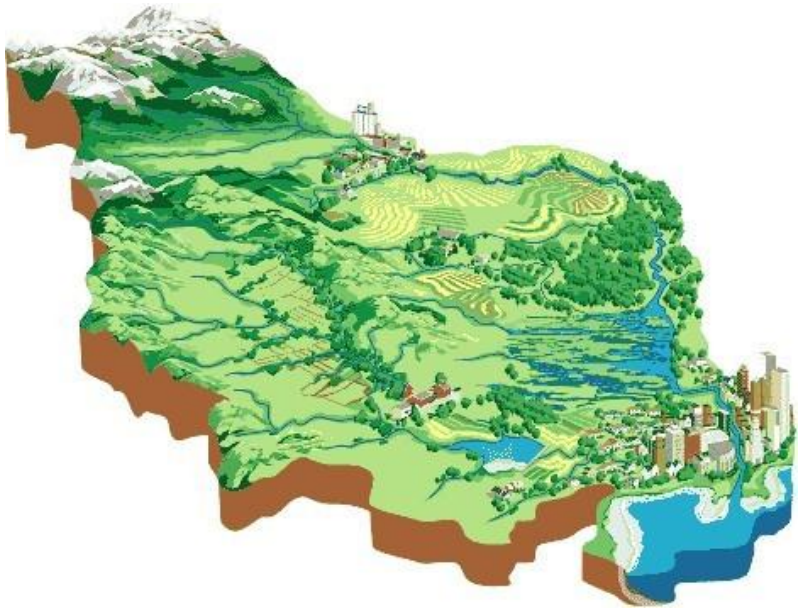

Figure II-4: An example of watershed: a unit of integrated water resources management

Generally speaking, for each watershed, one could produce technical and sectoral documents on the physical, chemical, biological, social and economic dimensions, including aspects on the human populations' health.

These sectoral papers are then compiled into an integrated document (**report document**) which clearly outlines the problems of the basin. This integration document will be a basis for the **consultation of the public** who is invited to participate in the definition of the priorities

and determination of the roles and mandates of each partner. This document will represent the action plan developed by the various local stakeholders.

Box 2.6: The Ten Commandments for IWRM

• An Integrated Management of Water Resources must target the sustainable and inter-sectoral satisfaction of all the basic and legitimate needs, including the protection against risks, the preservation and restoration of the ecosystems.
• The basins of rivers, lakes and aquifers are suitable territories for the organization of integrated management of water resources and ecosystems.
• A clear legal framework in each country must specify the rights and duties, including the institutional competences, the procedures and resources which are essential for a good water governance.
• Representatives of the populations and of the local authorities, the water users and organizations of public interests should participate in this management, especially within the Basin Councils or Committees.
• Information, awareness and education of people and their representatives are essential.
• Blueprints or plans for watershed management should be developed based on consultation and transparency so as to set the targets to be achieved in the medium term.
• Integrated systems for observation and monitoring, which are both reliable, representative, accessible, and harmonized must be initiated jointly with specific research on each basin.
• The establishment of financing systems, based on the contribution and the solidarity of consumers and polluters is a must, to ensure in each watershed priority programs of successive intervention and ensure that public services operate properly.
• These contributions, determined by consensus within the river basin committees, should be managed in the basin by an agency which is a technical and financial specialist
• For large rivers, lakes or aquifers, agreements for cooperation should be reinforced between the riparian countries, and management plans designed for those watersheds, especially at the level of the commissions, the authorities or the international bodies or border.

6. IWRM toolbox: organization and use

6.1 Content and organization of the toolbox

The Toolbox is a broad base of knowledge, experience and recommendations for the development and management of sustainable water resources including the provision of water services. The objective of the Toolkit is to help policy makers and practitioners to develop policy packages for sustainable management of water resources. The Toolkit includes sharing experiences and knowledge on the implementation of IWRM.

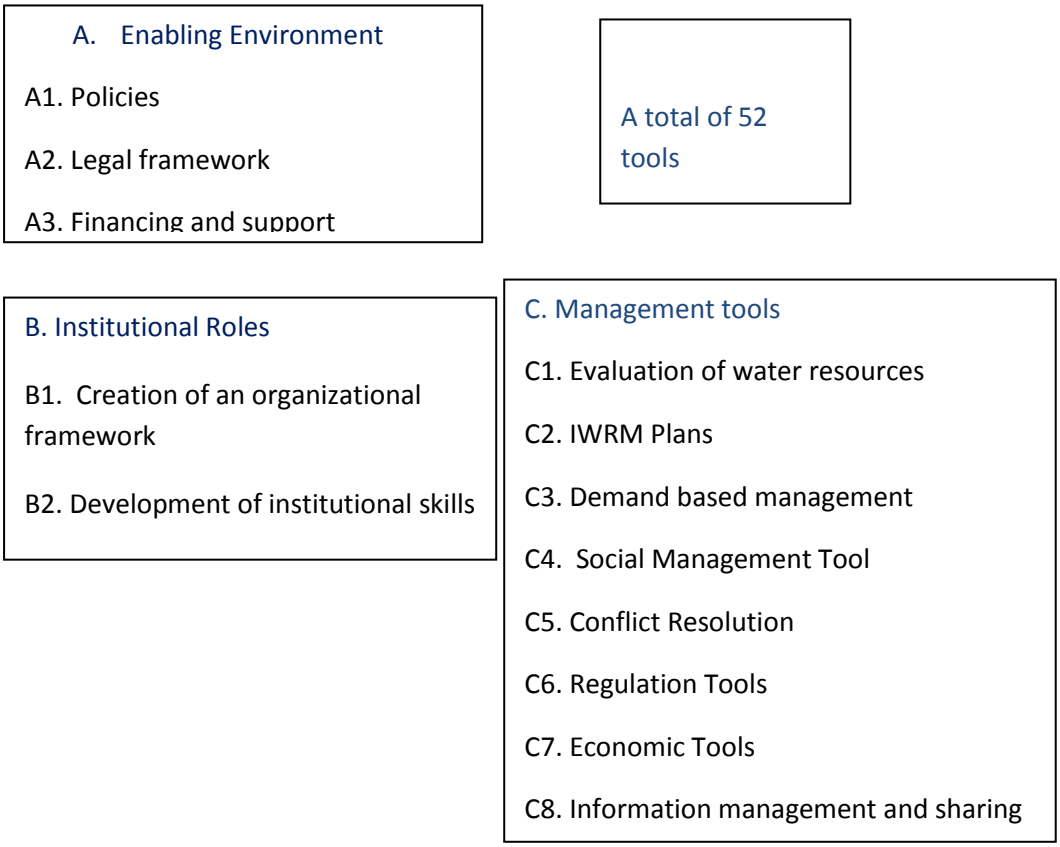

Figure II-5: Organization of the toolbox

It classifies the tools into three categories (Figure II-5, Figure II-6):

- those who create "an enabling environment", Class A;
- those who deal with the establishment of institutions, Class B;
- those who deal with the management instruments (tools), all of which can be used in IWRM, category C.

In addition, the Toolbox contains references. All tools and cases are related to reference texts (websites, organizations, or people). Lessons learned from the use of tools are described in cases. The case studies are practical descriptions of concrete experiences, given by the users of the Toolkit from all over the world and offering realistic lessons for the others. The case studies are reviewed by the peers through the GWP network.

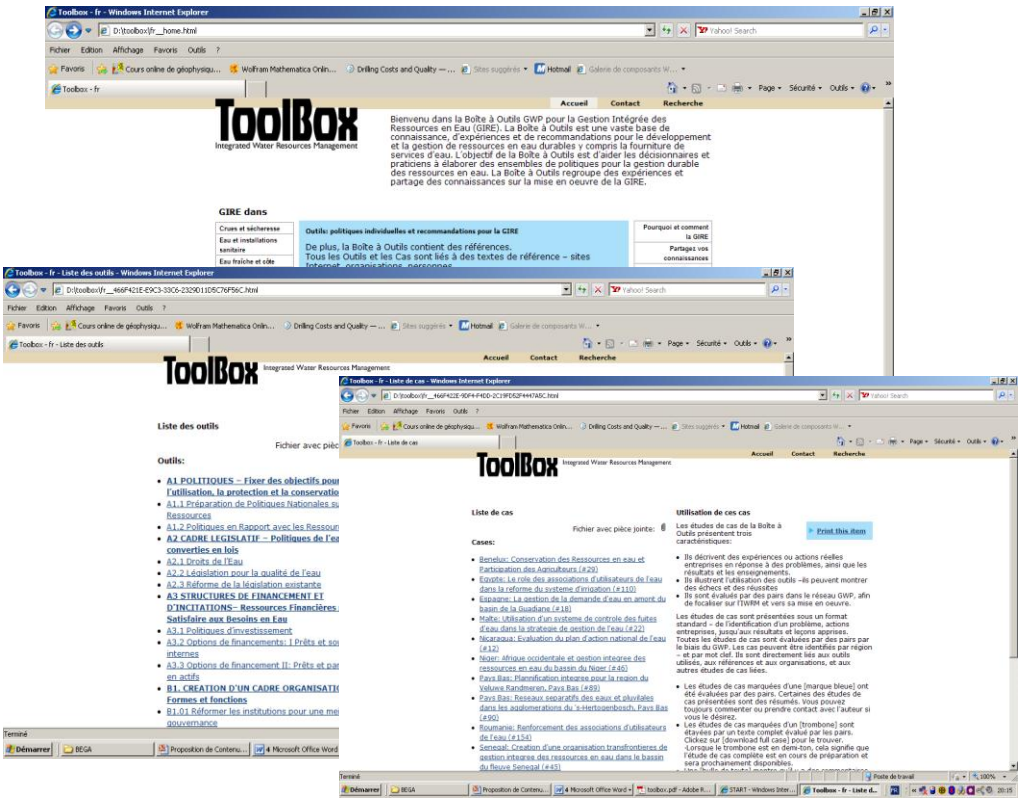

Figure 0-6 : Presentation of the tool

Box 2.7: Using the case of the toolbox

The case studies of the toolbox have three characteristics:

• They describe experiences or actions undertaken in response to real problems, as well as the results and lessons.

• They illustrate the use of the tools, which can result in failures and successes

• They are assessed by peers in the GWP network to focus on the IWRM and on its implementation.

The case studies are presented in a standard format - the identification of a problem, the actions undertaken, until the results, and the lessons learned. All case studies are reviewed by peers through the GWP. The cases can be identified by region - and by keyword. They are directly related to the tools used, to the references and to the organizations, and even to the other related case studies.

• Case studies marked with a [blue brand] were evaluated by peers. Some of the case studies are summarized. You can still comment on it or contact the author if you wish.

• Case studies marked with a [trombone] are supported by a full text evaluated by the peers. Click on [download full case] to find it. When the clip is half-tone, this means that the complete case study is being prepared and will be available shortly.

• A [text bubble] shows that there are comments or discussions on the case it refers to. You can add comments to case studies by going to comments.

*You can download case studies as **pdf** files, or email them to yourself or to a colleague.*

6.2 The tools in the box and their use

The search for solutions to problems related to water often requires a combination of approaches - policy changes or new types of planning and information. The tools provided here offer a range of available options. However the list is probably incomplete, and certainly not prescriptive. The types of tools that can be used and the manner they can be combined will vary from one location to the other and from one society to the other.

The toolbox classifies the tools into three categories: those that create an (appropriate) "enabling environment", including the laws, and investment policies which set the framework for other tools. To this, one must add the establishment of appropriate institutions, and the strengthening of existing capacities in these institutions. Finally we have the management tools, all of which can be used according to IWRM.

Enabling environment (A)

The policy framework sets objectives for the use, the protection and the conservation of water. Policy making is a key role of government. Through its policies, the state can determine the direct and indirect activities of all stakeholders, including the government. The government may be a direct supplier or the one who regulates or supports other providers. Appropriate policies can encourage a sustainable and participatory development, based on demand. Policies which promote the integrated water resources management refer to social and economic objectives which are widened to the nation and which comprise all the development goals for the society. The policy-makers draw up laws and regulations meant to achieve the broad policy goals.

The legal framework allows converting policies pertaining to water into laws. The water law provides a structural framework for the objectives of conservation and development. At best, it can promote efficient investment in the development and conservation of water. At worst, it may discourage investment and conservation and promote monopoly.

The security and flexibility of rights are two components in legislation in general and in water laws in particular. The water legislation addresses, among other things, the ownership of water resources, the legal nature and stability of water, the profitable and effective use of water, the transferable nature of the rights of water, and the need to recognize and respect the current use and the customary rights when it comes to changing water legislation.

Water laws also aim to prevent the transfer of negative externalities, to reduce monopolies, and to reduce transaction costs. In addition, water laws define the responsibilities and functions of agencies managing water / environment as well as organization in charge of providing water services.

- **Financing and incentives structures** make easier the finding of financial resources to meet water needs. Funding meant to meet this challenge can be found with governments, communities, individual people, commercial banks, private sector working on water and among the community of donors. However, none of these sources alone can meet the needs, hence a need to join forces. Financial resources are needed to cover the following components:

• The overall management of the resources, the conservation and protection of water resources;
• The provision of services (e.g. fresh water, irrigation and wastewater treatment);
• The investments required to balance supply and demand in terms of space and time;
• The public welfare such as the protection of populations against natural disasters like (floods or drought).

The availability of these funds for water depends on the priorities and overall economic development policies and on the legislative and the institutional frameworks. The introduction of IWRM principles does not change these realities but aims to adapt these policies to the development strategies. One part of the funding for the development strategy of a country implies the direct funding of the sector of water

Box 2.8: Structure of the "A Class"

• A1 POLICIES - Setting goals for the use, the protection and the conservation of water
• A1.1 Preparation of National Policy on the Resources
• A1.2 Policies in relation with Water Resources
• A2 LEGISLATIVE FRAMEWORK - water Policies converted into water laws
• A2.1 Water Rights
• A2.2 Legislation for water quality
• A2.3 Reform of the existing legislation
• A3 STRUCTURES FOR FINANCING AND offering INCENTIVES -Financial Resources to Meet Water Needs.

The total investment costs and operation of water services must eventually be recovered. The only and ultimate source of income is derived from charges and fees charged to users themselves, plus various national funds derived from taxes, international loans and voluntary contributions made via NGOs. All loans must be refunded and interest paid to shareholders, whatever the origin. This being said, the choice of the financial arrangements is significant. The financial engineering can make a difference as far as the sustainability and the feasibility of a project is concerned.

The organizational framework (B)

It is structured as follows:

Institutions of all kinds can be involved in the integrated water resources management from the large transboundary or international entities to the local or regional authorities, the institutions of civil society which are much smaller or even the community- based organizations.

Institutional structures vary from one country to another, but whatever the specific structure, it is essential that it includes mechanisms for dialogue and coordination to ensure a degree

of integration. A balance must be found between a fully integrated approach, in which specific items may be missed because of lack of expertise or of interest, and a sectoral approach in which different policies are applied without any coordination. The roles, responsibilities and functions of water management bodies vary. They may include the following components: policy drafting, education and promotion, networking and exchange of information, regulation, control and enforcement, monitoring, allocation and distribution of water, fight against floods and risk reduction, treatment and water reuse, conservation and protection, fight against pollution and management of water quality, and even the Arbitration in the event of conflict.

Box 2.9: Structure of class B

• *B1. CREATING AN ORGANIZATIONAL FRAMEWORK - Forms and functions*
• *B1.02 cross-border organizations for the management of water resources*
• *B1.03 National higher institutions*
• *B1.04 River basin organizations*
B1.05 • Regulation institutes and enforcement agencies
B1.06 • Service providers and IWRM
B1.07 • Strengthening water services from the public sector
B1.08 • Role of the private sector
• *B1.09 civil society institutions and community- based organizations*
• *B1.10 Local authorities*
• *B1.11 Building partnerships*
• *B2. INSTITUTIONAL CAPACITY BUILDING - Human Resources Development*
• *B2.1 participation Capacities and delegation of power in civil societies*
• *B2.2 Training capacity building among water professionals*
• B2.3 *Regulatory capacity*

Management tools (C)

This class is structured as follows:

The assessment of water resources involves their overall assessment in a country or a region in relation to their use by the society. This is a quantitative and qualitative assessment of surface water and groundwater, which identifies the relevant parameters of the hydrological cycle, and determines the water requirements associated with different development choices.

Contrary to guiding plans, which are often rigid and prescriptive, **the planning process** based on IWRM represents a more flexible and dynamic development planning and management of water resources. Planning reflects all the activities within the system, whether a river basin or a watershed, going from agriculture, forestry, mining, to the other destinations of lands. The planning process plays a vital role in enhancing good governance within a framework of strategic management of water covering the objectives, the policies and the actions planned.

The national IWRM plans include actions needed to develop an effective framework of policies, of legislation, of financing structures, and of competent institutions, with clearly defined roles and a set of management tools.

The management of the demand reflects a major shift in the approach to the management of water resources, moving from traditional supply, (construction of physical infrastructure to direct more water towards a more direct use) to improving the use, the conservation, and the recycling of water. The demand management studies both these changes and the way water is used to make them more efficient and improve their cost- effectiveness. The demand management applies to different levels: basin, more numerous consumers (businesses and industries), agriculture, households and communities. Although various techniques can be used at each level, the approach is identical.

To change practices in order to achieve an IWRM, it is necessary to substantially change the behaviours which are deeply rooted in the civil society (individuals, institutions, professionals and social organizations). By definition, **the instruments of social change** are not neutral, and the positive view point of one person can be perceived as negative by another person. The participatory approaches in IWRM are powerful instruments of social change at all levels (national, regional, or local one). It is most often the disadvantaged social groups who must be involved in this participatory process

The procedures permitting to reach a consensus and manage conflicts are essential to the success of IWRM. The causes of conflicts can be numerous. Among the potential conflicts, one can note: the interdependence of individuals and responsibilities, the legal ambiguities, the operational overlap, the competition for scarce resources, the differences in status , the organizational influence, the distortion of communication, the unsatisfied expectations, the needs and interests not being met, the inequality of power and of authority, together with the misunderstandings. **Conflict resolution** refers to a wide range of tools used to anticipate, prevent, and respond to conflicts. Identifying the appropriate tool depends on the type of conflict, its basic causes, and its location.

Four types of **regulatory instruments** play a role in the integrated water resources management:

- Direct regulations through the governmental authorities or the regulatory agencies,
- economic and market regulation,
- self-regulation where professional groups and industrial communities establish their own rules of conduct and mechanisms so as to ensure compliance,
- Social Regulation which is a tool calling for a change of behaviour in terms of water use through advocacy, information and education.

Economic instruments can be used in the water sector with the institutional, regulatory and technical tools. In general, economic instruments involve the use of price and other incentives so that consumers and all water users will consume with caution and safety. Economic instruments may offer certain advantages over the other tools, acting as incentives for the change in behaviours, and in generating income which permit to fund adjustments, by establishing priorities for users. If used alone, Economic instruments are likely to be ineffective but however they are particularly effective if combined with other supportive measures.

A process of exchanging IWRM **information** enables professionals, practitioners and general public to exchange and share experiences on the implementation of IWRM. This information sharing and development becomes a tool in the development of institutional

Box 2.10: Structuring of Class C

• C1. EVALUATION OF WATER RESOURCES - Assessment of Resources and Needs
o C1.1 Knowledge base on water resources
o C1.2 Water resources assessment
o C1.3 Modeling in the IWRM
o C1.4 Development of indicators on water management
o C1.5 Ecosystems Assessment
• C2. PLANS FOR the IWRM-combination of options pertaining to the development, the use of the resource and the human interaction.
o C2.1 National plans for the integrated water resources management
o C2.2 Basin management plans
o C2.3 Groundwater management plans
o C2.4 Coastal areas management plans
o C2.5 Assessment and Risk Management
o C2.6 Environmental Assessment (Environmental Assessment - EA)
o C2.7 Social assessment (Social Impact Assessment - SIA)
o C2.8 Economic assessment

C3. OPTIMUM USE OF WATER - and the demand and supply management
o C3.1 Use Efficiency optimized
o C3.2 Recycling and reuse
o C3.3 improving the supply

• C4. INSTRUMENTS OF SOCIAL CHANGE – Promoting a water company
o C4.1 Education curriculum on water management
o C4.2 Communication with stakeholders
o C4.3 Information and transparency for awareness
C5. CONFLICT RESOLUTION - Conflict management, guaranteeing the sharing of water
o C5.1 Conflict management
o C5.2 Planning a shared vision
o C5.3 Reaching a consensus
C6. STATUTORY INSTRUMENTS - Allocation and limits in the use of water
o C6.1 Regulations on water quality
o C6.2 Regulations on water quantity
o C6.3 Regulations for water services
o C6.4 Controlling land development and the protection of nature
C7. ECONOMIC INSTRUMENTS - Using the value and price for efficiency and equity
o C7.1 Pricing of water and services
o C7.2 Pollution and environmental taxes
o C7.3 Water Markets and transferable permits
o C7.4 Subsidies and incentives

C8. INFORMATION SHARING- Sharing knowledge for better water management
o C8.1 Information management systems
C8.2 o Sharing data for the IWRM

capacities. The process focuses on all relevant sources of information, and not only on those from the "technical experts". It facilitates discussions at the level of the local authorities and calls for easy supply / access to information.

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GWP, toolbox: http://www.gwptoolbox.org/images/stories/Docs/toolboxfr.pdf

Exercise 1 : the basic principles and the implementation of the IWRM

Document on water resources issued at the Johannesburg summit in 2002

Purpose: *to identify actions to be undertaken, and the constraints to be overcome for an effective implementation of the IWRM principles*
Duration*: 30-45 minutes*

Activities*: Having learned the basic principles of the IWRM you can probably assess the situation in your own country when it comes to the implementation of an IWRM*

Group 1: In view of government institutions in your country, what are the legal and institutional reforms you need to implement the IWRM and what are the requirements to make it effective? What are the benefits for different sectors of use?

Group 2: Are there any urgency to manage water resources in an integrated way and how this can be the best? How men and women are affected differently by changes in the management of water resources in your country?

Exercise 2 : the advantages of the IWRM for the supply of fresh water

Purpose*: To assess the status of the fresh water supply in your country and identify actions to be implemented within the framework of IWRM for sustainable and efficient use of water resources*
Duration: *30-45 minutes*

Activities: *In many countries the supply of drinking water in towns is the first priority when allocating resources.*
• Is this the situation in your country?
• In your country what is the status of water security and how can IWRM improve it?
• How the distribution of water may be affected by the use of water in other sectors?
• How are the water losses managed in the distribution system? Is there any service in charge of remedying it?
• What is the relationship between water availability and the well- being and comfort of the community?
• What do you do at home for an efficient use of water resources?

Exercise 3 : exploiting the toolbox

Purpose: *to examine the contents of the Toolbox*
Duration: *30-45 minutes*
Activities*: You are a multidisciplinary team with the mission of establishing a framework for assessing water resources. Basing on the toolbox, please:*
• Raise the interest inherent in the knowledge of the resource

- *List the quantitative and qualitative data needed to create a knowledge base of the resource;*
- *List the indicators of water management.*

CHAPTER III- IWRM implementation tools

Educational Objectives

- Knowing water resources planning tools and an overview on the management indicators
- Grasping the legal basis related to the management of catchments

1. Planning tools

1.1 The National IWRM Action Plan

The **national action plan for integrated water resources management** specifies the appropriate national framework for water management for the implementation of national water policy and the terms and timetable for its progressive implementation.

Planning to introduce an IWRM approach to the management and sustainable development of water resources could take many forms. The strongest reason will be to address water priority issues that affect society and this can lead to a focused action to move progressively towards IWRM. Generally, the recognition that water problems are symptomatic of a deep failure of water management systems leads to long-term planning with an agenda for a more sustainable use of water resources. The identification of water as a main factor in reducing poverty and sustainable development also leads to a national water planning.

One outcome of the process will be an IWRM Plan, approved and implemented by the government. In the process, stakeholders and policy makers will be more informed about water issues, the importance and benefits to address the management and sustainable development of water resources. The plan may be more or less detailed depending on the current situation in the country but it will identify longer-term steps that will be required to continue on the path of sustainability, social equity and efficiency in the use.

The understanding of the fundamental forces that pose problems related to water helps build a shared vision and commitment of water to bring this vision to fruition. In this regard, a strategy sets the framework for long-term incremental action towards a sustainable use of water resources by using the IWRM principles.

Another feature of the water strategy is to take into account the conflict. The water resources management is a process characterized by the disagreement between the viewpoints and contradictory interests. The integrated approach to the water resources management is the promotion of mechanisms for improved dialogue, negotiation and participation. Applying these principles in the strategy and subsequent planning process brings transparency in decision-making, compromise recognition, and commitment to implementation plans.

Planning is a logical process that is most effective when it is perceived as a continuous cycle. The planning cycle is a logical phase and is led and supported by ongoing support of management and events consultancy. IWRM planning requires a team to organize and

coordinate efforts and to facilitate regular consultation with stakeholders. An important starting point for a government's commitment is to understand IWRM principles and water resources management for sustainable development.

IWRM planning requires a strong commitment to a sustainable future water resources management. It requires political will and leadership of policy makers and stakeholders. The involvement of stakeholders is necessary since they are not the ones who strongly influence the water management through joint efforts and / or behavioural changes. Thus planning requires the identification and mobilization of appropriate stakeholders, despite their multiple and often conflicting objectives.

A national water vision captures the shared dreams, aspirations and hopes of the state, the water resources use and management in a country. In this regard, a vision provides the principles of governance and guidance for future actions on water resources and guides the planning process in particular. One would expect that the vision be translated into water policy which should address the sustainable use of water resources.

Box 3.1: IWRM Plan, example of Burkina Faso

Strategic areas

Operationalizing space management specified by the policy law on water; main action: establishing Water Agency, SDAGE.

Consolidating State sovereignty tasks in terms of water; main action: Water Policy, Bye-Laws

Consolidating knowledge and applied research related to climate change; main action: Studies of Water and practices, Resource monitoring and settings.

Strengthening the capacity of local communities, private sector and civil society in the field of water; main action: Support to Local Authorities in the management of natural resources (water).

Consolidating Human Resources of the Public Administration on water; main action: Training of human resources.

Contributing to the implementation of horizontal measures related to poverty alleviation, main action: Participation of women and vulnerable groups in decision making.

To define the action required to achieve this vision, **it is important to know the existing situation.** Consultation with stakeholders and various government entities in this process is vital to understand the needs and competitive goals compared with the water resources availability. This phase identifies the strengths and weaknesses in the water resources management, to clarify aspects that should be addressed to improve the situation and be on the way to achieving the vision.

The establishment of IWRM plan objectives is important at this stage once the magnitude of the problem and obstacles to overcome, are known. For each goal, the most appropriate **strategy** is chosen and assessed for both the feasibility and for consistency with the overall objective of sustainable management.

Based on the vision, the situational analysis, and the use of a water resources strategy can **prepare an IWRM Plan**. Several drafts may be required to achieve not only the feasible and realistic activities and budget, but also to bring policy makers and stakeholders to agree on various compromises and decisions. **The approval by the government** is essential for the mobilization and implementation of the resources.

Achieving IWRM Plan is an important step but not an end in itself. More often, the plans are not implemented and it is important to know and avoid to the main reasons:

• Lack of political commitment to the process. Usually, it is because of a pressure coming from external sources or a lack of commitment of key decision makers who have the initiative of the process.

• Unrealistic planning with unrealistic resource conditions which are beyond the reach of the Government.

• Unacceptable plans. Plans rejected by one or more influential groups because of inadequate consultation or unrealistic compromise expectations. With water, where the economic advantages or power relations may be affected, appropriate consultation is essential.

1.2 The master plan for development and management (SDAGE)

The SDAGE is a planning document prepared at the scale of a watershed. It captures all the hydrographical obligations set by law. SAGE coordinates and directs local initiatives through the development plan and water management (SAGE). It defines the basic guidelines of a balanced management of water resources and aims at implementing the objectives of the legislation on water.

It is meant for being revised periodically in order to be part of a dynamic approach. The SDAGE is actually a planning tool for the development and management of waters within which each stakeholder (State, local communities, users) plays its role. It constitutes a coherent, comprehensive and concerted answer to the water related issues in a given geographical area:

• Consistent, because the SDAGE is applied across the basin, from upstream to downstream, by analyzing and processing the stream from the source to the basin outlet;
• Overall, because this scheme will guide and prioritize a number of actions, projects and materials in the considered period;
• Concerted finally, as it is to give voice to all the concerned stakeholders (actors, consumers, users).

The SDAGE takes into account the major programs established by the state and local governments and establishes the general objectives and harmonized water quality and quantity as well as arrangements to be made for them to be achieved. It establishes a coherent and territorialized planning (at a basin) of water resources and aquatic environments. In addition, it has a legal characteristic and direct consequences on public policies that government and elected officials will have to take in water: on the regulatory level, the nature of the facilities in the program content .

The SDAGE is a tool for prospective management in the sense that it commits the state, it supervises the local authorities in their decisions, and it organizes the prospects for intervention (including those of water agencies). The SDAGE is a coherence tool in the major river because it directs the Water Development and Management Plan (SAGE), makes compatible public actions on major issues; it sets a new solidarity in the context of a comprehensive resource management and sustainable development.

The SDAGE has two main functions:

- Ensure the quantitative and qualitative management of water and aquatic environments: ecological heritage, biodiversity, natural landscape, public health. This management is done with a concern for sustainable economic development;

- Give priority to the local community's collective interest in order to facilitate the search for consensus, the SDAGE is based on principles of solidarity and collaborative management.

The initiative of the SDAGE emanates therefore from land managers, local elected officials, associations, business people and users who have a common project for water. The SDAGEs set basic guidelines for a balanced management of water resources, the objectives of water quality and quantity which corresponds to the "good condition" and that must be achieved, the modalities of support to costs related to the water use, by making the distinction between industrial, agricultural and domestic sectors. The SDAGEs establish the facilities and arrangements for preventing and protecting and improving the situation of water and aquatic environments, the hydrographical sub-basins for which a SAGE (Water Development and Management Plan) will be made as well as their development and revision schedule.

The SDAGE is developed by a relevant technical authority under the control of a basin committee. It gathers and takes into account initiatives, concerns and comments of various stakeholders at different stages of the development process. The SDAGE was adopted by the basin committee and approved by the relevant administrative authority. It shall be available and updated periodically (every 5 years for instance). Monitoring the implementation of SDAGE is ensured by the basin committee who must ensure the compatibility of the major issues and basin projects of interest with the provisions and objectives of SDAGE. In this regard, dashboards and indicators are developed. They can follow the progress of procedures, regulatory actions, the environmental quality objectives to be achieved, etc..

SAGE intrinsically carries a real "territorial project" and therefore of development. The most important thing is probably to create a space for discussion between policy makers, users and businesses that are the foundation stone for defining a local approach to sustainable development. A joint management of water resources coupled with a vision on planning policy can only have beneficial economic effects in terms of employment. From the composition of multiparty Basin Committee, it makes it possible to resolve disputes involving hydrological interests often divergent.

Box 3.2: The Example of Benin

The water bill (Art. 34 and 35) provides that the catchment and aquifer are appropriate settings of planning and management respectively of surface and groundwater. Basins and aquifers or portions of aquifers which underlie basins are grouped into sets which are the main units of the water management. Benin is organized into four catchment sets: ***the Mono-Couffo, the Niger, the Ouémé-Yeoua, the Volta****.*

Art. 36 stipulates that in each basin, it is created a basin committee composed of: representatives of the State, local government representatives, representatives of professional groups involved in water management, qualified individuals. The basin committee deliberates on: SDAGE and SAGE projects, the State intervention programs and local governments on water, the rate of royalties.

Art. 4 define SDAGE as a "document binding on others, which determines the basic guidelines for a balanced management and development of water resources at the scale of a basin for a specified period.

2. Management indicators

2.1 Importance of management indicators

The use of performance indicators in IWRM is a relatively new field of study, which, among others, assists in the management and governance of this public resource, provides an analytical tool to help decision making and is a communication tool that offers great opportunities. The indicators are considered important tools for sustainability and sustainable management of natural resources. They provide a basis for assessing achievement of objectives in a management process and impacts. With regard to aspects of governance, they provide information on the public resources management, which can be used to increase the accountability and transparency. In this way, they help the good governance of transboundary basins, which allows regional integration. Therefore, progress in regional integration opens new opportunities for overall development and management of transboundary waters in particular.

The application of performance indicators by a member of an organization to their own organization is part of the management procedures called "self-assessment of the organization." This self-assessment enables social learning and capacity building, adding value to the organization's own experiences and the transfer of results of evaluation of performance indicators in the management process. The evaluation of performance indicators can also be performed by actors outside the organization (part of the study called "participatory monitoring and evaluation (PM & E) in this case). The use of performance indicators by external actors, and input / opinions on the external management process, also ensures the participation of various audiences. The advantages of a participatory approach are a better quality of the project, governance and sustainability, empowerment of beneficiaries, and the contribution to capacity building and long-term self-sufficiency.

The performance indicators can be powerful tools for information synthesis and its clear dissemination to the public. Depending on the indicator, the value of information obtained can be optimized by successive evaluations. Because of these characteristics, performance indicators are frequently used in reporting. Reports to central authorities or project funders are obvious possibilities, but the reporting may also include the organization's self-promotion for instance.

2.2 Overview of some management indicators

There are different types of performance indicators, which rely on various reflection processes and focus on separate water management aspects.

Performance indicators targeting the institutional and management aspects

Although the implementation of IWRM aims at achieving concrete results on the field, it is extremely complex, and it is difficult if not impossible, to identify and isolate the specific results achieved by some processes. Phenomena such as environmental quality or water use efficiency in the basin result from many activities, and it may happen that good management is not accompanied by an improvement in these areas, or vice versa. One way to solve this problem is to focus on management procedures themselves, and identify

whether the "best practice" is used and produced in the process of decision-making body of the Basin.

Performance indicators evaluating the results of government policies: technical, financial, social, environmental

The information on the evolution of the physical and social field is really crucial for the management of water resources. The set of the following performance indicators addresses these realities. As mentioned above, keep in mind that in assessing these indicators, the status of the physical and social systems of a basin is the result of extremely related processes and, as such, the link between decisions made for water management and social or physical status is not straightforward.

The concept at the heart of this scheme is the notion of causality: the behaviour of human beings is putting pressure on the environment, causing changes in the quantity and quality of available resources. The response of society is to adapt itself to these changes. The indicators seek to measure these parameters for specific questions or problems, often relying on information / statistics derived from other government activities. The value of these indicators often depends as much on the actual indicators as their changes over time (time series), and indicators are actually quantitative, targeting a situation that changes over time.

Another example of indicator: efficient use of irrigation water

It is made up of two sub-indicators:

- E1: the physical efficiency of transport and distribution networks of irrigation water, upstream of agricultural plots, measured as the ratio between the water volume actually supplied to the plots and the total volume of water allocated to irrigation, upstream of the networks, including network losses.

- E2: the efficiency of irrigation at the plot, calculated as the sum of the efficiencies (the plot) of each irrigation method (surface irrigation, sprinkling irrigation, micro irrigation, other water control methods), weighted by the respective proportions of the various methods in the country.

The efficiency of E1 irrigation can be estimated by managing bodies, when meters are available on the networks. It is specific to each network. But it would be possible to evaluate an average efficiency at the level of the basin by making an average of the efficiencies of each network, weighted by the volumes they pass each year. The average efficiency of the E2 farm irrigation is defined as the ratio between the amount of water actually consumed by plants and the amount of water supplied to the plot and varies according to irrigation scheme.

3. The legal aspects of basin management

3.1 The international consensus on water management

The consensus base were established at the Copenhagen international meetings (Copenhagen Informal Consultation on development and integrated water resource management, November 1991) and expressed in Dublin (International Conference on Water

and Environment, January 1992), prior to the Earth Summit in Rio (June 1992).

The Dublin Principles have formed the Chapter 18 basis (on freshwater resources) of the Earth Summit discussion main document, Agenda 21. Chapter 18 has identified seven priority areas for action.

After Rio, these principles were endorsed at the Ministerial Meeting on Water and Sanitation in Noordwijk, in the Netherlands (1994). All major international organizations involved in the water development policies regularly referred to it, including the Development Assistance Committee (DAC) of OECD. While the debate continues (for instance the fact of recognizing that water has an economic value), **there is a broad consensus** and a clear desire to identify coherent actions in the framework of the **integrated water resources management**.

In June 1997, the Special Session of the UN General Assembly, which called for urgent action in the field of freshwater, many people insisted that these principles should become operational. The Member States of the European Union and the European Commission supported an initiative for fresh water first, a group of experts met in Harare, Zimbabwe, in January 1998. In Paris, in March of that year, the International Conference on Water and Sustainable Development identified a Priority Action Programme. In New York in April 1998, the 6th session of the UN Commission on Sustainable Development recommended approaches for the global freshwater strategic management. These recent discussions at the highest political level show that the water issue benefits from a growing interest in international politics.

However, it will take much effort before the agreement is truly materialized by actions on the ground. As it was pointed out by the UN session in 1997, intergovernmental declarations of intention on freshwater will have no effect in terms of necessary institutional and political reorganization at the national level and when the international community will be prepared to provide additional financial resources to support its recommendations. However, this unanimity of viewpoints at the international level is a key component of the strategies definition framework. It recognizes and reinforces the idea that the approaches adopted in the past are not sustainable. Not only do such approaches not address the water shortage and environmental issues, but they widen the gap between the populations served and others. Today, the challenge is to get the international consensus on water from theory to practice. There is still a gap between ideas and actions endorsed at the highest political level and their translation into the establishment of decision-making structures and programs in developing countries.

3.2 Promotion of cooperation at basin level

The theme of integrated water management resulted in the basin promotion as the logical geographic unit for its practical implementation, including the European Union, the World Bank and the Asian Development Bank. It offers the advantages of strategic planning, particularly at the highest level of governments, but the difficulties should not be underestimated.

Aquifers often exceed the limits of the catchment. Even more problematic is the fact that river basins are rarely in conformity with structures and administrations in place. Although the

basin organizations should not be seen as a panacea, they provide a coherent geographic base for the integrated water resources management.

In a major part of the developing world, most of the rivers cross at least a border and this seriously complicates the organization of river basins. The sharing of waters between the countries crossed by important rivers as the Gange, the Mekong, the Jordan, the Nile and the Niger is obviously a major political and strategic stake for the concerned countries. In the past, too many examples of projects have been planned to meet objectives at the national level which neglected the impact on the basin as a whole, and neglected to focus on conflicts that could arise from downstream needs in another country, or even within the federal states. The Convention on the Law relating to users of international rivers for non navigational purposes (April 1997) provides a basis for the establishment of the rights shared on transboundary Rivers and a framework for managing international basins.

In March 1998, a roundtable was held in Petersberg, Germany on the cooperation for the management of transboundary waters. The Petersberg Declaration emphasizes on the means to be used so as to consider water as a catalyst for regional cooperation rather than a source of conflict. The importance of promoting cooperation in the basin is increasingly recognized, as reflected in the interest for the International Network of Basin Organizations (INBO).

3.3 The international law on water

The need for effective regulation of international waters has become increasingly acute much like the supply from water sources shared by two or more countries increased and the quality got deteriorated. Water can be a source of conflict between neighbouring states, since almost half of all river basins in the world is shared; finding ways of sharing and protecting water among riparian states is an obvious logic. Although there is a wide range of laws on international rivers, no universal legal principle has been accepted.

Until recently, the legal basis for most of the negotiations on international rivers was given by the Helsinki Rules on the use of waters of international rivers. The rules were formulated in 1966 by the International Law Association, an NGO, and the International Law Commission, an organization emanating from the United Nations General Assembly. The Helsinki Rules deal with the concept of international rivers, including water resources, as they straddle international borders or flows only in one country, are treated as a property common to all basin states. The Helsinki Rules contain two substantive principles: (i) a prohibition of causing harm resulting from the deprivation of water rights, pollution or other means and (ii) the right of each basin State along an international river to a reasonable and equitable use of the river.

There are many regional agreements for rivers or specific lake basins, such as the Indus, Niger, Senegal, Zambezi and Lake Victoria. The Global Environment Fund provides assistance for projects related to transboundary waters in order to protect these waters. There are also other important international agreements for the management of water resources. They include those on climate change, biodiversity, wetlands (Ramsar Convention) and desertification or dry land.

The Ramsar Convention

The Convention on Wetlands, adopted in Ramsar, Iran in 1971 and known since as the "Ramsar Convention" came into force in 1975. It was the first global intergovernmental treaty intended to protect the modern environment and preserve the natural resources.

The mission of the Convention, which was reaffirmed in 1996, is the conservation and wise use of wetlands through national and international cooperation which will go towards a sustainable development everywhere in the world. Being a member of the Ramsar Convention entails acceptance of the principles that the Convention represents, facilitating the development of national policies and actions, including legislation, carried out for the best use of wetland resources. The Contracting Parties take the commitment to (i) identify at least one site that meets the Ramsar criteria for them to be included in the List of Wetlands of International Importance, (ii) to include the conservation of wetlands in the national planning for land use, (iii) to establish natural reserves, and (iv) to consult other parties for the implementation of the Convention, especially in the case of transboundary wetlands. The administration of the Convention is entrusted to a secretariat with the IUCN (International Union for the Conservation of the Nature) in Switzerland.

The Convention on the Law related to the use of international rivers for non navigational purposes

While the Convention adopted by the UN General Assembly on May 21, 1997 represents an important step towards an international agreement on the use of transboundary waters, many states whose interests are substantial, abstained or voted against. The main disagreement is emerging about the balance between rights and obligations of upstream and downstream States. Some states have held that the provisions for the settlement of disputes and those on groundwater were unsatisfactory.

The Convention aims at promoting an optimal and sustainable use of international rivers. It argued that countries along the rivers should use such waters in a "fair and reasonable way." This requires that all significant factors and circumstances are taken into account, whether geographic, hydrographical, hydrological, climatic, ecological, or relate to social and economic needs of the concerned States. The use effects in a State should consider the use in another, as well as the protection of the river and the costs and availability of alternatives for a planned or existing use.

The Convention requires prior notification of measures that could affect the river and arbitration if the states disagree on the proposed measure. For the preparation of legal agreements between states, there is a fundamental need for a scientifically tested knowledge, the disclosure of information and research; in many countries, little is known about the hydrological and scientific aspects of water resources. The various capacities of the riparian states as regard regulations and monitoring can be an obstacle to an effective agreement. The Convention recognizes the need for water to be treated as an economic good and for States, the fact that no water use has an inherent priority over other uses, unless there are agreements or customs saying the contrary.

Getting an international agreement on the river is difficult but essential to a sustainable and equitable use of the shared waters. Doctrines such as absolute sovereignty over water in a state (priority ownership or a "first come - first served") or its contrary (downstream users are entitled to the total flow of water of natural quality), are indefensible.

Countries need to adopt new principles outlined in the Convention, such as the doctrine that no one should use his property to injure others. The essence of this principle is that State A may exercise its rights, but cannot ignore the interests of the state B. This principle has formed the basis of an agreement between France and Spain on the use of transboundary water for hydropower.

The West African Strategy for the ratification of the 97 UN Convention

As of August 31, 2007, at the global level, fifteen States ratified the Convention, which requires 35 ratifications to enter into force. The failure to ratify the 1997 Convention of the United Nations on waterways by the States is probably a missed opportunity to improve cooperation on transboundary water and to avoid conflicts.

The West African countries are highly water interdependent. Indeed, on the 261 transboundary rivers reported in the world, 61 are found in Africa. Except for the Cape Verde islands, each of the 17 West African countries shares at least one of the 25 basins of the transboundary rivers of the region. The basins of transboundary rivers occupy 71% of the West African area (and 62% of Africa).

To avoid tensions, disputes and current risks of conflict to continue to grow and affect international security in West Africa, it is urgent to strengthen mechanisms for conflict prevention and conflict resolution. Unlike Southern Africa which has a regional agreement - known as the 2000 water Protocol of the SADC - West Africa has no regional mechanism to submit, prevent and arbitrate disputes on shared water.

The objective of the regional workshop in Dakar (on September 20 and 21, 2007) was to raise awareness about the role and relevance of the 1997 United Nations Convention on rivers with key stakeholders in the region, and promote ratification.

It is hoped that once the 1997 UN Convention on Rivers is ratified, it may serve as a platform to strengthen existing mechanisms for transboundary water management in the West African region (such as river basin organizations) and prepare groundwork for a West African Water Protocol.

3.4 The management bodies of shared watercourses

The roles, responsibilities and functions of management bodies of water vary. They may include the following points:

- Formulation of policies;
- Education and Promotion;
- Networking and information sharing;
- Regulation, monitoring and enforcement;
- Surveillance and monitoring;
- Water distribution;
- Flood control and risk reduction;
- Treatment and reuse of water;
- Conservation and protection;
- Fight against pollution and management of water quality;
- Arbitration in case of conflict.

The border agencies provide a framework for the management of water resources beyond national borders when management of common property resources (in different jurisdictions) is problematic.

Once created, organizations and agreements on transboundary waters are remarkably robust, in contrast to popular belief; they often act as moderating factors in a conflict situation. (Despite the fact that diplomatic crisis occurred between Senegal and Mauritania in 1989 and 2000, the bodies of the OMVS have regularly met).

Once the transboundary water management of is established, it must go beyond the views of the future and develop specific regulatory mechanisms, protocols for sharing data and information and funding mechanisms to give them a solid foundation. Experience shows that technical secretariats are essential in this regard.

Box 3.3: Cases of OMVS in the Senegal River Basin

In view of solving problems and realizing the potential of the basin, the Organization for the Development of the Senegal River was founded in 1972 by three of the four riparian states (Guinea joined OMVS in March 17, 2006)

The objectives of the OMVS are to (i) promote inter-State cooperation, (ii) coordinate the technical, economic, and other activities related to the development of the Senegal River, such as navigation, irrigation, production of hydroelectric power, protection and conservation of the environment, (iii) regulating the river flow for irrigation purposes, navigation, floods control, power generation, supply of industrial and domestic water, etc

Box 3.4: Case of the NBA in the Niger River Basin

The Niger Basin is located in West Africa and includes: Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria and Chad. The Niger Basin Authority (1980), coming after the Niger River Commission (1964), was established to foster, promote and coordinate studies and programs related to the basin

Today, the objectives of the NBA is to (i) promote cooperation between member states and (ii) promote integrated development of their resources, particularly in the areas of energy, water resources, Agriculture, forestry, exploitation, transport, communications, industry.

3.5 The role of national laws in the management of shared watercourses

The water laws, which connect the water policy to water rights, have existed for many years. They are necessary for the implementation and enforcement of policies, and provide effective administrative mechanisms and regulators at appropriate levels. The importance of water laws was highlighted in Agenda 21.

The main task of any government revising or drafting new legislation is to ensure that it is acceptable socially and administratively feasible. In deciding who will hold the final authority to control and distribute water and how existing laws and customs should be changed, we must consider a wide range of political, social, economic and administrative aspects.

National laws on water must also take into account all the international conventions accepted by the country.

The water law should result from the situation which prevails in a given country, rather than being imposed. This is particularly true of a law which deals with fundamental issues such as the respective rights of individuals and of the government over land and water, and are therefore the basis of the structure of a particular society. The preparation of the Water Act must involve technical experts such as hydrologists, engineers and economic experts, as well as lawyers.

The primary task of a Water Act is to give the State or its record agency sufficient authority to undertake various tasks related to knowledge, use, control, protection, management and administration of water. At the same time the rights of individual users to abstract and use water should be defined and protected. Therefore a law on water has two basic functions:

• It should confer certain powers of control over water and land to the government, while maintaining or guaranteeing rights to individual users, which are in harmony with the social, political, and economic development.

• It must establish a basic administrative framework and the institutions necessary for carrying out various duties assigned by law.

The sectors which should be covered by the Water Act are the following:

• **Rights on natural water rights**: These provisions should establish the rights, powers and duties of individual users, private operators and government on the water naturally present in various forms. They should identify the sources and problems subject to administrative control and those which are free from administrative intervention. The responsibilities for the service provision should be separate from those concerning the management or regulation of the resource.

• **Powers needed on the ground:** Some powers to start or conduct operations on land are essential to effective management of water. An action may be necessary to protect the beds and banks of rivers and lakes, and prevent erosion or pollution of adjacent land.

• **Authorization and Declaration of Rights of Water Use**: Information is needed on the availability of water to make realistic plans for sustainable development of water resources. This information should cover the quantity and the quality, current use and future needs. It is therefore important to provide for the various ways of consumption of water at their own level of quality, protection and quantification. Other uses such as effluent discharges must be controlled.

• **Administrative structure**: It is necessary to choose the administrative agencies responsible for the water development and control, define their goals and objectives, grant them the necessary powers and provide for their organization.

• **Other issues**: The water laws should cover many other issues, in addition to water rights, including: environmental protection, water waste and misuse, water recycling and reuse, promotion of health and pollution control.

Box 3.5: Examples ground water issues to be included in a water law

Designation of areas where ground water research and extraction are subject to control
- Drilling license
- Obligations to recharge underground aquifers;
- Consumption limitation by various means, including the installation of water meters;
- Procedures and requirements in the case of the water found incidentally;
- Interference with oil and mineral reserves.
In areas declared protected, restricted or rationed, the administration in charge of water may choose to impose limits on water abstraction or diversions, the prohibition of certain uses and other limitations or requirements dictated by the public interest.

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Assignment 1 : Using the Toolbox in the development of the IWRM Action Plan

Goal: getting acquainted with the IWRM Action Plan development process.
Duration: 30-45 minutes

Activities: You are a multidisciplinary and / or transdisciplinary team in charge of developing an IWRM Action Plan. Using the Toolbox:
• Say in a few words what an IWRM Plan of Action is;
• Set an overall goal of an IWRM Action Plan;
• Give specific objectives of an IWRM Action Plan;
• Submit a work methodology for the preparation of the document;
• Submit a drafting plan outline that will highlight the expected contents of the document.

Assignment 2 : Using the Toolbox in the preparation of the SDAGE

Goal: getting acquainted with the objectives and content of a Master Plan for Water Management.
Duration: 30-45 minutes

Activities: You are a multidisciplinary and / or transdisciplinary team in charge of developing a Master Plan for Water Management-SDAGE- at a level of a basin. Then using a Toolbox:
• Say in a few words what a Master Plan for Water Management (SDAGE) is;
• Set an overall goal of a Master Plan for Water Management-SDAGE-;
• Give the expected contents of a Master Plan for Water Management (SDAGE).

CHAPTER IV - The IWRM Economic and Financial Tools

Educational objectives

- Understanding the difference between financial tools and economic tools;
- Knowing how to implement the financial and economic tools;
- Have an overview on the water funding aspects.

1. Importance of economic considerations in IWRM

1.1 Water, an economic and social good

Water sustains life; it is a vital human need and a right without which human beings cannot survive. The competing demands and disputes over access rights arise because many people still do not have equal access to water and sanitation. Access to safe water and basic sanitation services is essential for achieving the Millennium Development Goals (MDGs), a fundamental requirement for effective primary health care, and a prerequisite to the success of the fight against poverty, hunger, child mortality, gender inequality and environmental damage.

In most countries, water is a public good; a public good is characterized by two concepts:

- The use of water is not competitive, its consumption by some users do not reduce the potential consumption of others;
- The second character is the non-exclusion, meaning that it is difficult or very costly to exclude a potential consumer from the benefits.

As water becomes increasingly scarce, its economic value is increasing and the use of economic tools for sharing its use or consumption by sectors or competing groups is also growing in societies.

As water becomes increasingly scarce, it is essential to consider it as an economic asset for better allocation, since its use or consumption by competing sectors or groups is also growing. In fact, it has important and diverse benefits for the society, for instance:

- The domestic use (drinking and other domestic uses)
- Industrial use
- The hydro electrical use
- Transport and Fisheries
- The use for agriculture (crop irrigation, livestock)
- Aesthetic values, recreational and medicinal
- Ecological values
- etc …

Water is also a social good. Indeed it is particularly important to view water allocation as a means of achieving social goals of equity, poverty reduction and health preservation. In countries where water is abundant, the tendency is to treat water as a social good to meet goals of equity, health and poverty reduction, rather than economic objectives. Safety and environmental protection also encourage consideration of water as a social good.

1.2 The importance of economic and financial tools

IWRM aims at improving the efficiency, sustainability and equity in water allocations using a multidisciplinary approach which recognizes cultural diversity and socio-economic disparities within societies and between societies. Therefore IWRM receives appropriate use of economic and financial tools that allow policy makers and water users to achieve these objectives in a context of democratic decision-making. From this perspective, the effectiveness of economic and financial tools is dependent on the historical context and socio-economic conditions. These should always be considered with caution when considered for a specific use in IWRM.

The economic use of water resources, in very simple terms, refers primarily to situations in which a decision must be made in allocating scarce resources among alternative uses. Economic analysis gives much attention to the efficient allocation and distribution of property and income behind and around the allocation process. **Economic tools** for IWRM are rational rules or **incentives that influence the allocation and distribution of water** or property and income related to water. The water price, the water tariffs, water rights and regulatory policies in the water sector are among the most important economic tools.

Finance refers to other specific actions taken by organizations and companies, which can be private or public, in order to maximize revenue of their property and their investments in the short and long term. It is assumed that the corporate objectives are clear and the role of financial tools is to ensure the availability of the resources (in time and space) to achieve these goals. The standard financial tools are those which are under the control of the company and affect the flow of resources to achieve goals such as funding, shares and cash management. **Financial tools** are evaluated in terms of efficiency to achieve a specific purpose. Financial tools generate financial revenue for the operation and development of the water sector.

The effects of the two tools can be found in one tool: the price. Indeed, pricing may include the processing and distribution cost (financial) plus a supplement to discourage waste (economic).

We might conclude that, as water is increasingly scarce (in quantity and quality), corporations (which are also facing the growing population and associated requirements in terms of access to water, food production and industrial development) face increasing challenges in the water allocation and distribution, as well as water related property and income. This situation caused a growing interest in the use of economic and financial tools.

1.3 Evaluation criteria

Economic tools are evaluated in terms of impacts on the **efficiency, equity**, **environmental sustainability** for society, and **feasibility.**

Economic efficiency is the organization of producers and consumers so as to deplete the unmistakable possibilities of economic growth of well-being. Economic efficiency in resource allocation is an important goal for a pricing policy. If they are well structured, economic tools will ration the demand and provide incentives to avoid waste, provide guidance to the provider regarding the optimal production scale, provide resources to the supplier for the increase of the supply and give information to the consumer about scarcity.

To ensure economic efficiency, use charges such as water rates should cover the actual costs of water supply (including environmental externalities) and if possible, reflect the opportunity cost of the resource. Charges should reflect the water scarcity, population growth and revenue increases as these changes inevitably result in the increase of the imbalance in water supply and demand.

In most countries, **efficiency in water** use can be improved. It should include better decisions regarding the allocation between different types of uses (agriculture, human consumption and industrial use), but also improve the functioning of the organization created to achieve the expected results.

Box 4.1: Importance of economic and financial tools
Operation and maintenance of water infrastructure
An important situation is when the water system (eg irrigation) is already in place and the system of administration has not enough resources to use and maintain due to various reasons (tax brackets have been withdrawn, users do not pay and water tariffs are low). In this case, the administration will seek to establish a basic water tariff to finance activities related to the use and maintenance.
Managing water quality and environmental goods
The water management is a key element in managing the environment. The water quality and quantity of have an impact on the surrounding environment which can also be considered as "users" of water services. In the absence of markets, economic tools can also be used so that suppliers and consumers recognize these benefits. The pollution charges, rubbish dumps and pollution on the contamination activities are options to reduce the negative effects (externalities) on water plans.
Provision for water management activities
Another usual situation for the use of economic tools is when the water service administration will include new activities or investments which are directed towards improving water management purposes or to extend the water management in a given area (such as a pool for example). The need to establish and record access licenses in a basin, the need for a multi-sectoral management for a better functioning of the water system. In this case, the discussion on water tariffs will need to adopt integrated management approach. The abstraction costs and the apparent water pricing are the most important tools which can be used for that purpose.

When we speak about achieving **equity** in the water sector, we mainly have in mind the situation of vulnerable groups in society who are excluded from access to goods and basic services in our case of access to water.

A particularly acute problem of equity would arise where the poorest pay more per water unit than other social groups, a situation that is encountered in cities offering partial access to drinking water. **The situation of women and children** is often acute. They find it difficult to get access to drinking water, or it requires considerable effort on their behalf to raise money or time. Other equity issues in irrigation include farmers downstream who receive less water than planned due to increased losses in the distribution and the marginalized sectors in the irrigated areas which are the first to suffer from water shortages in time of drought.

Environmental sustainability is an environmental criterion, which cares when the conditions of production or extraction of natural resources and environmental assets which should be evaluated for current and future generations. The relationship between the environmental objective and water systems operation can be very complex.

In an institutional context where environmental objectives are not clearly expressed either in institutions or among policy makers, the water sector will tend to reflect this situation and is unlikely to produce positive environmental effects. For example, if the overall effect of economic policies is to foster rapid economic growth with an incentive to use the contamination process, the water sector will only amplify it when the water will be allocated to activities which promote these policies.

Box 4.2: Sustainability
- **Economic sustainability***: the benefits are higher than the costs incurred.*
- **Financial sustainability***: an activity can continue without external additional funding.*
- **Social sustainability***: a solution is socially acceptable in a social and cultural context.*

The administrative and political **feasibility** is an important criterion in the application of economic tools so, it is recommended to see to it that they are not neglected. For example, water rates based on the price of marginal cost which changes on the basis of each consumed additional unit is not administratively feasible in the absence of a meter.

1.4 Water price and value

Economic principles (besides the rational use of water), which are used in water conservation and the environment are: the costs coverage of costs polluter payers. The financial tools also help make specific investment decisions.

What is the value of water for its user? The **economic value** of water to a user depends on its specific use. A user can specify the value that water has for them, the amount they are willing to pay to use it, if water is used in the production of goods sold on the market, its value can be measured after the offers made by the buyer. These offers are based on individual preferences and are restricted by the distribution of wealth, which is dependent on human capacities and property ownership. They therefore express some willingness to pay which varies from one person to another. Therefore, it would be possible to classify the water consumers according to the order of their preference and the water quantity they are ready to buy.

We can classify the various types of value in:

- **The value of the direct use of water** for irrigation and domestic purposes, industry and commerce which gives rise to the activities that would not exist without that water.
- **The value associated to water conservation**: some people may want to keep groundwater for future use or for the benefit of future generations. This water can fill ecological functions such as maintaining the flora and fauna, wildlife habitat and other ecosystem components.
- **The indirect values** associated to recreation and tourism in the region.
- **The water intrinsic value**: a value deriving from the satisfaction that people can draw due to the existence of a basin or a delta.
- **The water heritage value** resulting from the fact that people attribute to the groundwater a certain value while wishing to have the choice to leave this resource for generations to come.

In a competitive market, the law of supply and demand determines the balance price and leads to an optimal allocation of the resources. The demand determines the consumer's behaviour; he is demanding for a better water service and he takes into account the water price and his budgetary constraints (the money he has to pay for water)

The water supply is often regulated by the state and the price does not automatically result from the interaction between supply and demand in the market. However if the price paid for the use of water does not cover the costs, there are problems in achieving the supply of water which is an economic resource that must **cover the total costs related to its production.**

1.4 Assessment method for water price

Economic tools are very important in the water management especially if there is an imbalance and a notorious misallocation between supply and demand. Because of market failures, the authorities must make decisions related to the levels and to the economic tools (tariffs, fees and taxes) to influence the behaviour and resource allocation. Various assessment methods are used to determine a balance price:

• Cost-profit analysis: it is an informal approach to make a decision and is the mostly used analyzing framework provides.

• When the water is a perfect substitute for another product on the market and it reduces production costs, the savings represent the water value.

• Hedonic valuation of prices: hedonic pricing method makes it possible to measure the amenity value or environmental damage by using the market data, that is to say real estate transaction (disclosed preferences), and not the intentions stated by people questioned in the survey (contingent valuation method)

Box 4.3: Water cost
It is the cost required for the mobilization of water to the final recipient and not the water cost itself.
It is made up of: the supply total cost related to resource management, operation and maintenance expenses, financial costs, opportunity costs related to subsidiary uses of water and external economic factors related to changes in economic activities in the indirectly affected area. It is this cost that is generally based on water costs or prices.

• Contingent Valuation Methods: The contingent valuation method is not based on behaviour observation, but uses the reconstruction of a fictitious market (quota) to induce individuals to disclose the value they attach to property or natural environment, improvement or damages which were caused. Its implementation is based on surveys, with a representative abstraction of the population, in which respondents are subjected to various fictitious scenarios which estimate the value they attach to the studied good.

• Transport cost methods: The transport cost method is used to determine **the value of recreational use** of natural sites, such as river on which fishing is practiced, hiking trail, Natural Park to observe the flora and the fauna. To take advantage of recreational amenities obtained through a natural site, the visitor must travel to the site and incur transportation costs. These costs are implicit prices and can estimate the value of recreational use of the site.

2. Economic and financial tools

2.1 Economic tools

The well known economic tools are the water tariffs, the abstraction fees, water subsidies, and taxes on water. The use of these tools are based on economic principles (besides the

rational use of water), which are applied in water conservation and environment, and which cover the costs and the polluter payers.

The water tariffs are among the most important economic tools and are put in place to make users pay their recurrent use of water services. They may or may not fully cover the cost of water service. They are broadly defined as all taxes and charges levied on users of a service, if they maintain a certain relationship with the direct provision of service. The water collection, storage, transport, processing and distribution cost in major sectors such as households, industry and farmers is covered (wholly or partially) by charging fees to the users.
Charges for water abstraction, on the other hand, are similar to water tariffs, but are levied on the multiple users of the source of water abstraction. These charges are extremely important for the funding of IWRM activities. Both cannot be imposed as a fixed amount (as a right) or depend on water use. Such charges are also known as the water pricing "in bulk" (large quantities), and could be differentiated through the types of uses (industrial, agricultural or public service). These are potentially important economic tools for managing water allocations between sectors.

Box 4.4: Irrigation water charges and sewage, effluent and wastewater charges
Charges for irrigation water
In most of public irrigation projects, the price paid for the use of water are well below the levels of full cost recovery and usually represent only a fraction of the recurrent costs of operation and maintenance. Many farms (large or small) do not pay formal charges for water, through which they could make informal payments to obtain access to public irrigation.

Charges for sewage, effluent and wastewater
where public sewer systems exist it is appropriate to encourage businesses and households to connect up and use. The extra cost on the system of additional users is generally insignificant, except for major industries, and there are benefits in terms of public health, to use a centralized collection and treatment, rather than private solutions. It is also important to maintain adequate flow for the sewage and wastewater treatment plant to work correctly.

The disposal charges are applied to activities which discharge effluent into hydrological units. Such fees are increasingly used to monitor and reduce water pollution (especially in developed countries) and will vary depending on the quantity and quality of the discharge. The administration and control cost of these discharges are generally high. Therefore, poor countries are less willing to impose them, even when there is a considerable pollution due to economic activities in their main stream or hydrological features.

Water subsidies should be used to promote social equity, growth, employment and income growth in particular economic sectors. A case of subsidies and social equity occurs when the water service is beneficial to the individual user. Subsidies to water users are management tools which can be justified by the fact that:

- Many users are poor and cannot afford the tariffs of recovery cost;
- the use of healthy water sources and basic household hygiene should be promoted because they improve public health;
- Subsidies can be used to accelerate measures to save water, or pollution reduction by businesses and households.

The pollution taxes are applied in many projects of public and private investment which negatively affect water quality and degrade aquatic ecosystems. However, many countries have no standards to control the water pollution or the ability to enforce existing legislation. Some countries levy environmental taxes on effluent wastewater directly rejected into natural rivers. This practice is based on **the polluter-payer** principle. The establishment of appropriate standards for setting pollution taxes requires a careful analysis of costs and benefits, given the high costs of decontamination, monitoring and enforcement. In addition, data from effluent discharges should be the subject of public information for the system to work properly.

2.2 Financial tools

As a reminder, **funding** means individual decisions made by organizations and companies (public or private) to maximize in the short or long term, the incomes from their assets or return on investments.
Some tools can be used for both economic and financial goals. However, the two effects may overlap, and the same tool can perform a single goal, or two, in various circumstances.
Some financial tools used affect the way water is used or managed. The water tariff generates revenue to fund the continued operation of water systems (financial), but it can also influence consumer behaviour vis-à-vis water, for example by encouraging more careful use and promoting its preservation (economic).
Indeed, the economic tools are those which influence user behaviour vis-à-vis water allocation and water resources, while financial tools generate income for the operation and development of the sector.

3. Financing water

3.1 Inequities in financing

Most of the industrialized and middle-income countries are able to complete the strategic development process by their own means. But some low-income countries do not have adequate human, technical or financial resources to finance the water sector. In these countries, the sector funding is broadly made by technical and financial partners through bilateral and multilateral mechanisms.

The "water sector" includes all aspects of development, management and use of water and infrastructure. Other functions and services (planning, data collection, decision making, support and institutional reform, regulation, legislation, compliance, awareness, etc..) also need adequate funding.

In reality there are inequalities in the water sector funding and some services / functions are easier to fund than others.

Easier to finance: some sub-sectors are well specified and provide public services clearly recognizable and marketed. These sub-sectors often have their own public sponsoring agencies (in some cases, a regular budget, a certain degree of financial autonomy and financial self-sufficiency). For sub-sectors such as hydropower, navigation, urban water supply and forestry elements of protection of recharge areas, the funding does not constitute a problem.

More difficult to finance: other sub-sectors such as services, irrigation and wastewater tend to be underfunded in practice, mainly because of the difficulties in recovering costs from users.

More easily overlooked and underfunded: some services and functions essential for the regular operation of other components of the water sector, which act as IWRM cement, tend to be neglected and underfunded. Such integrative functions, such as environmental protection, management of recharge areas, protection against floods, research, hydrological / piezometric monitoring and forecasting, coordination, public awareness raising, consultation with stakeholders and institutional capacity building are vital but often neglected and underfunded.

3.2 The costs to be funded

The water services are subject to both the regular and one-time financial costs, requiring various funding sources. The two categories of conventional costs are recurrent costs and capital costs:

Recurrent Costs: Recurrent costs include the expenses involved in the continual operation of all parts of the water sector, including wages and salaries, fuel, electricity, chemicals, spare parts and minor financial tools necessary for equipment maintenance and repair. Some recurrent expenditures constitute the **general expenses** heading which are fixed and do not vary with the level of service (eg salaries, office rent, research, monitoring, meter reading and maintenance routine). Other items are **variable** and rise and fall with the level of service provided (eg, chemicals for water treatment and power consumption for pumping water).

Capital costs: Capital costs involve considerable investment headings such as:

- The infrastructures (dams, urban distribution of water networks, etc.).
- The development of the resource (eg, protection of recharge areas or groundwater wells drilling);
- Major repairs;
- Modernization (eg, improving water treatment plants),
- The rehabilitation of old or damaged facilities, etc..

These activities normally require specific financial resources. In a water system which is "mature" (developed), the water services capital costs are largely funded by fees paid by present and future users. In developing countries, the government subsidies, the "soft loan" and ODA (Official Development Assistance) are more commonly used.

For the funding of the recurrent costs, the most sustainable source is in the fees paid by users, including cross-subsidies between various categories of consumers. When governments are willing and able to subsidize water services, funding can also be done through the annual budgets. In countries moving towards IWRM, institutional arrangements and financial mechanisms for these functions may fail and need to be scheduled, probably from the beginning. The preparation of IWRM plans, the participation of various stakeholders, and preparation of necessary reforms for good governance in the sector are themselves functions of the water sector which need to be funded.

3.3 Funding strategies

The water sector institutions are highly country specific, and their financial architecture should be tailored in each case. There is no universal plan, but some common sense principles can be offered as a guide when setting up a strategy for water funding:

Use of public funds for public goods: Some activities have clear characteristics of public goods and have important externalities (eg, research and information, flood control, reforestation, protection of recharge areas, the establishment of general policies and the protection of wetland biodiversity). There are strong reasons for continuing to use public funds for these activities, which should have priority in case of tight budgets.

Cost recovery from users for directly productive services. They introduce user charges for water services when they are affordable and when services are used in a commercial or recreational context. The water management agencies should be able to collect profitable and non-profitable services to subsidize them in a crosscutting way. Concerning household water and sanitation, tariffs need to be developed by thinking about affordable prices. If subsidies are used, they should be directed to those who are mostly in need. Water subsidies for farmers are a special and difficult case.

Appropriate financial power delegation to infra-sovereign and local bodies (eg, pricing, contract loans, bonds, levy pollution taxes, issuance of private concessions and direct contacts with banks and foreign agencies). This is in conformity with the widespread delegation of responsibility of services to sub-sovereign agencies. There are strong reasons to support their responsibilities with necessary financial powers and responsibilities for an effective delegation. Such power will require a major effort to strengthen local capacity in many countries, with appropriate support and control by the central government. Financial delegation will be subject to national macroeconomic considerations and will need to be subject to Treasury rules, which is not appropriate in all cases.

Increase of the service providers self-financing. The potentially self-financed projects and institutions should be encouraged to improve their funds and attract more funds. Comparisons of performance with similar companies should be made. The evaluation agencies also have a useful role in introducing transparency in the financial performance of public agencies.

Subscription for foreign subsidies. It makes sense to maximize subscription to available subsidies before seeking alternative sources of funding. However, the Official Development Assistance (ODA) should be used to collect other sources and create incentives (eg through assistance based on production), and should avoid creating a dependency on assistance and reduce the pressure for reforms which are essential in the long term.

Co-funding should be sought for transnational projects and those with international benefits, such as cross-border programs with "global" dimensions. This is more important when the upstream or downstream environmental standards impose additional costs to the concerned country.

The cost of multiple-goal plans can be shared with other sectors when the water resources management creates additional products and services (eg, hydropower, protection against floods, irrigation and leisure).

Some water externalities can be collected cash and revenues assigned to IWRM. Water can sometimes be the victim, sometimes the author of environmental or social "evil deeds". According to the polluter-payer principle, the rejection of untreated wastewater into rivers should be taxed. The revenue should be reinvested in the water sector, for example through an Environmental fund, or through subsidies and special loans for sewage treatment and rehabilitation of rivers. The water sector should also receive payments from other sectors (or other departmental budgets), for example various forms of government payments to farmers for them to practice a new type of mixed farming (fewer livestock, use of organic fertilizers and practice of fallow), which imposes lower costs of processing or water storage.

Partnerships (between governments, external agencies, NGOs, private operators, non-profit foundations, civil society and community organizations, etc..) are a good way to exploit new sources of funding. But they should observe the principles of comparative advantage and the appropriate allocation of risks (risks should be borne by the party who can best manage them, and / or mitigate them at the lowest cost). The PSP project development within multi-purpose water projects, and in municipal water and sanitation, was not ideal (eg, private partners were left with the risks they managed with difficulty or at a higher cost). A specific type of partnership is between the utility companies and operators in the water sector to provide mutual support (eg through the new 'Water Operators' Partnership' presented by the UN Habitat). If successful, these partnerships should improve access to funding sources.

Using funds from commercial sources is a logical progression for water agencies or service providers having reached a sufficient level of autonomy, capacity and solvency. Several sources are available, each with advantages and disadvantages (for example, loans from commercial banks, IFIs, bonds, shares and microfinance agencies). The central and external guarantees and insurance techniques can improve the conditions of access to these sources.

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Exercise 1 : Knowing IWRM and its economic tools

- **Goal**: Applying IWRM knowledge on pricing and water resource use situations
  Duration: 30-45 minutes

Activities: Comment the practice below in relation with IWRM approach and your knowledge on the economic and financial tools:

• Trade unions of workers in a water company, claiming their outright free water consumption. The water company authorities defended the principle of compensation for water consumption of workers. The former will then pay their water bills. In connection with the IWRM approach, which opinion do you support? Justify your position.
• The BRUM water company established, in terms of pricing, a minimum of 15m3 per month: If you consume less than 15m3 in the month you pay for consumption at a tariff of 15m3 socially studied. It is beyond 15m3 per month than the actual charging begins.
• On an irrigated area irrigators are charged for water on the basis of a set price of 75 000FCFA per hectare operated.
• The general meeting of water users in the city of Kokoti adopted the principle of charging per household of 5,000 CFA francs per year per household.

Exercise 2 : The advantages of considering water as an economic good

Goal: Learning how to prepare an argument for advocating the consideration of the water economic dimension
Duration: 30-45 minutes

Activities: A member of the civil society argues that recognizing the water economic value certainly jeopardizes its access to the poorest.
Do you have any arguments to respond to his concerns?

Exercise 3 : Implementation of Economic tools

Purpose: Discussing how to implement the economic tools to encourage behavioral change.
Duration: 30-45 minutes

Activities: Do you want to change the following behaviors?
• Water waste by farmers pumping water from a river:
• Water pollution by industrial waste and household solid waste;

How can you apply the economic tools to encourage behavioral change? What other mechanisms can be used to change behavior and achieve desired results?

Young, 1996. *Measuring Economic Benefits for Water Investments and Policies*. World Bank Technical Paper No. 338.

CHAPTER V - Stakeholders involvement in IWRM

Educational Objectives

• Identify the various actors in water and implement mechanisms for participation of all stakeholders
• Have some knowledge on conflict, mediation, advocacy and types of potential conflicts related to water
• Develop concepts on gender and the process of its being taken into account in water management

1. Participatory approach

1.1 Importance of stakeholder involvement

One of the guiding principles of IWRM, drawn from Dublin states that " *water development and management should be based on a participatory approach involving users, planners and policymakers at all levels*." The participatory approach is organized by the idea that individuals and groups have the capacity to make the necessary changes to ensure their access to resources, even to CONTROL them. It is therefore an approach aiming to support communities in the context of acquisition of a POWER over their destiny. Consequently, the use of participatory methods play a role of social facilitation, of consultation, of coordination and training, of advocacy, of mobilization, of sensitization, of accountability, and finally of awareness. Participation is identified with a social process to return to all the stakeholders the power of initiative and decision in the definition and implementation of actions and programs that affect their own future.

Participation means that external interveners recognize all stakeholders as agents of mobilization, social change or as full partners, not as targets or means of implementation of decisions taken without them. Water is a resource that is subject to multiple competing uses. Due to the increasing pressure it undergoes because of the increased pollution / negative externalities, of use practices that could lead to conflicts upstream and downstream, it is important to ensure the participation of as many stakeholders as possible and different authorities in the management of this vital resource.

The integrated management of resources is partly based on participation which is at the heart of most of these basic principles. Planning and implementing IWRM require a strong commitment for a sustainable management of water resources. They require political will and leadership from all the stakeholders. The stakeholder engagement is necessary at all stages of the process especially as they strongly influence water management through joint efforts and / or behavioural changes. Hence, the need to identify and mobilize relevant stakeholders, in spite of their multiple and often conflicting objectives.

The involvement of stakeholders is crucial for several reasons:

- The identification of stakeholders' interests, their importance and their influence on water resources management and use;
- The development of a basis and a strategy to involve stakeholders at different stages of preparation and implementation of IWRM;
- The knowledge of views and interests of stakeholders through effective participation to ensure the success of reforms in the sector of water when the water is known to be everybody's business.

1.2 Characteristics of stakeholders participation

The stakeholders want to participate to protect their interests and solve their problems. They must be involved because the decisions of governments are difficult to implement without a participatory approach. In fact management is most effective when it is performed by stakeholders. We must recognize that decisions taken unilaterally by the regulatory agency without social consensus is often impossible to implement. It is clear that the strategy of stakeholder engagement is an integral component of the management of water resources and does not constitute a one-time event.

Several advantages are related to stakeholders' participation; we can reach consensus decisions in using stakeholders' experience. We can develop a consensus and information sharing through the prevention of conflicts. There are also socio-economic aspects linked on the one hand to the promotion of equity among users, and on the other hand to the optimization of pumping and to the reduction of energy costs. The technical advantages consist in a better estimate of water abstraction volumes.

Stakeholder participation can take place at different levels, and this highlights their level of commitment that depends on the nature of this participation:

• **Information**: This is to provide stakeholders with balanced and objective information to help them understand the problem, alternatives, opportunities and / or solutions. The experts from outside the community decide unilaterally on the planning and direct the process; there is lack of users involvement.

• **Consultation**: It means obtaining feedback from stakeholders on analysis, alternatives and / or decisions. The external or local development agents learn about the views at the local level, analyze the information and decide what action to take.

• **Implication**: The technicians work directly with the actors all process long to ensure that the concerns and aspirations are understood and taken into account.

• **Collaboration:** We must work in partnership with the public in every aspect of the decision including the development of alternatives and the identification of the preferred solution. Local population work with experts non-member of the community to determine priorities. But experts have the responsibility to lead the process.

• **Delegation**: It means placing the final decision in the hands of stakeholders. The population develops its own program, mobilizes and implement it. It uses outside experts, not as initiators / mediators, but as advisors.

The type of participation can also vary depending on the features and aspects of stakeholder involvement and participation can be:

• **manipulated**: It is merely an attempt;

• **passive**: People participate in being informed of what has already been decided or has already occurred and the information shared belongs only to external professionals;

• **consultative**: People participate by being consulted or by answering questions, no part is granted in the decision-making and professionals are not obliged to take into account the views of people;
• **for material incentives**: People participate in return for food, cash or other material incentives, they have no stake in prolonging practices when the incentives stop;

• **functional**: Participation is seen by external agencies as a means of achieving the project objectives, especially reducing costs, people can participate by forming groups to meet the predetermined objectives of the project;
• **Interactive**: People participate in joint analysis leading to action plans and formation or strengthening of local groups or institutions that decide how resources are used, learning methods are used to gather multiple viewpoints;
• **by self mobilization**: People participate by taking initiatives independently of external institutions, they develop contacts with external institutions for resources and technical advice but control the resources management.

2. The types of actors and their involvement

2.1 Identification of stakeholders

Ensuring the sound understanding of issues of various interest groups, why and where they wish to participate and what their expectations and skills consist in, goes through the stakeholder analysis which has four main steps. The main steps of this analysis involve:

• The identification of potentially affected actors or who can potentially be affected by changes in water management; at this level the following questions must be asked: *Who are the potential beneficiaries? Who might be harmed? Have the vulnerable groups that may be affected by the plan been identified? Have the advocates and opponents of changes in the systems of water management been identified? Are Gender interests adequately identified and represented? What are the relationships among stakeholders?*

▪ The assessment of stakeholders interests and IWRM potential impact on these interests: what are the advantages that may derive from this project at the benefit of the stakeholders? What resources the stakeholders can and want to mobilize? What interests of the stakeholders are conflicting with IWRM objectives?

• The assessment of the influence and importance of identified actors: *What are the power and status (political, social and economic) of each stakeholder? What is the extent of organization of each stakeholder? What are the controls that stakeholders have on strategic resources? What are the informal influences of stakeholders (personal connections, etc..)? What is the importance of these stakeholders to the success of IWRM / of the project?* In this step the identification of categories of stakeholders (Table V 1) is undertaken.

• The definition of a strategy and plan for the participation of stakeholders at different stages of IWRM planning and implementation. The participation of stakeholders should be planned according to the interest, the importance and influence of each stakeholder, and special efforts are needed to involve important stakeholders who lack influence. Methods of stakeholder involvement should be considered with the organization of workshops with stakeholders to discuss on water issues, the establishment of a representation in the management structure of the planning process, local consultation on the field and with partner organizations (such as NGOs, academic institutions, etc..).

SOURCE: Overseas Development Administration 1995

Interest	Importance	
	High Influence	**Low influence**
Great Interest	These stakeholders form the basis for an effective coalition to support the project	These stakeholders will need a special initiative if their interests must be protected
Low interest	These stakeholders can influence the direct effects of the project but their priorities are not those of the project. They can be a danger or obstacle to the project	These stakeholders are less important for the project

SOURCE: Overseas Development Administration 1995

V Table 1: Influence and interest of the stakeholders

There are different categories of actors (those who can influence decisions and those whose influence is low) with varying interests. Various stakeholders with a wide variety of groups or individuals whose influence and importance will be assessed. We can mention, among others: water users who may form an association, the services involved or in charge of water resources management, public sector, private sector, NGO ...

To assess the importance and influence of stakeholders one must consider:

- The (political, social and economic) power and status of the stakeholder.
- The degree of organization of the stakeholder.
- The stakeholder's control over the strategic resources.
- The influence of informal stakeholders (personal relationships, etc..)
- The importance of these stakeholders in the successful management of water resources.

These evaluations will determine the appropriate strategy for the participation of various stakeholders. Then they will be invited to consultations through a participatory approach (awareness campaign and make them participate in decision making and in water resources management).

2.2 The mechanisms of participation

The institutional mechanisms to implement the participation of stakeholders in water management cover several aspects. The government should launch the legal, institutional and organizational reform to improve the protection, the technical, economic and financial management of water resources by involving all stakeholders. The aim of this reform will promote a change of governance in the country, which would balance the satisfaction of demand and conservation of water resources by promoting equity and social dialogue.

It should also improve equity in access to water, the capacity to contribute and the effective participation of all stakeholders in the mobilization, operation, and protection of water resources. The authorities should also promote and implement IWRM principles in the development and implementation of policies and legal instruments related to water, improve

communication, information, education and awareness on water.

The participation of all stakeholders in decision-making process requires that three conditions be met:

- Setting up institutions for stakeholder participation;
- Providing appropriate information to stakeholders so that they can participate knowingly and not just make up numbers, that is, mechanisms of participation and information are defined and implemented ;
- The definition of representation mechanisms accepted by all, this is particularly important for non-state actors (farmers, livestock farmers, NGOs, grassroots groups, etc..).

The institutions to be created or reformed will be fully effective if they are given the means proportionate to their missions. Among these means, human resources are crucial.

3. Gender Mainstreaming

3.1 The Gender concept, basic principles

The concept of "Gender" appeared in 1972 and spread in the 80's in development vocabulary. The concept, which first spread in the English speaking countries, refers in the one hand to a development philosophy and on the other hand to an approach of analysis.

The Gender concept refers to the concept of social inequality, and can show how unequal relations can be inhibiting factors for development. Gender is a way to see, understand and act on all the details of the lives of women, men, girls and boys. It is a concept that identifies and refers to relations between women and men, boys and girls, how these relationships are socially constructed and to social differences between women and men.

The term Gender is a social and cultural construction that refers to the acquired character, roles and tasks performed by men / boys and women / girls of a given society. It describes the relationship that society created between men and women that can influence development goals. It also refers to differences and / or inequalities that characterize and influence the lives of men and women in a given context.

The differences between men and women are biological and social. Sex refers to biological differences between women and men. Gender refers to social differences between women and men.

Relations between men and women are learned, are changeable over time and vary widely from one country to another and among different cultures within the same country. The Gender concept is the problems of men, women, girls and boys as part of a set of norms, values, attitudes and perceptions through which the societies affect social roles and status to each of both sexes.

Two fundamental principles underlie the concept of "Gender": **equality** and **equity**. Equality refers to rights, opportunities for all members of society. Everyone has equal opportunities, particularly in the area of access to resources. Everyone has the same rights to a given situation. It refers to non-discrimination against persons based on sex regarding the opportunities, the allocation of resources and benefits and access to public services such as: the right of access to drinking water, education, health, voting, etc.

In general equity reflects the discriminating factors that do not allow those who are designated as equal to benefit from these advantages truly equal. Equity enables the consideration of gaps from the start. It is also the requirement of a fair treatment and equitable distribution of income and profits. The concept of equity requires social justice for the creation of social harmony. It is envisaged that the distribution, representation, duties or choice of roles, tasks, functions and responsibilities will be shared equitably between women and men in development.

Equity therefore refers to the concept of justice in all aspects of life. It recognizes that men and women have different needs and these needs must be taken into account in order to correct the gender imbalance: equity in the quality of services in the salary, in the choice of careers for girls and boys.

3.2 Gender in Water Resources Management

Gender disparities are noted in the formal management of water that is predominantly male. Although their numbers begins to grow, women's representation in the institutions of the water sector is still very low. This is important because the way water resources are managed affects women and men differently. As guardians of family health and hygiene and as key figures in the water supply and domestic supply, women are the primary stakeholders of water and household sanitation. However, decisions on technology of water supply and sanitation, the locations of water points, operation and maintenance systems are mainly provided by men. Crucial to the philosophy of IWRM is that users of water, rich and poor, men and women can influence decisions that affect their daily lives.

The central role of women as providers and users of water and as guardians of the environment is a guiding principle of Dublin. IWRM requires Gender consciousness. In developing the full and effective participation of women at all levels of decision making must take into account how various societies affect social, economic, and cultural roles peculiar to men and women. There is considerable synergy between gender equity and sustainable management of water. Engaging men and women in influential roles at all levels of water management can accelerate the achievement of sustainability; and water management in an integrated and sustainable way contributes significantly to Gender equity by improving access of women and men to water and related services for the satisfaction of their basic needs.

Putting the emphasis on gender is essential to sound development practices and is at the heart of economic and social progress. The results of a development can neither be maximized nor sustainable if it is not clearly acknowledged that every policy, program and project affects men and women differently. Considering gender as an interdisciplinary view implies that women's views, interests and needs shape the development agenda as much as men, in addition to supporting progress toward more equal relations between men and women.

The Dublin Principles, the basic philosophy of GWP, recognize the special role of women in the management of water resources. Several tools can be used to build meaningful recognition of Gender in the management of water resources. Gender needs should be part of the overall policy framework to ensure that policies, programs and projects consider the differences in experiences and situations between men and women. Equal participation in

political and social problems implies the equal right of women to express their needs and interests as well as their vision of society and take part in decisions that affect them. Their ability to do so may be reinforced by community organizations and institutions and capacity building for participation.

During the planning process of the project or program cycle, a social and Gender analysis should be done in its early stages of to integrate the findings in its planning. Hence, institutional weaknesses or cultural biases that could lead to the securing of Gender outcomes would be identified and the needed reforms implemented. The means must be identified to ensure the participation of women and men in decision-making in the planning process and gain knowledge that will enable them to participate without indication of prejudice on information. The ongoing search of data, the development of indicators and exchange of information helps to build the basis of a significant Gender awareness and effective changes in the context of IWRM.

3.2 Gender analysis

Gender analysis is taking into account the multidimensional concept of Gender in various sectors / development activities. It is a diagnostic study which allows a better understanding of the situation of men and women in a given environment, and their specific needs to formulate strategies and remedial measures.

Gender analysis examines the factors rationally related Gender that is found in an entire program, from the initial idea, the needs assessment and the design till implementation and evaluation. It also takes into account other criteria in the categorization of gender that is not necessarily homogeneous: age, ethnicity, social status, economic power, religion, socio-professional categories etc.

It also provides a systematic method of observing the various roles of women and men in development, as well as their differential impact in their roles for the development. It essentially raises the question of "who": *who does what, who controls and who has access, who benefits from what, for the two sexes according to their age, religion, social class, ethnicity, race and caste?*

Gender analysis also implies that within the major demographic, socio economic and cultural groups, data and analysis are organized and grouped by sex.

Gender analysis determines if it is enough to reduce just duties or to build capacities, it has three main steps:

- Identification of roles, responsibilities, needs and interests of women AND men.
- Identification of constraints / obstacles, of socio-political, institutional, economic factors.
- The formulation of policy measures and actions to reduce quantitative and qualitative imbalances.

The key elements of Gender analysis relate to:

- **Labour division according to gender:** the society assigned different roles,

responsibilities and activities to men and women based on biological characteristics, since the process of their socialization.

• **The triple role of Gender:**

o **Reproductive and productive role:** They are the responsibilities and domestic tasks which sharing is related to the sexual division of labour. It includes all activities related to family welfare, care and education of children, collecting water and fuel, etc.. The productive aspect includes the production of goods and services meant for consumption and trade (agriculture, industry, fisheries, livestock etc..). It is generally associated with a remunerated activity/ or which generates income.

o **Role of community management:** It includes all tasks associated with organizing collective activities and social services: ceremonies and festivals, all activities to maintain social cohesion and linkages within a community, local political activities, participation in social groups, etc..

o **Political Role:** This role is exercised through the political activities and advocacy of traditional structures (village chief), political parties or civil society. These political activities may be at the community, local, national or international level. The participation of women and men in these activities depends much of their class, their education, their age...

- **Practical needs and strategic interests**: Practical needs are those related to the improvement of living conditions. The strategic interests of women are related to a need for greater equality in the division of labour, access to training, distribution of wealth and resources, participation in decision making and the exercise of power. The satisfaction of strategic interests is in the long-term and creates changes in roles, access and control over resources and benefits. One can indeed improve the living conditions of women without improving their position and status in society.

- **Access to resources and benefits / control:** Access is the opportunity to take advantage of a resource or a benefit. The control requires the ability to decide the use of these resources and those profits. Economic or productive resources relating to land, equipment, tools, labour, money, credit, skills relevant to job market and opportunities in the labour market so as to earn an income. The political resources address leadership, education, information, confidence, experience, credibility, while time resource is related to the availability for training, recreation, meetings, etc..

- Etc.

Box 5.1: Gender analysis for a project/ program of management and for WR development

Design/formulation phase

The data collected in the three stages will have to be used during this phase. The other Gender-related aspects will have to be collected through (I) the analysis of the stakeholders, (II) the analysis of the problems, (III) the analysis of the objectives, (iv) the elements of these analyzes will be integrated in the logical framework

Phase of implementation and monitoring

- *Establish organizational structures that promote participation of men and women.*
- *Identify centers of power in local organizations and analyze their operation and the role of women and men to avoid any obstacles in supporting the organization of beneficiary groups.*
- *Talk to women separately to know the ways to influence decision-making.*
- *Designate representative (s) (men and women) of the beneficiary population and define with them the organization of various activities and various types of committees to set up.*
- *Define the level of participation.*
- *Depending on the level of participation, establish structures / organizations to manage the actions.*
- *Involve men and women beneficiaries in the choice of technology.*
- *Identify the needs of women and men in order to strengthen their capacities.*

Evaluation Phase

Follow-up activities to measure the extent to which project objectives have been achieved. That is why a clear and precise formulation of objectives is paramount at planning stage:

- *Check that the needs of women and men are met, particularly those of women and men the most in need.*
- *Ensure that women and men are involved in planning of activities and decision making.*
- *Check if the implementation is consistent with the objectives and whether the needs of the beneficiaries are really satisfied*
- *Check the quality of information available on the profiles of beneficiaries and their level of participation.*

4. Conflict management

4.1 The conflicting issue of water use

A conflict is a social situation in which two stakeholders (two stakeholders or more) pursue incompatible goals (objectives). Water is the basis of all life. It is both a habitat, food, means of production, transportation and commodity; it is also a source of competition and conflict. This competitive and conflicting feature for the use of water resources has been seen elsewhere since humans evolved from Homo Faber, host of nature to become Homo Sapiens, teacher and master of nature whose limits or limitations certainly belong to a dimension other than those of our technologies at the service of a practically inhumane consumerism.

Conflicts experienced by humanity for water control follow a model that corresponds to its complexity, to the social differentiations that enrich increasingly social relationships. Because of the very important internal social differentiation, we can notice in:

- urban societies: water needs of cities steadily increase and generate conflicts

- rural societies: the rural communities sometimes suffer from water monopoly by powerful small groups who exert their power over water resources control.

Box 5.2 : Case of DWS Project in the city of SOKODE(Togo) : findings of sociological survey

Case.1. Situation of water fountains management after two years of operation

	Total number of water fountains and water points		
	Total	*Functioning*	*Non-functioning*
Managed by women	*36*	*32 (89%)*	*4 (11%)*
Managed by men	*91*	*26 (29%)*	*65 (71%)*
TOTAL	***127***	***58 (46%)***	***69 (54%)***

Situation August 2006/ Findings of sociological survey

Cas.2. Management situation of water fountains after a increased involvement of women

	Total number of water fountains and water points		
	Total	*Functioning*	*Non-functioning*
Managed by women	*84*	*81 (96%)*	*3 (4%)*
Managed by men	*43*	*31 (72%)*	*12 (28%)*

Situation March to August 2006/ Findings of sociological survey

Box 5.3: Conflicting Declaration of Egypt

President Anwar Sadat in 1979

"The only factor that could trigger Egypt to wage war is water"

The Minister of Foreign Affairs, Boutros Boutros Ghali in 1987

"The next war in the region [will be] on the waters of the Nile."

The Nile is a river shared by 10 states including Egypt which is the country furthest downstream and whose 95% of water come from outside its borders.

Note that many conflicts over water use correspond to differences of interest between social groups involved in this social differentiation. The problem becomes complex with the increasing water needs whereas the sources of supply are stable, and the phenomena of deforestation and increasing pollution of natural water sources.

Water conflict can be defined as a situation where many of these parties are in disagreement, with the distribution of material resources (like water) or symbolic (value given to a source) and act according to a perception that their interests are opposed. Access to water has always been a central concern in human societies. This concern becomes a source of conflict when certain social groups cannot meet their needs. Conflicts between groups have increased due to: the process of desertification and climate change, population growth and overexploitation of groundwater. Water conflicts are expressed in different ways depending on the context related to local conditions and regional development, cultural characteristics, and / or hydro geological and ecological data.

Faced with the difficulties of providing an overview of the mechanisms at work in a conflict, there is an attempt to propose a typology of conflict. Most cases presented are internal processes of a country. Because the risk of conflicts within countries is greater than the risk of conflicts between countries. Leif Ohlsson (1999) argues that " it is the fact of trying to avoid what are considered second-class conflicts within countries, and which are not related

to the scarcity of water but the institutional changes needed to adapt to water scarcity, which may cause international conflicts ".

4.2 Illustration of water conflicts

The conflicting uses of a river or an aquifer

In countries of the North, the rivers are now used by various sectors of the population with different objectives. This multiple use is a source of conflict between:

- Farmers (pumping too much water)
- Conservationists (slow economic development)
- practitioners of recreational activities (fishing, canoe kayak ... destroy fish spawning grounds).

In the countries of the South, the conflicts between:

- different types of farmers (sedentary and transhumant);
- farmers and municipalities of neighbouring cities (including market gardeners whose irrigation scheme is linked to the DWS).

Pollution of a source, water table or a watercourse

In this type of conflict, farmers find themselves in the position of accused or victims. These long and intense conflicts oppose:

- Environmentalists and consumer associations, to industrial agriculture, which pollutes groundwater and rivers;
- industries or cities that pollute irrigation water, to farmers;

The degradation of a wetland

Conflicts may arise between:

- farmers and nature protectors and users;
- farmers and the authorities responsible for the preservation of natural environments;
- important role of waterfowl hunters who may find themselves at the side of the advocates of nature or against them according to the interests at stake

The accusations against farmers relate to the decline of water levels in ponds due to irrigation and / or to drainage of certain wetlands for cropping.

The management of a drinking water system

The water supply of homes is a major point of conflict between the marginalized and the state, municipalities or dealers over access to water supply, on pricing or on the improvement of the system. So, popular movements can be born, combining street

demonstrations, information campaigns through the media, or negotiations for government intervention.

The distribution of irrigation water

Conflicts between farmers on the distribution of irrigation water are among the oldest water disputes and widespread on earth. Over the centuries, many community mechanisms for resolution have been developed. Given the relative failure of the centralized management of new irrigation schemes, the transfer of the management of irrigation areas to water user associations is a source of conflict between the administration and irrigation farmers.

The construction of a dam

Dams projects generate strong oppositions and trigger conflicts that are sometimes lengthy and intense. Because the construction of a dam is a trauma for the people evicted, and also a threat to the environment. These oppositions are reflected in more or less massive mobilizations and demonstrations.

Managing a large river and a basin

At this level, conflicts are extremely complex because of the multitude of actors, the large area, and the high stakes. Across the world many examples may illustrate this:

- Ethiopia-Eritrea conflict over access to water
- Chad-Nigeria: Tensions repeatedly in the islands of the shared Lake
- Senegal - Mauritania, the use of water, bone of contention in 2000
- The waters of the Nile, at stake in the relationship between Egypt and upstream countries

4.3 Management of water related conflicts

The principles of equity and transparency of IWRM require the promotion of good governance of water, the non-conflicting use of the water resource not to mention the prevention and management of conflicts over water resources. To achieve the effective operationalization of these principles, it is essential to master one of the objective manifestations of the use of this resource which is the conflict related to its unique nature. Conflicts over water resource does not relate to a single category. They are complex from the time users do not necessarily share the same objectives, nor the same behaviours / activities. In addition, they also do not have the same values / attitudes regarding the water resource.

The conflict management refers to a wide range of tools used to predict, prevent and respond to conflicts. Sometimes the local traditional systems of conflict management can help resolve conflicts. But in case of failure, we must develop a management strategy that takes into account:

- the typology of the conflicts: conflicts should be classified following the goals and behaviours:
    - o the conflict of interest or use related to division of property and resources;
    - o the instrumental conflicts related to procedures of social organization;

- o the personal conflicts related to beliefs and values of people;
- o the interpersonal conflicts related to considerations of situations, position, hierarchy of men.

• the causes of conflict, refer to everything that could cause the conflict in its essence

• the actors in a conflict: we distinguish on the one hand the direct actors, called belligerents, who are apparently committed and / or suffer the consequences of other indirect actors (the persons concerned), are those who hide behind and who can sustain or mitigate the conflict, because of their position regarding the problem or the direct actors.

• the solutions to resolve conflicts, it's how we want to resolve a dispute. We can adopt a particular attitude to manage our conflict. Thus, resolution of conflict can take many different approaches, through negotiation, mediation, arbitration, which are all tools of conflict management.

Moderation is often used in situations that involve multiple parties. An impartial person involved in the design and conduct of meetings to solve problems, to assist the parties to diagnose, create and implement common solutions.

Mediation is a process of negotiation based on interests. The parties choose an acceptable mediator to guide the design process and obtain an agreement on mutually acceptable solutions. Mediation is generally used when the parties are deadlocked.

Investigation is used when the conflict is too technical. The investigation aims to clarify the issue and make recommendations to solve the problem.

Arbitration: the parties present arguments to an arbitrator "judge" and ask him to find the solution.

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Exercise 1: The participation of stakeholders in water management

Purpose: To identify the roles that stakeholders can play in managing water resources
Duration: 30-45 minutes

Activities
Scenario 1: You are responsible for managing a watershed where: irrigated agriculture is practiced, a catchment is installed to provide drinking water to a secondary city, a food-processing industry is established. Given the drastic decline in rainfall, a significant reduction in rates is noted. Then you decide to proceed with the allocation of water.
• What approach should be taken to involve stakeholders?
• What tasks / responsibilities you give them? And how do you ensure that this responsibility is assumed?
• What is your role?

Scenario 2: You are a stakeholder and your business greatly affected by the reduced flow.
• In your opinion, what should be considered to find a solution?
• What role do you play and what should the government / management agency do?
• What powers and responsibilities must be given to the actors?
• How to finance the actions you recommend?

Exercise 2: Stakeholders 'participation in the management of a shared basin
Purpose: Sensitize on the issues of stakeholders effective involvement in the integrated management of a shared basin
Duration: 30-45mn
Activities: Organize a debate between those for the involvement of stakeholders and those against.
Those who are for: are arguing why actors should be involved in managing a shared basin? How involved? What level of involvement?
Those cons: say why stakeholders cannot be involved in managing a shared basin? What are the constraints / difficulties for a major basin organization to involve stakeholders?

Exercise 3: Gender approach in IWRM

Purpose: To consider gender in the management of water resources
Duration: 30-45 minutes
Activities:
A village in the south has a drinking water point. To ensure the maintenance of the facility, the management committee of the water point sets a payment of 5,000 francs per month per household.
Some households in the place which heads are widows, elderly and poor, say they are unable to pay this sum and decide to fetch water from the creek, with no other suggestion of the community.
• What is your analysis of this situation?
• What steps to take to ensure equitable access of all to drinking water?
• As a community member, what role can you play to find a solution? In your opinion, what role should the management committee play?

Exercise 4: Role play on negotiation between several stakeholders

Purpose: Exposing participants to a situation of conflict of interest, understand the reaction of the actors involved in conflict, apply negotiation skills of a hypothetical case, apply the concepts of IWRM, fostering teamwork

Duration: 2 hours

Activities :

Case Presentation: A basin is located within the country. Development activities in the basin have resulted in drastic changes in patterns of water use and therefore the exploitation of water resources. In a relatively recent past, the basin was covered by 60% of primary forest, and the rest was used for extensive agriculture. Logging, once allowed, but forbidden now resulted in severe impacts on the ecosystem and hydrological conditions of the basin. Mining activities upstream of the basin have affected the quality of the water. Extensive ecotourism weighs heavily on the availability of water and water companies have difficulties to supply people with sufficient quantity. Therefore, large investments are needed to respond to domestic needs in quality and quantity water. The combined effects of the ban on logging, the depletion of mineral resources in addition to traditional farming and extensive ecotourism, lead to high rates of unemployment in the basin with the risk of youth mass migration towards urban areas.

Problems:

Insufficient water

- The water supply is not adequate to meet the increased demand due to population growth and tourism development.
- The erosion has increased with deforestation and led to reduced water availability.

Water Quality

- Spills of upstream mining industries, deteriorating quality of water downstream of the basin;
- Cattle ranching in combination with the highly permeable soil has decreased the quality of groundwater.

The conflicting uses of water

- The domestic water supply is seriously affected by the mining industry both upstream and downstream livestock.
- Industry and livestock have serious consequences for the ecosystem and the development of ecotourism.
- The cattle breeders are affected by the deteriorating quality of water caused by discharges from mines and are forced to drive their animals to another basin.

Game

Because of the reduced availability and increasing pollution of water resources, the authorities have decided to: reduce the allocation of water by 1 / 3, and double the price of water in order to reduce consumption and waste and boost the efficient and rational use.

Roles

Group 1: Small cattle breeders, Group 2: Environmental NGOs; Group 3: Agencies of community water supply; Group 4: Local authorities, Group 5: Industries / mining; Group 6: Tourist Agencies

Participants will form six groups of interest as indicated above. Each group will make a brief description of relevant aspects of its position (use of water, serious problems, interaction with other groups, natural allies, competitors,) and they will formulate their own objectives and arguments to defend their own cause, anything that can help them achieve their goals.

The groups prepare their opening arguments and responds to the government proposal. Each group has three minutes to present its case. During the cycle of negotiation, the groups can make alliance with others to improve their positions. The negotiations are informal and can be held publicly or privately with the allies. After this cycle of negotiations, the groups or the coalitions report back into plenary to convince the authorities of the interest of their activities for the populations. The authorities formulate a policy of consensus acceptable for all.

Discussion and reflection

After the game, the group will discuss in plenary on the following points: Does this imaginary case correspond to a reality experienced? What are the most important lessons to be learnt? Do the negotiation and the consensus, necessarily lead to the most favorable solution for the sustainable use of water resources? - Who should make this decision and how?

CHAPTER VI – Management of DWSS services and agricultural water in IWRM

Educational Objectives

• Have a better understanding of the criteria of access to drinking water and to DWSS systems
• Have an overview of methods of managing DWSS services
• Appreciate the importance of water in agriculture and impacts of agricultural practice on water resources
• Learn techniques for saving water in irrigated agriculture

1. DWSS Services

1.1 Access to safe water and sanitation

Drinking water is essential for health, survival, growth and there is no development without water, without sanitation and without hygiene. In fact, it is so obvious that drinking water and basic sanitation are essential to health that may be considered as granted. Furthermore, the global community committed to halve the number of people without sustainable access to safe drinking water and basic sanitation. Achieving the MDGs remains a major challenge of our states. Sub-Saharan Africa remains the region where the situation remains most alarming, the rate of coverage in terms of access to drinking water and sanitation is still low there.

According to the 2009 Report of the MDGs (UNDP, 2009), in 2006, 2.5 billion people remain unserved in terms of access to sanitation. Sub-Saharan Africa is also facing a real challenge. The goal is to provide access to improved sanitation for 63 % of the population of the region. This represents approximately 370 million people in addition to some 242 million who used such facilities in 2006. Whereas they had the lowest coverage in the field of sanitation in 1990, South Asia and Sub-Saharan Africa have made significant progress. In South Asia, the population using improved sanitation facilities more than doubled since then.

As for the access rate to drinking water in the world, progress has been made mid-way of 2015, yet 884 million people worldwide still rely on unimproved water sources for drinking, cooking, washing and other domestic activities, 84 % of them (746 million) live in rural areas.

Globally, only 27 % of the rural population enjoyed in 2006, the comfort and substantial health benefits provided by running water at home or at the living place. Fifty per cent of rural people had to rely on other improved water sources, such as public water points, hand pumps, wells or improved water source (a small proportion of the population use water from rain). And nearly a quarter of the rural population (24 %) provided drinking water from "unimproved" sources: surface water such as lakes, rivers or dams, wells or unprotected sources.

The challenge remains for our countries to improve the rate of DWSS supply; to that end, the management of the services in charge of water provision is a key component on the side of resources in an integrated approach.

The criteria allowing characterizing the access to drinking water and sanitation were developed by WHO and UNICEF within the framework of the *Joint Monitoring Programs for Water Supply and Sanitation* (JMP) initiated in the early 90's. The JMP report of the year 2000 adopts the following criteria:

- The access to water and sanitation is defined in terms of technologies and services; a range of improved technologies was defined (Table VI - 1). This range is not exclusive and can be open to locally defined technologies;
- The reasonable access to drinking water is defined by the availability of at least **20 litres per person and per day** at a water point located **at less than one kilometre** of the dwelling place of the individual;
- The access to sanitation is defined by the use of a **private or shared system** (but not public) and of a technology guaranteeing that the excreta are hygienically separated from any human contact. Here again a range of improved technologies, nonexclusive of locally defined technologies, has been defined.

Table 0 -1: Improved and inimproved technologies for DWSS

Services	Improved	Unimproved
Water supply	Home connection	Non protected well
	Public fountain	Non protected source
	Drilling with human powered pump	Water provided by water seller
	Protected well	Bottled water [1]
	Improved source	Water provided by tanker
	Rainwater harvesting	
Sanitation	Connection with a public sewerage system	Backet latrine [2]
	Connection with a septic tank	Public latrines
	Flush latrine	Open pit latrine
	Dry latrine	
	Ventilated improved Latrine	

[1] *Considered as "unimproved "because of the low quantity rather than quality*
[2] *Latrines which faeces are manually evacuatedSources: World Report on the development of water in the world and WHO*

1.2 DWSS systems

The DWSS ensures the supply of communities with drinking water for domestic use (for example for drink, food, cooking, bath and hygiene) and requires a continuous supply of good quality water. The drinking water systems in general replace traditional sources of water such as the rivers and the open wells, often contaminated and far away from the dwellings. The benefits in terms of health related to the improvement of water and sanitation services result primarily from the effective and sustainable use of drinking water, as means of hygiene and of elimination of the risks related to human faeces.

The system of Drinking Water Supply consist in a set of works which help make available to consumers water of good quality in sufficient quantity. According to the context, the system must provide water needed for:

- domestic consumption;
- the needs for economic and social development (industrial needs, recreation needs etc.).

It must meet the requirements hereafter:

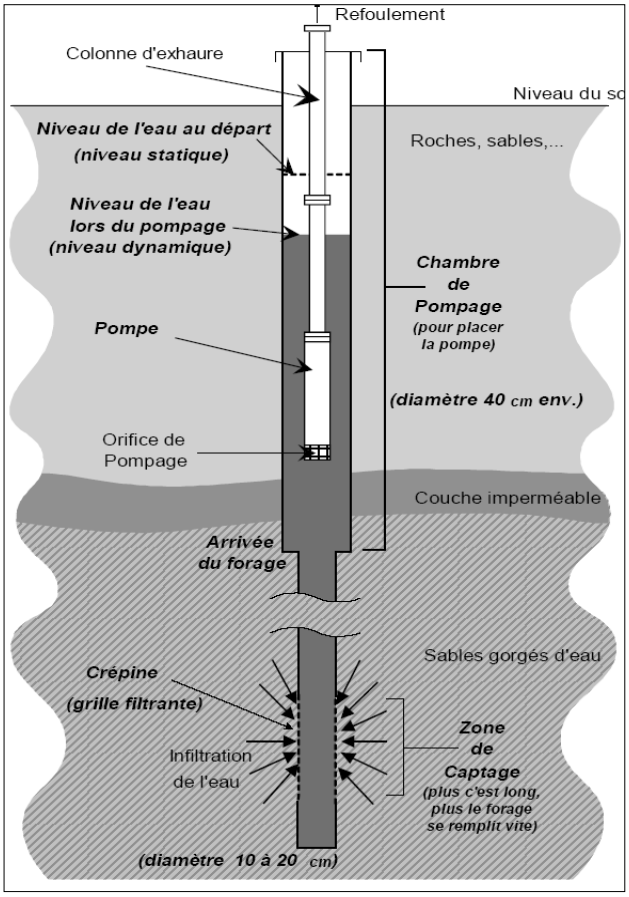
- Availability of water in sufficient quantity constantly and at any season, at all the levels of the area concerned by the system (flow, pressure),
- Distributed water quality must be likely to preserve the health of the consumers and to protect the various equipment; water must be allocated to the user at the least cost possible (taking into account the purchasing power of the users)
- The system built out must be dynamic and open to allow later modifications.

A DWSS system consists in a set of elements which make the requirements for availability, for distributed water quality, satisfactory for the users:

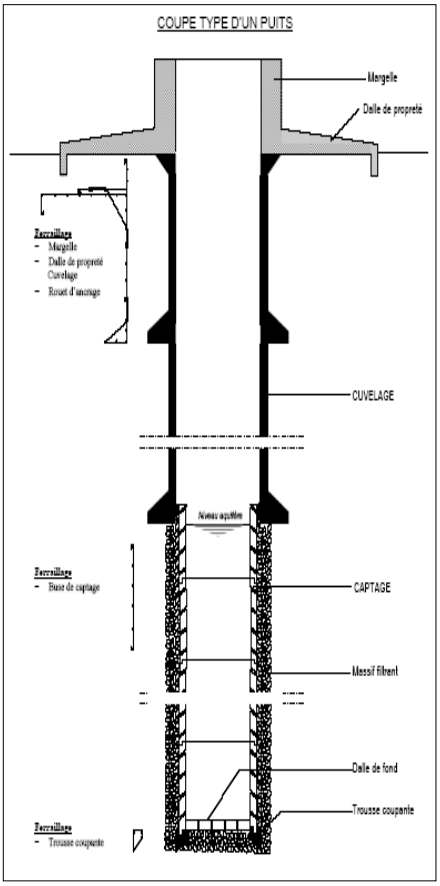
- **The works of mobilization of the resource** which allow the in *situ* abstraction of raw water. Abstraction can be done in using:
    - **Surface water** by arranging abstraction in river, or with dams which create artificial reservoirs.
    - **groundwater** by making drillings or wells (Figure VI - 1), or by developing sources.
    - **Rainwater** by constructing impluviums, or by harvesting rainwater
- **Works for the treatment** of **surface water** which ensures:
    - Clarification of water by decantation of the elements in suspension and a filtering setup (fast or slow) made up of a mixture of sand, gravel and active carbon.
    - Disinfection (proportioning pumps, solution containers) with a chlorine solution to eliminate the pathogenic germs and to supplement the treatment.
- **Specific treatments** for the groundwater which always suffer from a favourable prejudice with regard to their potability; however specific treatments can be started for the elimination of the excess of fluorine, iron, or various pollutants.
- **Pumping works and equipment**, consist of pumps and desurger devices, secondary equipments (like a water meter and a valve), energy sources. Pumping is the means of extraction of the resource towards the works of storage. In the case of a **ground**

water the abstraction of water can be done directly in plunging the pump in the resource. The pumps are activated thanks to energy provided by a man, an animal, a mechanical or motorized device supplied by wind, solar, thermal or electric energy.

- **Storage Works** like tanks, and reservoirs; in the case of a water tower, it will be made up:
    - of a base which is the lower part of the work being used as a support for the tank;
    - of a tank which receives pumped volumes: its dimensions are calculated by taking account of the safety of the service supply;
    - of equipments made up of distribution , emptying and overflow column and a valve allowing the filling of the tank and the distribution.
- **Supply and distribution networks and works** which include the supply network, that of distribution, and the drains, valves and fittings, connections:
    - The distribution network is composed of pipes for the transport of water, of works of distribution and of metering equipment;
    - The distribution network is composed of a principal section and secondary pipes; it can be in the form of a ramification or a grid.
- **Hydraulic equipment** which comprise works and accessories such as the valves, meters, valves, suction cups, drainings placed in glances to facilitate the exploitation, the maintenance and the safety of the network.



Drilling (source : anonyme)



Modern well (source : anonymous)

Figure VI-1: A drilling and a modern well

There are various types of DWS systems, ranging from the well with or without a pump, the drilling with a manual pump, the simplified system, the conventional system with water companies like ONEA Burkina, TdE in Togo.

The choice of a given system depends on criteria like the size of the city, of the population, the level of urbanization (socio-economic development), the nature of the resource and the quality required for use, the distribution mode (private connection and / or collective water point). The level of urbanization of a city can be characterized by the concentration of populations and activities which complexity determines the size and nature of works to implement.

In terms of DWSS it should be noted that economies of scale achieved in major urban centres are not done in smaller centres where water needs and people's incomes are relatively low. Thus, in the equipment of the city with DWSS system, administrative, technical and financial authorities face different situations:

- Large cities with high water demand with a population exceeding 100,000 inhabitants;
- The so-called secondary cities or urban centres with a population between 10,000 to 20,000 and 50,000-100,000 inhabitants;
- Large towns or large rural centres (developed or not) with a population between 2000-3000 and 10,000-20,000 inhabitants.

Box 6.1: Wellbore / drill-well

• The drill-well is a combination of the wells and drilling. The drilling of the borehole precedes that of the well. The advantages are easy access to the resource, the productivity (higher than a conventional well because of the performance of the drilling). The major drawback is the possibility of pollution of the resource, the degradation of the borehole and equipment from the drill-well, by the passage of contaminants from the well into the borehole.

• The wellbore is a well without water collecting nozzles prolonged by a drilling.

In **rural areas** the DWS is primarily concerned with water which is characterized by both quality and closeness, that is to say groundwater. In general the problems are different depending on the DWS scenarios involved:

- For villages with low demand, the use of human powered modern wells or drillings is often recommended; they belong to the domain of rural water
- For large villages and large rural centres, the problems are virtually identical to those in the disadvantaged areas and illegal settlements of large and medium cities. It is advisable to opt for simplified systems that require less investment, such a distribution method for collective water points (water-fountains). Indeed these large rural centres are too small to develop a profitable classic water system, but too large to be in the field of rural water supply.

The major challenge is the sustainability of water services and the organization of the management of water services which implies a strong involvement of beneficiary communities.

The rural DWS has some special features that make that the economic profitability is not a major concern, rather it is essential to aim for cost recovery of maintenance works, but also take into consideration the benefits in terms of health related to the improvement of water services and sanitation that result from the use of effective and sustainable drinking water, but also in terms of poverty reduction.

The best arrangements for managing DWSS services are those that empower the community. Provided, however, that it is accountable and representative; that it has the ability to perform its duties; but also that appropriate pricing and cost recovery mechanisms exist to cover the costs of the provision of services.

For the DWS of large rural centres, it is strongly advised to opt for simplified systems that require less investment and management methods that generate the least cost burden in terms of personnel. Do not forget in this diagram the organization of monitoring and quality control.

In **urban areas** the demand is high and related to sustained population growth in developing countries, as in SSA. The level of urbanization can be characterized by the concentration of populations and activities which complexity determines the size and nature of the works to implement. The **conventional system** is typically required for large centres and secondary centres. In urban secondary centres, this system remains economically unviable due to the low number of subscribers and low consumptions. The existence of competing water points further exacerbates the situation. However economies of scale in large cities compensate the deficits incurred in the secondary centres. Generally in Africa, these centres depend on the National Water Companies.

The undeveloped areas of cities are areas of temporary occupation that offers no guarantee of tenure; Connection of suburban neighbourhoods is often expensive because of their remoteness from urban centres. In addition they offer immediate few demands. The low-income areas have little economic interest with a low water consumption and a reduced rate of connection.

The challenge lies in meeting a growing demand and uncontrolled supply of periurban areas which neighbourhoods are often undeveloped and where there is a spontaneous settlement of poor people. It also consist for all providers, both public and private, to expand access to water and to overcome the tariff handicaps faced by poor people.

1.3 The DWSS management methods

The service management of water supply may take several patterns, ranging from support by the government or public entity delegated to a private public partnership that can take several forms.

The Managing Authority

A managing authority is a management method where the State, the commune or any other public administration funds facilities and operates with its staff. It is directly paid by users. The authority may take several forms: a State service that directly manages an entity with financial autonomy, like a public Institution of Commercial Interest, or a State-owned Company, operating like a private, as in the case of ONEA in Burkina Faso.

When the public sector acts as a direct provider responsible for water services, it often fails in addressing the issues of demand management. The main reason is that governments are reluctant to decide the actual high rates, in order to recover at least the operating costs. In other words, drinking water too often engender losses to public sector services which fail in turn to send the right signal to consumers about the economic value of water. In addition, several public service providers tolerate a massive loss of water through water that is not measured by meters and which sometimes exceeds half of the entire quantity of water produced.

Shortcomings of this management of water services are primarily related to the defective nature of public service in our states. It can be noted:

- Lack of qualified personnel;
- overstaffing which affect the effectiveness and costs of operation;
- lack of rigor in billing, collection procedures with graceful discounts: poor performance;
- the requirement to deposit funds to the public treasury without financial compensation imposed on local authorities with often lengthy disbursement procedures.

It includes several organizational weaknesses related to institutional bodies that are not created, the non-observance of rules and procedures for awarding contracts. Also elected officials, administrators and users should be better able to exercise their responsibilities regarding checks on the quality of service and price; this is rarely checked, because users are not consulted;

Leasing

In this case the State or the municipality finance a facility that is entrusted to a company (the lessee who runs it with his staff, but the State or the municipality remains the owner. Subscribers pay on the one hand, the “lessee- price " which is the remuneration of the lessee company for the service it provides, and on the other hand, an extra-tax for the State to enable it to pay the annuities of loans for the equipment.

It is the company which periodically return to the State or the commune the product of the extra-taxes. The duration of the leasing contract is relatively short and will not exceed 10-12 years because the company has little equipment to be amortized. In leasing, the necessary works are not constructed by the lessee but made available by the community or state. The farmer is therefore only entrusted with the operation of the service.

Leasing has a number of financial and economic benefits. In fact, the delegation of public service is a formula that suits well the community needs, it allows, thanks to substantial funding provided by private sector companies to quickly resolve management and

investment problems induced by an over binding legislation. It allows greater gains in operational efficiency; but the State assumes the investment risk which requires that it exerts control on the farmer. The change of management style is often the consequence of a situation that involves substantial additional costs.

Leasing is justified by the motivation to delegate the management of public service which resides in the extent and modalities of its financial contribution. The delegation has then become an elaborate means of financing the core budget, which is unfavourable to the user taxpayer, while for the delegating authority, the contract of delegation of the public service has the advantage of loosening in the short term immediate budgetary constraints. However, the resulting tariff constraints weigh on users on the long-term.

Outsourcing

The State or municipality finances the equipment and entrust them to a company that operates with its staff. Subscribers pay their bills either to the manager who pays all the amount to State, or directly to the State. In turn, the State pays the manager. Commercial risks are entirely borne by the State, with contract duration of 3-5 years. The advantage of this form of management is a gain in management efficiency; it is also a simple procedure in terms of transfer. But the drawback noted is the lack of continuous incentives for the private sector.

Concession

The company finances the equipment and operates them with its staff. It is directly remunerated from its subscribers. The duration of the concession contract (20-30 years) is longer than the duration of the lease taking into account the need for the company to amortize its investments. Upon completion of the facilities by the company, the state or municipality becomes the owner. Here the commercial risks are completely supported by private enterprise. This management method provides gains in operational efficiency, assets maintenance and management; it nevertheless requires stable commitment and a strong regulatory capacity, the bidding process is also complicated.

Concessions may evolve into leasing, because the concessions, in which the delegate normally bears the investment limit in fact, in some cases the actual responsibilities of the concessionaire. Thus, certain clauses provide that if the work would come to exceed a given budget, it will be under the responsibility of the licensing authority. The risks of uncontrolled prices under such clauses are ultimately important.

Leasing may also move towards concession, because we found situations of leasing where the tenant is given the concession of a part of the works. A farmer in the DWS services can become a concessionaire of sanitation works.

In all cases the realistic pricing of water is a critical component, a dominant factor for the effective management of water demand. The issue of water pricing is central for three reasons:

- First, experience has shown that transparency on who pays what and what resources to use is a prerequisite for accountability and stakeholder participation.
- Second, the pricing of water is a major element in the elimination of water loss and

environmental degradation.
• Third, the pricing of water is a main theme if a quantitative breakthrough in investment in the sector is to occur.

An effective partnership with the private sector requires changes in the role of governments, which must always retain a central place. So they must create the enabling environment for large and small private enterprises to participate as true partners. The role of government is to form a legal and regulatory framework to govern water, creating organizations at national and basin level to provide the working framework to encourage any action which would help poor communities, minorities and women's groups to fully participate.

Community management

The management is done by users themselves organized into Users' committee or association. The advantage is that there is no spending on wages, but there are disadvantages related to the "operators" lack of qualification and motivation, but also the non-transparency of management. In general, the set up management committee accounts, at a general meeting whose powers and responsibilities remain questionable and whose frequency of meetings is not respected.

It is a management mode generally suited to the rural area, it empowers the community, provided that it is accountable and representative, it has the ability to perform the duties devolving upon it. That is why community management committees should also have continuous technical assistance, which may come from local authorities, an agency of the public or private sector.
It is important that the role and responsibilities of stakeholders (communities, private sector and government) be clearly defined and fit within a satisfactory legal framework for ownership and management. This shall include, without limitation, an autonomous association of water users elected by the community that manages the services, establishes the fee schedule and manages the funds.

Capacity building and training at local level are other elements essential to the success of community management. Indeed, to ensure the continuous operation and maintenance of facilities, communities must be trained before, during and after the construction of the infrastructure, to be able to make choices based on all available options, and have the opportunity to develop their skills.

Box 6.2: Adverse effects of concessions or leases

The effects of imperfect competition

• The private sector of DWSS remains dominated by few large-sized international corporations, by agreements often signed between them to participate in tenders and for a distribution of areas of influence.
• If the constraints of continuity of public service and the need to amortize the substantial resources implemented requires a certain duration of the delegation, a tendency to perpetuate existing situations have been observed in many cases.
• The delegation of works to the operator sometimes has as corollary their preferred allocation to companies of the same group.
• If the constraints of continuity of public service and the need to amortize the substantial resources implemented requires a certain duration of the delegation, a tendency to perpetuate existing situations has been observed in many cases.

The effects of imperfect competition

• Local authorities and users lack information on the reasons for change of management mode, for lack of previous checks and real control over services. Studies to evaluate the benefits of different management options or proposals received were often inadequate. The prospective delegates often do not provide technical documents and / or financial documents allowing judging their offers with discernment.
• The modalities of the exercise of the delegation prevent or complicate the production of information that politicians and users should have to fully exercise their prerogatives. Activity reports of farmers and delegates, when they were provided, lacked sufficient information. The opacity, observed in many cases was an obstacle to information of elected officials and users. It is necessary to establish common rules of presentation for the entire profession.
• The local authorities often rely totally on the delegates of their public services, neglecting the duty of control that falls upon them. Activity reports of farmers and delegatees, when they were provided lacked sufficient information. Personnel costs are often controlled by the local authorities. The delegatee often obscures the conditions of employment of staff and allocation of their cost. The trend is to the increase.

The challenge here is to provide better access to water which positive effect is the time savings for women and girls, and expanding their range of choices. The water supply is part of a division of labour based on sex, which increases inequality within households. Charging for services is a central element. Rates are often set to cover a small portion of operating costs. Better cost recovery from households with sufficient financial capacity would allow allocating receipts for the maintenance and for the increase in efficiency, while generating funds to meet the demand of households unable to pay.

Box 6.3: DWS in Ghana: a participatory approach

The effects of imperfect competition

In little more than a decade, Ghana has changed the structure of water supply in rural areas, increasing coverage through more participatory and effective supply systems.

The change was drastic. In the early 1990s, the water supply in rural areas was managed by the Ghana Water Company, a public service responsible for the planning, construction and maintenance of water supply infrastructure in rural areas. The boreholes drilled in Ghana were among the most expensive in the world and only 40% of hand pumps were operating at the same time due to poor maintenance.

Access to water is now extended to some 200,000 people each year. The coverage increased from 55% in 1990 to 75% in 2004, rural areas figuring prominently. Ghana has achieved this through a deep reform of a system that was down, unresponsive and unsatisfactory.

The responsibility of water supply in rural areas has been entrusted to local and rural communities. The authority for coordinating and implementing the national strategy on water supply and sanitation managed by the communities has been delegated to the Community Water and Sanitation Agency, a strong body decentralized with a multidisciplinary staff in 10 regions of the country. The regional teams provide direct support to District Assemblies in planning and management of safe water distribution and sanitation.

New political structures of governance of water have emerged in the context of a broader program of decentralization. The District Assemblies, a major component of elected local government, are responsible for processing and ranking of priority requests from communities for water supply. They also issue contracts for hand-dug wells and construction of latrines and, finally, they manage the grant program on latrines. These Assemblies also provide 5% of capital cost financing facilities of water supply.

Village structures are part of the new system. To be eligible for financial aid, communities must form village committees in charge of water and develop plans outlining how they will manage their system, make a contribution equivalent to 5% of capital costs and assume the maintenance costs.

Source HDR 2006 (UNDP)

Box 6.4: Level of freedom of choice of management mode of their DWSS services

Our Communes do not often have the competencies and skills for DWS projects development, the financial capacity to fund equipment, the management experience, the experience in preparing and monitoring contracts.

So very often the technical, administrative and political authorities after consultation workshops, pilot studies, while recognizing the freedom of Communes to choose their management mode, often give them prescriptive guidance.

What you should know beforehand is that each management mode has specificities allowing to meet specific situations. The choice is extremely important because it often commits the commune for a long period (sometimes up to 20 years for the concession). The management gives different duties and responsibilities depending on the cases and may impact on the quality of service rendered to the user. The delegation or concession does not mean that the commune takes no responsibility for the execution of the service (here water service). It is up to the commune to monitor the conditions in which the delegatee executes the contract.

Careful thought is needed first, to analyze the situation of the commune, its needs, constraints, resources, etc ....

For the chosen mode of management the commune should be sufficiently informed to conduct discussions with various stakeholders including consumers, private candidates, etc. ...

Careful thought is therefore essential first to analyze the situation of the skills of candidates with the other actors:

- *existence of locally trained stakeholders, regional level, national level. Do not forget to assess their financial capabilities;*
- *existence of associations of users: level of organization, management mode, insufficient achievements;*
- *the problem of monitoring and control of water quality;*
- *The level of information of various stakeholders on the issue: workshop, a forum for information*

2. Water management in agriculture

2.1 Agricultural Water

Currently, about 3,600 km3 of freshwater is withdrawn for human use, the equivalent of 580 m3 per capita per year. In all regions of the world except Europe and North America, agriculture is by far the largest user of water as the water used in agriculture account for about 69% of all withdrawals, domestic uses account for about 10% and industry about 21% (Figure VI-2).

It is important to distinguish between water that is abstracted and the water that is actually consumed. Among the 3, 600 km3 of water abstracted each year, about half is taken up by evaporation and transpiration from plants. The water that is abstracted but not consumed, by contrast, is a return flow in runoff into rivers or seeps into the soil and is stored in aquifers. However, this water is generally of poorer quality than the water that has been abstracted. Much of the water withdrawn for irrigation (often more than half) is consumed as a result of evaporation, or "swallowed" by crops and crop transpiration. The rest (almost half) infiltrates and recharges the ground water supplies or surface water runoff or lost in unproductive evaporation.

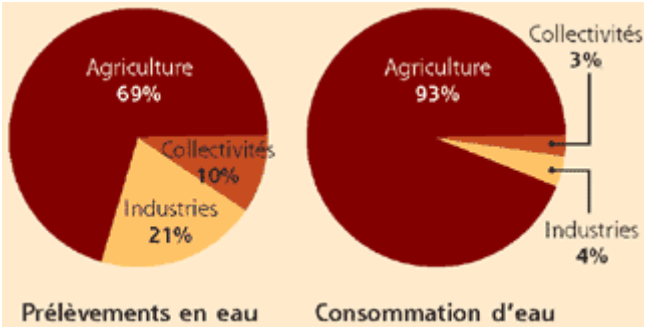


Figure VI-2: Withdrawals and water consumption of three main sectors of use (FAO, 2002)

Nearly 90% of the water withdrawn for domestic use is returned as sewage into rivers and aquifers. Industries in general consume only about 5% of the water they withdraw. Wastewater from domestic sewage systems and industry should be treated before being discharged into rivers and eventually reused, but they are often heavily polluted.

The figures of water withdrawals in agriculture do not take into account the direct use made of rainwater in rainfed agriculture. In fact, most agricultural produce come from the direct use of rainwater and irrigated agriculture uses a lot of rainwater. Overall, these figures show the importance of agriculture in the global challenge to ensure food security with increasing water users. For one ton of grain harvested it takes 1,000 – 3,000 m3 of water used, that is to say 1-3 tons of water for one kilogram of rice (FAO, 2002).

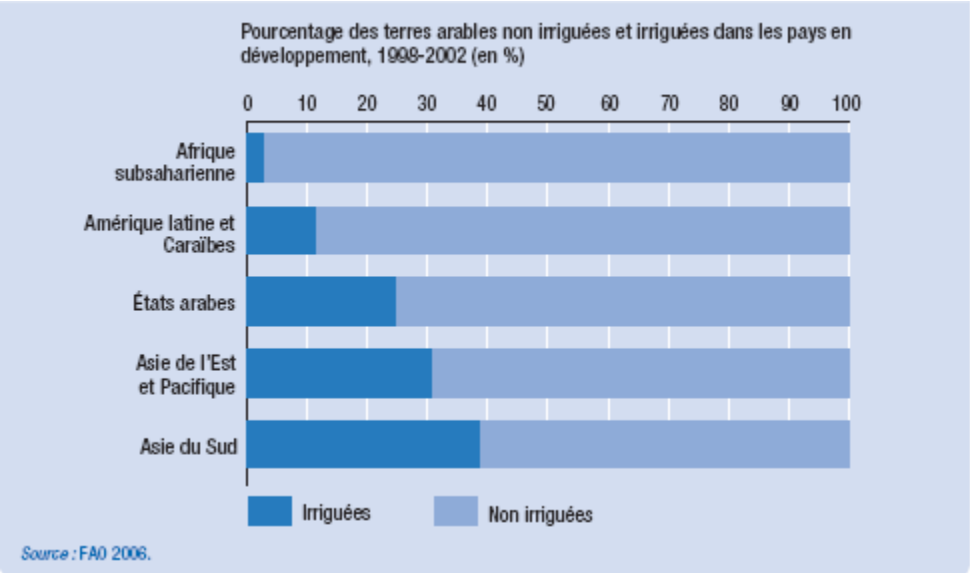


Figure VI-3: Irrigated and non irrigated arable lands in developing countries (FAO, 2002)

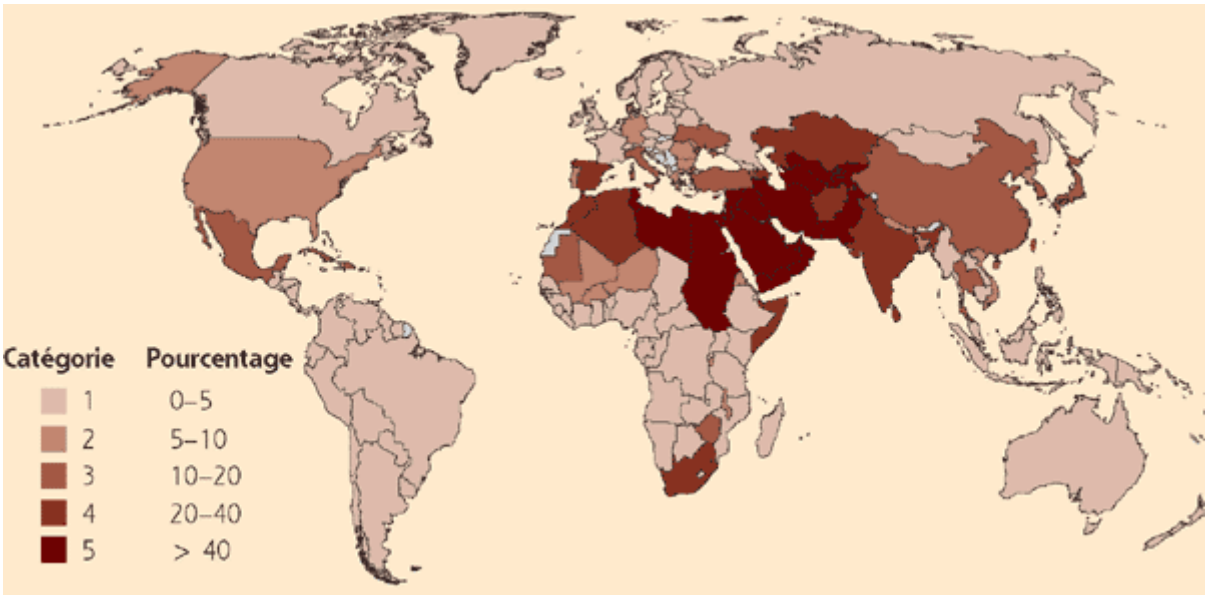


Figure VI-4: Water withdrawals in agriculture as a percentage of renewable resources (data from FA0 in 1998 in FAO, 2002)

It may be noted in a study conducted by FAO (2002) that irrigated agriculture is little used in North and Sub-Saharan Africa (Figure VI-3), compared to Asian countries and other countries of North Africa and Middle East. The challenge must be to increase the yield of rain-fed crops, while attention is focused primarily on irrigated agriculture, which relies heavily on surface water or aquifers. In many developing countries (18 of 93 studied by FAO) irrigated agriculture is practiced on 20-40% of cultivated land. It is also clear that intensive use puts pressure on water resources already solicited for an increasing domestic use. This creates a critical situation in several countries where over 40% of renewable water resources are withdrawn for agriculture (Figure VI-4), whereas it is considered that a country experiences water stress when it uses 20% of its renewable waters.

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2.2 Efficient water management

The water savings are of great importance in research to improve irrigation techniques, particularly in arid countries. Indeed the more a climate is arid, the more water resources are limited and the more important are irrigation needs to agricultural production. We must therefore bring out the best water available. Progress in irrigation techniques contribute to it thanks to the best equipment performance, provided that such equipment are well chosen and well used. We can note some critical factors for improving irrigation efficiency:

- Reduce seepage losses in channels protecting them with coatings or using closed conduits;
- Reduce evaporation by avoiding mid-day irrigation and choosing to spray under the leaves rather than overhead;
- Avoid excessive irrigation or irrigating frequently in using the exact quantity of water to avoid plant stress;
- Fight against weeds between the rows and let them dry;
- Plant and harvest at the right time.

In the same vein we can improve **cropping techniques** for a better use of rainwater, reducing at the same time the withdrawals from surface water or groundwater:

- Improving infiltration and reducing runoff, this requires reworking the soil, implementing the rows following the contour lines or making ridges in contour lines, or blind drains (Figure VI-1).
- Improving soil structural stability through green manure setting, lime application, a stabilization of aggregates with organic matter, sanding too clayey lands on vegetables soils (Figure VI-2).
- Developing water collection techniques by building reservoirs and small water reservoirs to maximize rain water.
- Mobilizing surface waters through the control measures against erosion with facilities such as pools.
- Developing techniques for water and soil conservation with the building of dikelets along the contour lines, of stone lines, of compartmentalized earth ridges, etc ...

Figure VI 1: Blind drains dug in a banana plantation .

Figure VI-2: Mulching to benefit from residual moisture in dry season cropping (Okra) after rice harvesting in lowlands

The use of wastewater for irrigation has several advantages, and may be considered. With the reduction of pollution load of water used by agriculture, industries and communities should help to recycle a greater portion for irrigation, which could be extremely beneficial for irrigation.

Box 6.5: Illustration of waste water use

Let us take the example of a town of 500,000 inhabitants which consumes 120 litres of water per day and per capita: it produces approximately 48,000 m3 of waste water per day (to be supposed that 80 % of water pass in the public sewage system). If this waste water was treated and used within the framework of a strictly regulated plan of irrigation, they could be used ***to irrigate nearly 3,500 hectares****, at a rate of 5,000 m3 per hectare and per year.*

The fertilizing value of effluents is almost as interesting as the water itself. The standard nutrient concentration in effluents from sewage, after the application of conventional treatment of sewage, is 50 mg of nitrogen, 10 mg of phosphorus and 30 mg of potassium per litre. The annual fertilizer input of effluent, for a volume of 5,000 m^3/ha/year, would be 250 kg of nitrogen, 50 kg phosphorus and 150 kg of potassium per hectare. This means that all the nitrogen needs and much of phosphorus and potassium needs in a normal agricultural production would be provided by the effluent. Furthermore, another beneficial effect of such use would be the valuable contribution of other micronutrients and organic matter in the effluents. The impact would also be interesting for the environment since most of these nutrients absorbed by crops, would be eliminated from the hydrological cycle and no longer contribute to the eutrophication of rivers or the creation of dead zones in coastal areas.

Efficient water management also requires consideration of the main functions involved in a hydro-agricultural development, and these are organized into four areas that are subject to interactions and are often subject to antagonisms:

- The **hydraulic function**, in which there are activities related to the mobilization of water resources (pumping station), operation of networks (Irrigation and drainage) and maintenance of infrastructure;
- The agricultural **production function** valuing pumped and distributed water through the management of cropping systems;
- The **financial function,** including hydraulic costing and invoicing, budget management and accounting, and finally the management of cash;
- The **social function** that governs, in time and space, the establishment and operation of the peasant organization.

In this complex pattern of operation of a facility, the charge at the crossroads of the main flows, constitute a decisive nodal point. Its accurate collection and good management are necessary for the sustainability of the facility. However, the sustainability of the irrigation area depends more heavily on the performance of each function, on the management of the interactions between the functions and on the coordination of actors who perform them.

The sustainability of hydro-agricultural development is now directly linked to issues of management and maintenance of community infrastructure and to technical solutions, but mostly, organizational and institutional solutions must be sought to improve the performance of farmers management of irrigated schemes.

Box 6.6: The supply of agricultural drinking water for market gardeners in the urban and peri-urban area of Dakar

The only centralized management system for agricultural water currently operated is the SDE, which ensures its quality as a farmer and on behalf of SONES, infrastructures management and service to the point of delivery (water meter at the entrance to the perimeter). Subscribers are responsible for the management of the network between these points and their agricultural plot. Market farmers benefit from favorable pricing (subsidized) for drinking water in theory within a given quota for each market gardener that varies between 5 and 50 m^3/day. The effective implementation of the new pricing occurred in 2003, involved a strong deterrent tariff for consumptions beyond the quota. Indeed, the price within this quota is 113.4 FCFA/m^3 in 2007. From 51m^3 / day up to 333 m^3 / day, the price jumps to 508 FCFA, then to 789 FCFA/m^3 beyond (equivalent to that of other non-residential customers). In practice, the quota system is not applied. The so granted subsidy is about 300 FCFA/m^3. This grant is supported by the other consumers (mainly other professional groups), it is not sustainable in the long term.

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Exercise 1: Water supply in rural area

Purpose: Identify the constraints of water supply, management issues and share DWSS best practices
Duration: 30-45 minutes

Activities
Scenario 1: By taking the example of your country discuss the best practices in the management of a multi-village water supply system fed by a drill hole.
• What type of management and organization to ensure the maintenance and guarantee the sustainability and effectiveness of service?
• How to promote public - private partnership for an improved service management?
• How are the different actors involved? Is gender taken into account? If so, how?
Scenario 2: In using the example your country to discuss the best practices in the management of a water supply system of a semi-rural sub-center supplied by a drill hole.
• What type of management and organization to ensure the maintenance and guarantee the sustainability and effectiveness of service?
• How to promote public - private partnership for an improved service management?
• How are the different actors involved? Is gender taken into account? If so, how?

Exercise 2: Efficient management of agricultural water

Purpose: Efficiently manage agricultural water
Duration: 30-45 minutes

Activity: List in a table the technical, economic and social measures to take, to save water used in agriculture in a context of scarcity and competing uses

CHAPTER VII- Climate change and water resources management

Educational Objectives

- becoming familiar with basic concepts and causes of climate change
- assessing the impacts of climate change on water resources
- Learning how to take effective adaptation measures

1. Climate Variability and Changes

1.1 Basic concepts

Climatology is the science of climates which is studied in the context of basic and applied research. Climate is designed as a state of the atmosphere which is translated in a unique way, depending on the latitude position of a given location and the pace of its geographical substratum (continent, ocean).

The atmosphere provides a framework for the movement of weather and climate. It is also a climatic factor, given the changes in its structure and its instantaneous composition. The atmosphere is a lively environment which influences the time by correlative movements of major action- centres and of small vortices which impose major climate issues (distribution of areas of dryness and of moisture in particular). These movements themselves result from solar radiation, from the sphere nature of the planet, from the earth rotation around itself and around the sun, and from the aspect of the geographical substratum.

The hot energy received by the atmosphere and the earth are all coming exclusively from the sun. The atmosphere changes the light spectrum thanks to: its degree of transparency, to certain gas content (water vapour, carbon dioxide ...),to its shape, to its rotation around itself and around the sun. This radiation or solar spectrum, which is found mostly in the ultraviolet, the visible and infrared radiation, reaches the ground with many vicissitudes, including the top and bottom of the atmosphere.

Box 7.1: The radiative phenomenon in the atmosphere
The most significant process in the earth / atmosphere system, are:
• dispersion and diffusion: Some incident rays are reflected when meeting with the components of the atmosphere (air molecules, dust, water droplets from the clouds, etc.).. This justifies the illumination of the atmosphere even on cloudy days.
• Atmospheric albedo and surface albedo: The light spectrum is reflected back to the cosmos when meeting with dazzling bodies. This process occurs in the atmosphere (atmospheric albedo) and the surface of the Earth (surface albedo), and is very important to the poles.

• Absorption: the radiation that comes from the solar or diffuse radiationdoes not go back to the space. By absorbing, the atmosphere and the earth store energy. Water vapour is, at the lower troposphere the major sorbent. The air is almost transparent to solar radiation, hence the intensity of the radiation reaching the ground in dry air (as in the Sahara).
• The radiation characteristic of the earth and the atmosphere: The soil and the atmosphere being warmed by absorption become sources of heat radiation (black bodies). By conduction the earth radiates the heat towards the atmosphere. It is a loss for the land but a gain for the atmosphere which absorbs the range of infrared thanks to the ozone, the carbon anhydride, the water vapour and the dust in the air. The atmosphere heats and also radiates toward the Earth and the space.

The most important filtering occurs in the stratosphere by the ozone, which has strong absorbent properties in the extreme ultraviolet. In the troposphere, particularly in the lower troposphere, the radiative phenomena are complex, and are varying by location and time (diurnal radiation by bright sun or hazy sun, night radiation).

The atmosphere, by its composition and structure, helps define and maintain large areas in the global climate. We should remember that climate being the whole of the phenomena (pressure, temperature, humidity, rainfalls, sunshine, wind, etc..) which characterize the average state of the atmosphere and its evolution in a given location. These parameters must practically be constant to define a given climate unit. It is thus understandable that any significant modification of these components would lead to a global climate change (toward greater variability or a radical change in the climate)

1.2 **Causes of climate change**

Under natural conditions, the earth-atmosphere radiative balance is constantly balancing. Heated by absorption of incident radiation from the sun, the earth returns to the atmosphere the excess energy in the form of infrared radiation. This thermodynamics equilibrium of the earth-atmosphere system is broken when the natural composition of the atmosphere in terms of substantial changes of certain gases. This happens when the **greenhouse gas** emissions accumulates in the atmosphere. Under these conditions, the telluric emanation gets stuck in the troposphere to constitute the atmospheric layer from which the climate expresses itself. (Figure VII 1). This blocking of the telluric infrared causes global warming which can lead to sustainable changes in the climate, called **climate change**.

Greenhouse gas emissions reduces the net loss of infrared radiation towards the space while having little absorption properties on the incident radiation. In other words, they are transparent to the incident rays but opaque to the infrared radiation emitted by the earth. This leads to the accumulation of energy in the lower layers of the atmosphere by which the climate is perceived. Consequently, there is a rise in the surface temperature of the earth. Aerosols cause the opposite effect however. They cool the earth's surface thanks to their absorbing and reflecting properties. The Increase in the temperature of the globe, following the accumulation of energy in the atmosphere by greenhouse gas emissions, is called the radiative forcing. These changes lead to modifications:

- **The Global Climate:** Climate is, after all, a state of dynamic equilibrium between its components that are the land surface, oceans, cryosphere, biosphere and the atmosphere. The change in the parameters of this system at any point on earth can have an impact on a global scale;

- **The cloud cover:** The quantity, location, height, lifetime and optical properties of clouds play an important role in the climate of the earth. Any change in these components can result in significant changes in climate across the globe. And yet, these parameters are intimately related to the fields of temperature and to the three-dimensional humidity as well as the dynamic processes of the atmosphere (i.e., wind). Therefore, we understand the significant impact of the radiative forcing on the evolution of rainfalls.

- **The Earth surface**: The characteristics of the surface of the Earth like the vegetation cover and ice caps, strongly influence the distribution of the global energy balance. The vegetation cover plays an important role in the absorption of the solar energy, carbon dioxide (a major greenhouse gas), the flow of heat, water vapour and energy transfer between soil and atmosphere. All movements affect the local climate and may extend to the entire planet. Through their reflecting power, the cover of ice and snow can also contribute to reflecting the distribution of the radiation balance. Their disappearance as a result of a thermal evolution inevitably leads to a positive feedback effect on the radiative forcing;

- **The Oceans:** The oceans play an important role in the distribution of the global energy balance. In addition to absorbing CO2 and thus the regulation of the radiative forcing, the oceans, through the system of the oceanic currents, contribute to the thermal exchange between cold zones (polar) and hot (equatorial) zone. Changes of thermal balance, following the radiative forcing, would result in an imbalance in the ocean composition and circulation; the consequences of which would be incalculable worldwide.

Climate change generally refers to longer-term trends in the average temperature or rainfall or climate variability itself or often to trends resulting entirely or partly from human activities including global warming caused by the combustion of fossil fuels. The scenarios of climate change in general tries to represent the climate in 50 or 100 years.

The term "**climate variability**" however, refers to changes in the climate system, which encompasses the oceans, the land surface and the atmosphere, over months, years or decades. This concept includes predictable variability, i.e. the evolution of seasons, but it also has an inherent uncertainty. The rainy season is a predictable event, but the quantity of rains when they arrive and their distribution are uncertain. Progress in climatology described below improves the predictability of climate fluctuations.

Climate variability is a normal phenomenon reflecting the fluctuations in climate parameters, but over a short time. As for climate change, they reflect persistent or irreversible changes in climatic parameters over time. This term usually refers to longer-term trends in average temperature or rainfall or climate variability itself and often at trends resulting entirely or partly from human activities, including global warming caused by the burning of fossil fuels, deforestation and various air pollution which increase the concentrations of greenhouse gases (GHG): carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), halocarbons or CFCs (chlorofluorocarbons), ozone (O3), etc..

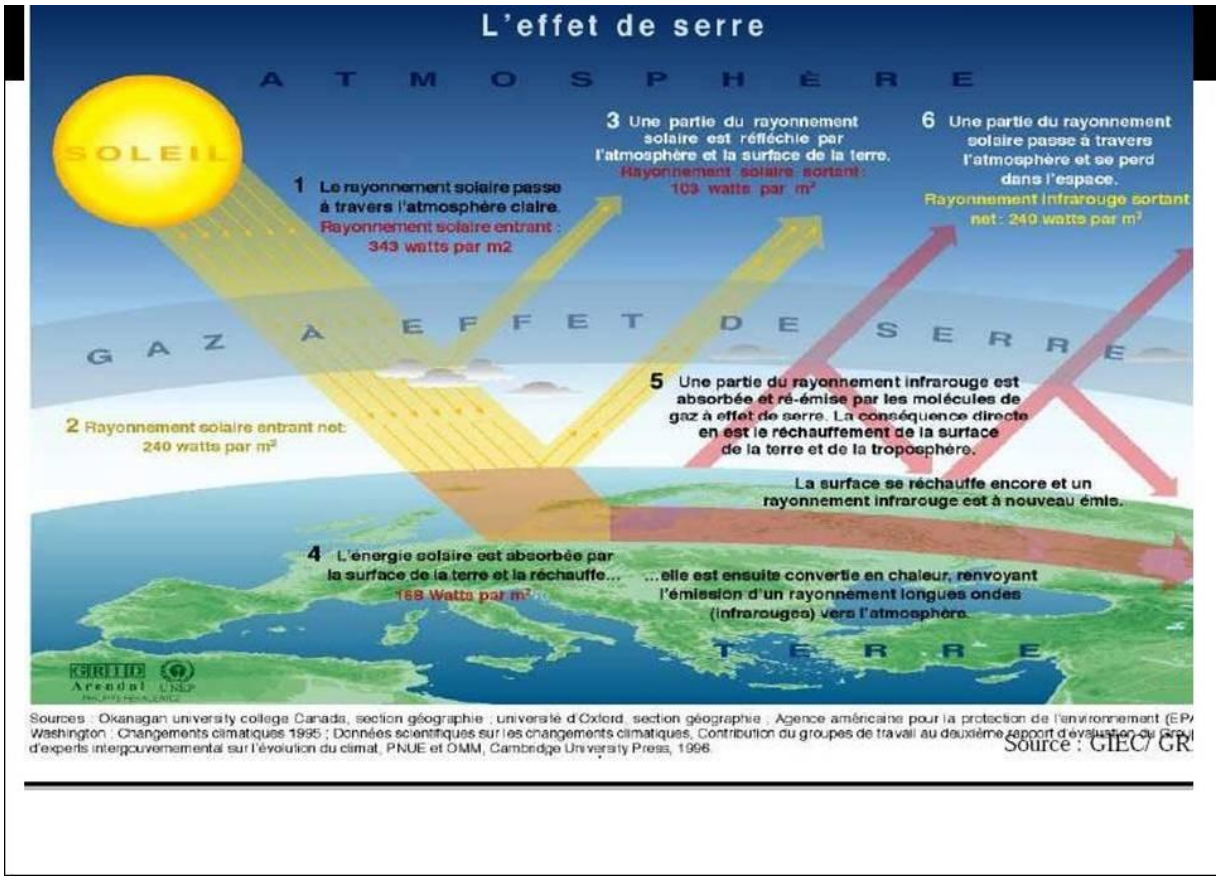


Figure 0-1: Process of the greenhouse effect on a global scale (IPCC 1996)

2. The impacts of climate change

2.1 Findings

In the world many significant changes were noted as to the point of eliciting the concern of the international community which began to search for ways and means to establish an international order on the issues of global environment, including the limitation of the greenhouse gas emissions. Thus in 1990, the United Nations General Assembly has established an Intergovernmental Committee with the mission of establishing a Framework Convention on Climate Change (UNFCCC).

Under the leadership of the international community, extensive studies on climate change have been conducted and a working group (the Intergovernmental Panel on Climate Change, IPCC) was set up with the mission of monitoring and coordinating these studies. This research helped describe and model the essential transformations the humanity will experience as a result of what is called the "danger of greenhouse gas."

Box 7.2: Impacts of the fall in rainfall on the flow of the Senegal River

In the more specific case of the Senegal River, the annual mean flow at Bakel (station of reference) decreased from 1,374 $m^{3/}$s of the period 1903-1950 to 597 m^3/s at the period 1951-2002; and from an average of 840 m^3/s of the period 1950-1972 to only 419 m^3/s over the period 1973-2002. One of the most serious consequences of this situation, was that during the dry season, the estuary (sea water) went up to 200 km approximately upstream of Saint-Louis, obviously posing problems of availability of fresh water for the domestic, agricultural uses, etc

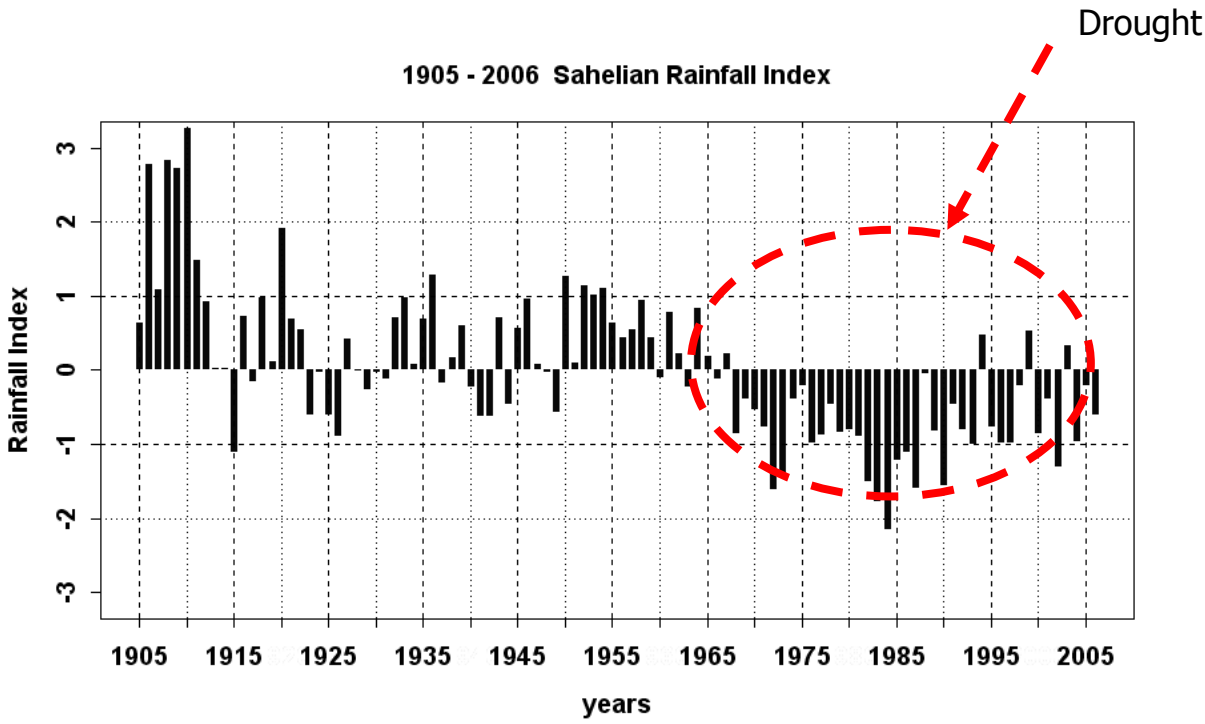
In the face of these multiple problems linked to the impacts of variability and climate change on the water resources, the Coastal states decided to combine their efforts for a concerted management of transboundary water, in particular by the installation of a basin organizations, later by the construction of anti-salt dam (that of Diama in Senegal)

The rising in average **temperatures** on the surface of the globe has been observed since the pre-industrial era. Starting from that period this is the first consequence of the massive concentration of greenhouse gases in the atmosphere,. Comparisons made by the IPCC on the temperature increase, based on the level of concentration of the GHG in the atmosphere and on the rise in the sea level give a good illustration of the cause and effect relationship between higher concentrations and global warming on the one hand, and between warming and rising sea level on the other hand,

The basic rainfall situation, which is fairly well known through various publications, has shown a marked tendency to drought during the past four decades. From the decade 1970-1980 the rainfall deficit was unanimous in all countries, especially in West Africa and in the inter-tropical band of the continent. The index of rainfall in the Sahelian band (Figure VII-2) is quite revealing on this process from the decade 1960-1970.

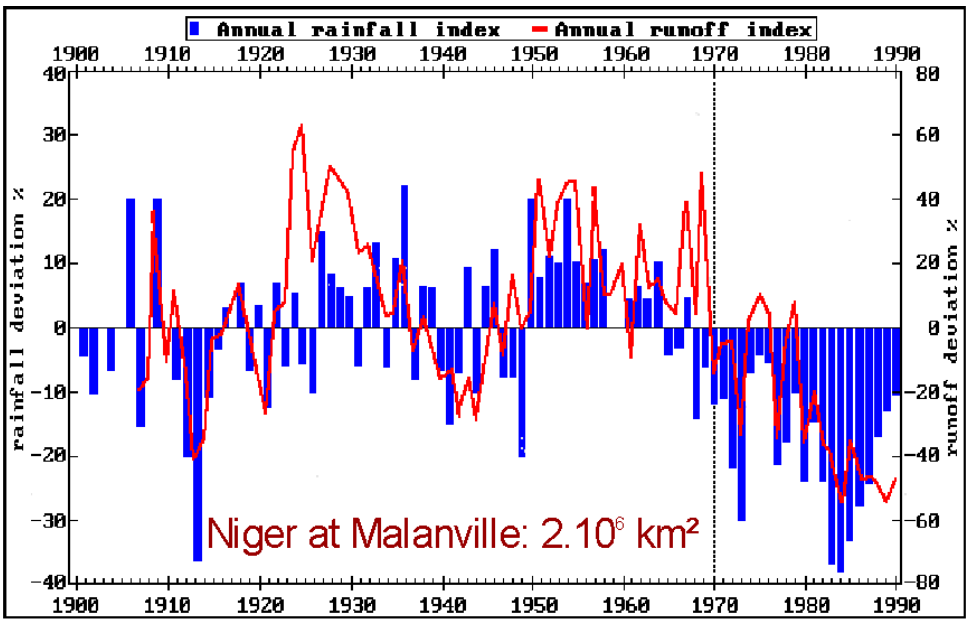
Declining rainfalls have had a noticeable impact on **river regimes and** even over the larger ones. Lower floods and shrinking areas in the beds are the major characteristics of the hydrology in West Africa. The relationship between the rainfall and runoff appear markedly in all the major rivers, as is illustrated in Figure VII-3, where the decline in rainfall index coincides with a negative trend in flow indices. In West Africa, the average flows of major rivers have been experiencing significant marked and concomitant variations. Thus it was noted an average decrease of 40-60% of flows since the early 70s (Afouda et al. 2007). This resulted in a significant reduction of major natural wetlands. For example, Lake Chad, estimated before 1970 to 20,000 km2, has shrunk to less than 7,000 km^2 since the 90s, with the resulting separation of the lake into two parts, of which only one is permanent (Figure VII-4).

The general deterioration of climate in the West African region has resulted in the proliferation of floating plants (water hyacinth salad, Typha ..) linked to reduced flow rates of streams, to the change in their temperature and the deterioration of their quality.



Courtesy: Abdou Ali &Thierry Lebel

Figure 0-2: Rain Index of the Sahel



Courtesy: Arona DIEDHIOU, 2006

Figure 0-3 : Comparative evolution of rainfall indices and the yearly modules of the Niger River at Malanville

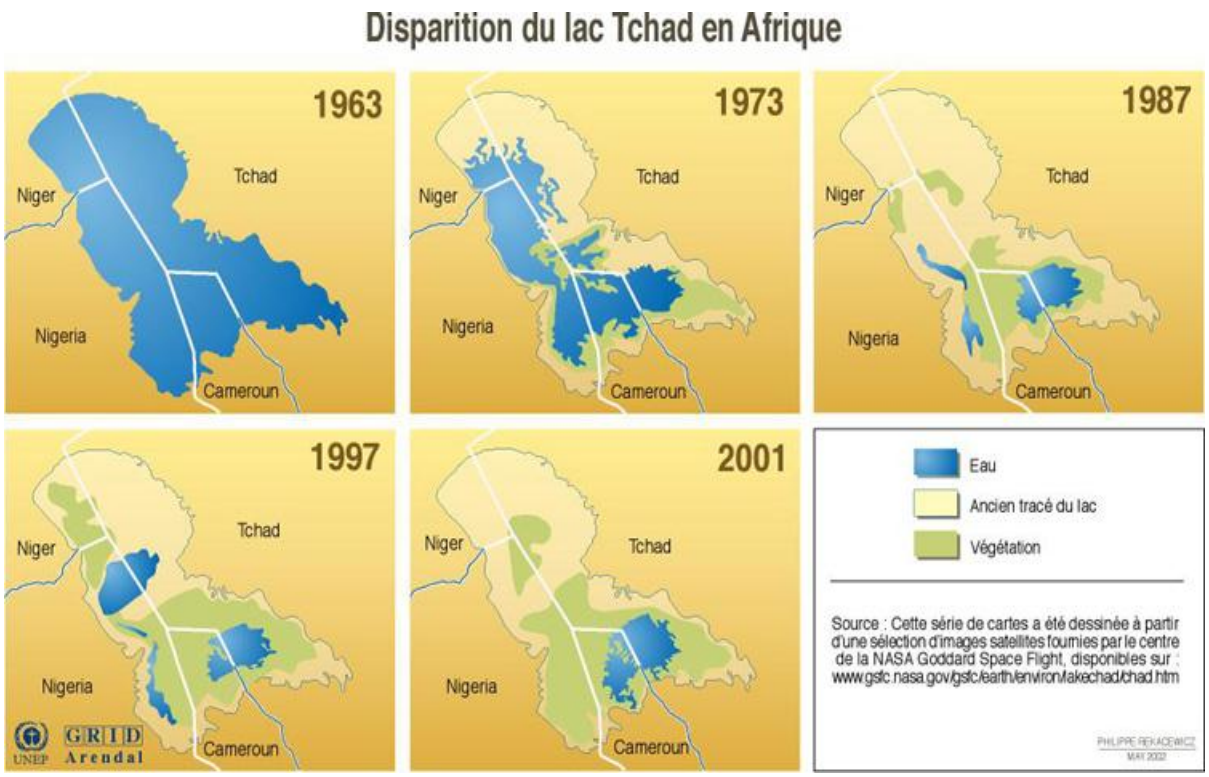


Figure 0-4 : Reduction of the size of Lake Chad

Aquifers are not immune to the climatic influence. Although they are protected from the surface processes by the non- saturated reservoir, they are often very sensitive and very vulnerable to climate, especially shallow water bodies. Reduced recharge results in lower quantities of groundwater, but deep aquifers are less affected. Thus the period of rainfall deficit noted in both the rainfall and the hydrometric analysis appears in all piezometric chronics; the groundwater stocks, are constantly declining

2 .2 Predictable impacts:

Today, weather reports reveal temperature positive abnormalities which is being confirmed annually compared to the temperatures recorded since the mid-nineteenth century. According to the IPCC, Africa has experienced during the 20th century, a temperature increase of 0.7 ° C. Compared to 1990, the average temperature of the air will experience an increase of 1.4 to 5.8 degrees Celsius by 2100 (Figure VII-5).

Climate models which are simulating global temperature trends show with relevance the responsibility of man in the global warming. A comparison of the radiative forcings (natural and anthropogenic), shows everywhere that without anthropogenic GHG emissions there would be no noticeable warming during the 20th century.

The general problem of impact studies of climate change is based on the choice of a climate model (GCM). Several models have been proposed (e.g. GCM IPCC) with different scales of resolution (Table VII-1).

Table0-1**: Some GCM models**

GCM Models	Country of origine	Resolution Lat * long
CCSR-98	Japan	5.62° per 5.62°
CGCM1	Canada	3.75° per 3.75°
CSIRO-Mk2	Australia	3.21° per 5.62°
ECHAM4	Germany	2.81° per 2.81°
GFDL-R15	USA	4.50° per 7.50°
HadCM2	United Kingdom	2.50° per 3.75°
NCAR-DOE	USA	4.50° per 7.50°

The scale in the production of climate models has a space ranging from 200-600 km with a duration of 15 min (in practice the month). The outputs of rains are difficult to exploit (bias error), while the dynamic variables (pressure, wind, ..) are better simulated.

The scales for impact studies are rather resolutions of 1 km to 10 km, regarding the studies to conduct, including the occasional ones, with a daily schedule, hours, or minutes depending on the study, the interest variables was generally related to rain, temperature and evapotranspiration.

The general steps of the impact study of climate change on water resources consist in:

- Choosing a reference period: usually, 30 years of data are needed (e.g. 1961-1990);
- Assessing changes in climate variables in relation to the baseline period ;
- Disaggregating changes at appropriate scales of space and time;
- Adjusting (calibration and validation) a hydrological model at the baseline reference;
- Applying the hydrological model to the constructed scenarios
- Assessing changes in the hydrological variables as compared to the baseline;
- Sensitivity study of these various changes;
- Comparing the results to all retained GCMs and scenarios.

Rainfall is the determining climatic factor with regard to water resources. It is then necessary to establish the baseline before analyzing rainfall water availability (both surface and groundwater) which variability depends first on the rainfall.

During the 20th century, inter-annual rainfall variability appears globally. If during this century, no cycle of periodic evolution seems to be emerging in this situation of low rainfall, the 1970 period to date is particularized anywhere worldwide (Figure VII-6). While some regions show an increase in rainfall amounts (those at high latitudes), others are included into a rainfall deficit (those of the tropical band, the Sahel and West Africa in particular).This means that the current warming does not have the same impact everywhere in terms of rainfalls. Some regions tend to move into a humid climate, while others are drying. Added to this is the development of extreme unpredictable weather forecasts, (heavy rains and severe sporadic low flows).

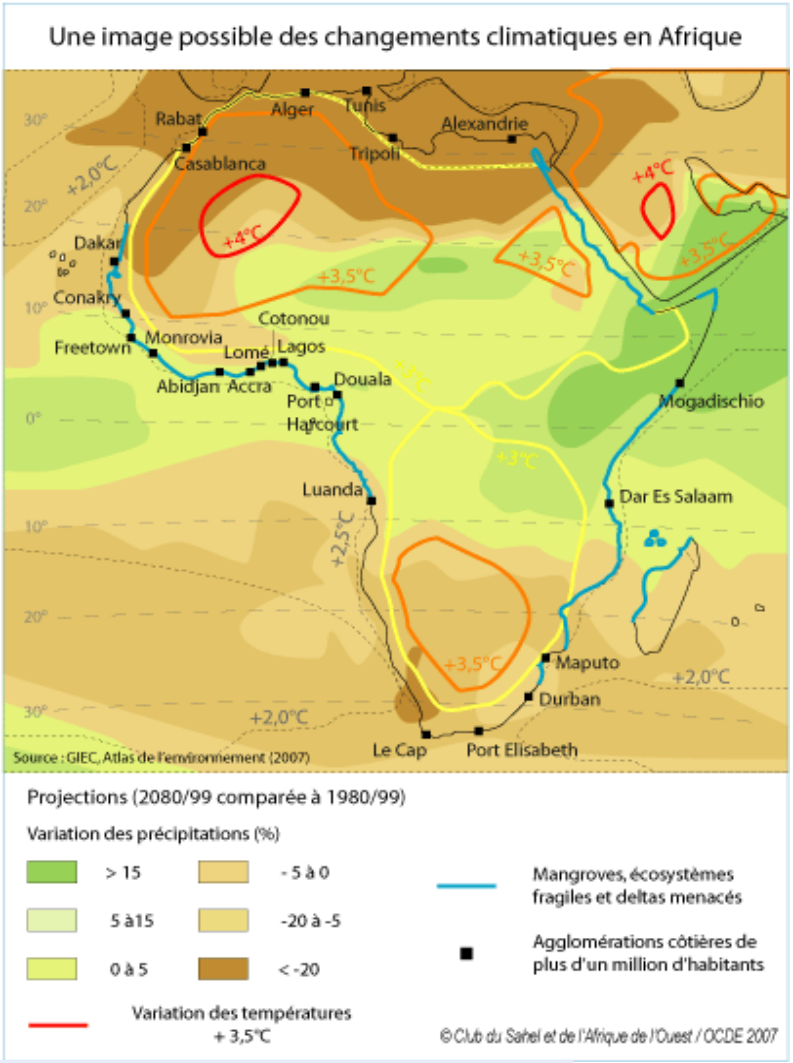


Figure 0-5 **:** Predictable climate variations in 2100 (IPCC)

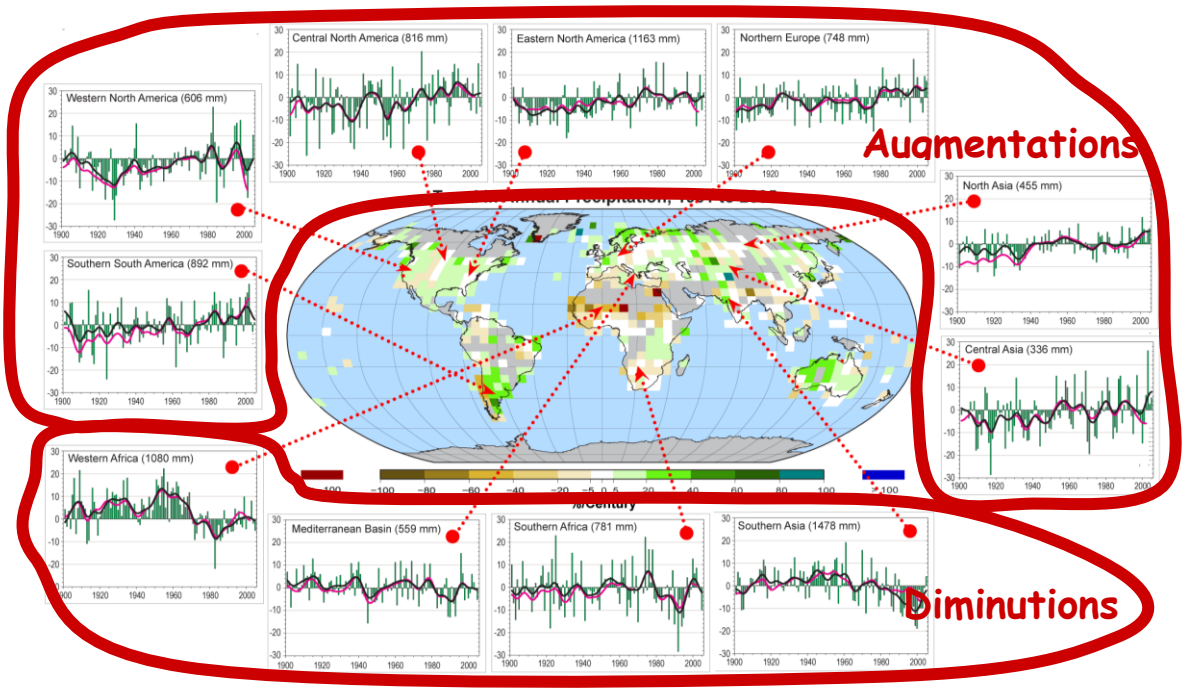


Figure 0-6 **:** Evolution of rainfall on a global scale during the 20th century

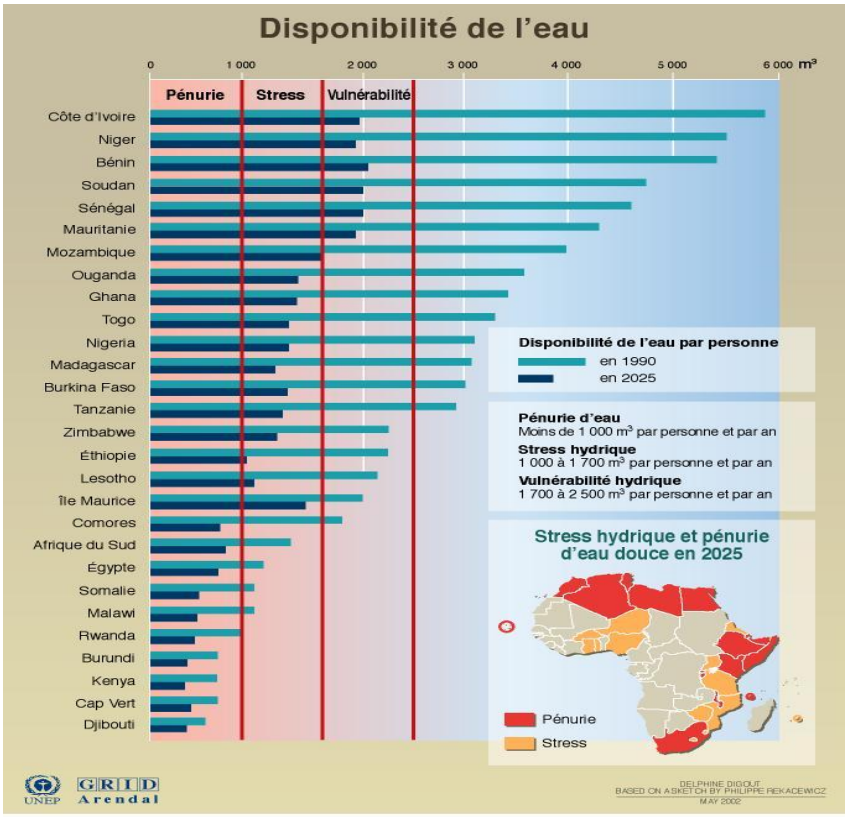
Several approaches are commonly used by the IPCC in the study of climate change and its impacts in various sectors. But the " General circulation models of the atmosphere currently provide the only tool that scientists have to obtain reliable results on the simulation of physical processes that determine climate, and to propose coping and intervention strategies which could be adopted. Despite the uncertainties associated with the use of these models, a general consensus around the following aspects can be highlighted (IPCC, 2001):

- A temperature increase, this warming trend will continue up to the end of the century in 2100; an increase of about 1.4 to 5.8 ° C as compared to the year 1990 (Figure VII 5);
- A variability in rainfall and other climatic variables, but most of the scenarios project a decrease in rainfall ranging from 0.5 to 40% with an average of 10-20% by 2025;
- An amplification of extremes (floods and droughts), but were uncertain about the places and the periods;
- A rise in sea level (0.5 to 1 m), which may affect coastal aquifers.

The plausible evolution given by global climate models reveals impacts on water resources, like strengthening of the hydrological cycle (with the appearance of previously unknown phenomena in the sub-region), increased frequency and / or magnitude of flooding, more and more severe droughts, declining water tables (mostly alluvial aquifers), a deterioration of water quality ... etc..

In general, water availability will be greatly modified (Figure VII 7): most African countries are projected to experience by 2025 water shortage or stress, the consequences of which can be detrimental to the livelihoods and exacerbate problems related to water. This can pose

serious threats to food security, with lower yields in some African countries by 50% in 2020 and even 90% in 2100.



Source : Commission économique des Nations unies pour l'Afrique (UNECA), Addis Abeba, Avenir de l'environnement mondial 2000 (AEM), PNUE, Earthscan, Londres, 1999.

Figure 0-7: Water availability in African countries

3. Adaptation measures and strategies

The vulnerability of a sector to climate change being proved and the projections of its situation in the future established, as shown above, it is appropriate to **evaluate the adaptation options** so as to minimize its drawbacks and to promote the benefits of its impacts. Methodologically, three tasks are to be done, which are:

- Identifying and ranking the options;
- Defining priorities;
- Evaluating and making recommendations.

Adaptation addresses the effects of climate change. It aims to reduce adverse impacts and increase opportunities. Adaptation options can be:

- Passive (accept or absorb losses);
- At community level (distribution of losses, insurance system);
- Preventive (prior preparation of the systems to minimize adverse impacts and maximize benefits.)
- Defensive (modifying the physical systems, case of the embankment of the river banks for instance).

3.1. National and regional actions

Given the worsening of the climate, the responses are various and punctuated with political and institutional measures which could facilitate the adoption of concrete options to strengthen the adaptation capacity

At the national level, water sector reform processes were, in many cases supported by international institutions. Through these processes a number of countries have adopted water codes in the same dynamic. One can also note that several states are planning to develop their National Action Plan for Integrated water resources management, based on the commitment made at the Johannesburg Summit in 2002, inviting all states to develop their own IWRM plans by 2005.

Similarly, nearly all countries in West Africa have developed strategies and plans of action against drought, in line with the United Nations Convention of Drought Control (1992). These plans have been complemented by the development of a sub-regional action plan for drought control. The creation of CILSS (Permanent Inter-State Committee for Drought control in the Sahel) in 1973 is also a response to the regional African climate variability and to the chronic drought in particular. The creation of basin organizations for the major transboundary rivers in West Africa is also a political and institutional response at regional level. The mission of the basin authority consists among other things in making necessary investments in the development of resources and in the coordination of the riparian States.

In the same approach, the African Centre of Meteorological Applications for Development (ACMAD) has been created to develop approaches for greater use of climate related information and data in the various sectors of the economy. The Observatory of the Sahara and Sahel (OSS) has been created in 1992 to help in understanding and managing water resources in the major river aquifers of the Sahara and the Sahel while promoting interstate cooperation in the management of water resources.

To reduce the vulnerability of West Africa to predicted and predictable impacts of climate on water resources, IWRM approach is also envisaged as an institutional measure / initiative. IWRM is a process and a management strategy permitting to sustainably manage water resources at both basin, regional, national and international levels, while preserving the character and integrity of the ecosystems in which these water resources are found.
It thereby permits to mitigate the social unrest that may arise from the inequitable access to water and the environmental consequences of the deterioration of climate in a context punctuated with an increasing demand and a scarcity of water resources resulting from climate change. Consequently, there is increased competition for access and control of these resources and also, risks of conflicts over water.

3.2. Community actions

At community level, the people who remained in rural areas have tried to diversify their production systems as a strategy of minimizing risks. During these periods of chronic hydro-climatic deficits, they have been reducing their food vulnerability and insecurity thanks to new techniques. Everywhere, increased investment for the water control such as the: low level village water supply, boreholes for livestock, more voluntary policy in the promotion of irrigated agriculture and increased investment in dams.

The local populations take options from the moment climate variability became part of their daily life. These may be reactive options, such as:

- Changes in the agricultural schedule (late planting strategy, short cycles crops, several seeding sessions, dry sowing)
- Artificial rain (local traditional practices)
- Collective prayers for a productive raining season
- Need to practice simultaneously rain-fed and irrigated agriculture,
- Abandoning cultures associated with rain-fed agriculture.

It may also include measures for effective and efficient management of water in the area of agriculture, such as:

- Artificial depressions dug in the ground as water reservoirs,
- Division of plots with the help of stone rows forming curbs designed to hold as long as possible on the soil runoff waters resulting from torrential rains in order to obtain maximum infiltration and percolation,

- Division of the fields into rectangular plots delimited by soil embankment and through which a canal system is dug equipped with pipes
- Pricking out techniques for a better water management,
- Etc.

Box 7.3: Institutional measures advocated in West Africa
• Promote the Integrated Water Resources Management
• The protection of wetlands;
• The promotion of the United Nations Framework Convention on the use of transboundary waters for non navigational purposes;
• Strengthening legal and regulatory measures to preserve water quality;
• Mobilize financial and human resources for the effective implementation of national plans for adaptation to climate change;
• Consideration of climate change in the feasibility studies of water projects and irrigation schemes;
• Take appropriate legal, regulatory and organizational measures to mitigate the impacts of flood which magnitude and frequency should increase with climate change.

Source: Synthesis Report writeshop (2007)

3.3 Analysis and evaluation of the adaptation

The analysis criteria takes into account the incorporation of climate change into the planning of decisions in the long term, the improvement of flexibility because of uncertainties in connexion with the impacts of climate change, the effective character in conjunction with non-climate pressure factors They also consider the benefits in the absence of climate change, the cultural acceptability and the political feasibility.

The evaluation of adaptation options involves both a national and a regional development and is based on considerations which are as important according to **IWRM approach**. They are the economic efficiency, the risk avoidance, the protection of environment, the social equity, and the sustainable development. These evaluation criteria permit to establish a hierarchy of options and to set a priority order according to the matrix of **Table VII-2.**

Table 0-2: Adaptation Evaluation Matrix

Adaptation Strategies	Example	Economic effectiveness	Avoided risks	Protection of environment	Equity	Regional development
Passive	Absorb losses	**-**	**-**	**o**	**-**	**-**
Distribution	Government support in terms of rehabilitation	**-** **-**	**-** **-**	**o** **o**	**+** **+**	**+** **+**
Sharing	Regulation of floodplains	**+**	**+**	**+**	**o**	**-**
	Warning and evacuation	**+**	**+**	**o**	**o**	**+**
Protection	Dams for the control of floods	**-**	**+**	**-**	**o**	**+**
	The embanking of river-sides	**+**	**+**	**-**	**o**	**+**

+ Positive contribution: 0 neutral contribution; - negative contribution

The major studies carried out within the framework of the national action plan for adaptation in Africa (PANA), especially in West Africa and in its sub-Saharan Africa show that the major constraints are the following:

- In coastal area, there is flooding and the deterioration of the quality of water
- In the continental area: there is the decrease of the quality of fresh water, the drop in the water table, the drying of rivers and of wetlands

On the basis of these major constraints a tree of constraints should be drawn so as to lead to actions aimed at removing those constraints. The planned activities must in turn, be ranked in order to undertake the most urgent ones (Table VII-3), which delays in implementation, would either prevent the adaptation or increase its cost.

Box 7.4: Concrete actions for adaption to changes and for resources management in West Africa at basin level

*The creation of the OMVS is viewed as a comprehensive response to the sustainable management of water resources in the basin, given the variability of these resources. The critical analysis of its long experience of more than 30 years could therefore serve t*o identify concrete actions for a sustainable management of resources at basin level. The main lessons learned are:

- *Expression of a strong political will;*
- *Establishing a strong and flexible legal and institutional framework;*
- *Adoption of measures and rules prevailing in the operation of the institutions and management of shared resources based on equity, solidarity and transparency;*
- *Implementation of management , prevention, monitoring and evaluation tools which are both scientifically reliable and accessible to all categories of stakeholders;*
- *Establishing a sustainable financial mechanism which will support programs and projects;*
- *Creation of multi-purpose integrating structures, etc.*

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Exercise : Adaptation to climate change within the IWRM

Purpose: Identify climate change adaptation measures within the framework of the IWRM

Duration : 45 – 60 mn

Activities :

- Identify the measures to take (according to the IWRM approach) in the watershed so as to contribute to the adaptation to climate changes
- Identify at least for each country the immediate action to undertake.

Those measures can be linked to:
- The planning of actions
- The adaptation process
- Concrete adaptation actions

Actions should be undertaken at:

- transboundary, national and bassin levels.

For each action:
- Describe the action
- Explain how you will « sell » the action to the politicians and to the managers
- Explain who should be involved, how and why?

Table 0-3: Example of identification of adaptation measures

Serious Problems		Causes		Target Populations	Solutions	Ranking/Order of priority of the options
		climatic	Anthropogenic			
Foods		Extremes rain falls • Upwelling of aquifer	• poorly designed urbanisation in flood-risk areas • deforestation, soil waterproofing, accelerated runoff	• Flood-risk areas Population • market gardeners	• Displacement of populations towards resettlement areas • Housing restructuring and the development of suitable sanitation strategies • Development of the unblocking basins in habitable areas • watershed management decongesting habitable zones • polderization of the unblocking areas • Promotion of water crops • Redistribution of polluted water into development activities	1 Sensitizing/information/training of the populations 2 extension of the sanitation network /promotion of social connections 3 reassignment of waters of the polluted water tables 4 Development of ponds and of the hydrographical network/recharge of the ground water 5 installation of unblocking basins of the agricultural zones 6 reforestation/fixing of the dunes 7 treatment of polluted water 8 restructuring of the social habitat/displacement of the populations
Deterioration of fresh water resources	Upwelling of marine waters	• deficit in rainfalls • decrease in fresh water tables • rise in sea level and intrusion of salt water tables		• women and children • market gardeners	• Extension of water purification techniques (Marine saline water conversion) • Anti-salt dike	
	Anthropogenic Pollution		• population pressure • over-exploitation of water resources • lack or deficit of sanitation network • Agricultural pollution	• populations not connected to the fresh water distribution network • populations not connected to the sanitation network	• Sensitizing, informing, and training the population on hygiene rules • Extending the water supply network and promoting social connections to water supply system	
Water deficit		• Decline of water tables • drying of the hydrographical network	• over-use of water	• women • market gardeners	• Promotion of water saving techniques (drop by drop system etc.) • sensitizing, informing on water saving policies	

					• groundwater recharge by impluviums in refilling the water system	
Disappearance of ponds and wetlands		• wind erosion • siltation of valleys	• Urbanization of wetlands	• Market gardeners • breeders	• dune fixation • Reforestation • development of ponds and surface water bodies	

CHAPTER VIII- Management of project cycle for water resources development

Educational objectives

- Become familiar with the concept of project and the life cycle of a project
- Learn how to implement a logical framework
- Be able to take into account environmental impacts in the project management.

1 . The project concept

A project is a set of activities limited in time and space. It is oriented towards achieving a development and/or research goal, and requires human and financial means. These means must be implemented in a coordinated manner to achieve one or several goals set in advance.

A project can also be defined as:

- **A goal**: a project makes sense only when it has a goal to achieve, a result to reach;
- **A commitment**: Wanting the change and engage in this change;
- **Time**: anticipating the future and setting the time for action;
- C**omplexity**: Numerous factors, Numerous stakeholders, different means;
- **A territory**: a place, actors and networks;
- **A rationality**: search for coherence to control the complexity and the optimization of the implementation of means to achieve the purpose;
- **A double distance between the project and the action**: in time, the project precedes action, in the order of the will, action belongs to reality whereas the purpose of the project relates to the desire;
- **A gradual adjustment of desire and reality**: it means developing a dynamic system that ensures consistency between objectives, expected results, activities, means.

2. The project life cycle

The project life cycle is also known as the project path. It consists of all the phases the project goes through. Generally there are four main phases:

Identification phase

At this level, it is about defining the main problem (Issue) to be addressed; the goal (purpose of the project) and the target population (target unit). This phase should provide answers to the questions "**why** the project and for **whom**?. The answers to these questions are made in a participatory appraisal in which all stakeholders participate in the reflection in the form of brainstorming. The purpose to which the project is expected to contribute is usually worded in general terms. The mission of the organization that will implement this project must be

answered, as well as the problem that the project must address. Example: supplying a given target population with drinking water..

The identification phase thus establishes the basic idea of the project (not the program) in terms of objectives, expected outcomes and activities; intentions being described, the question arises whether the idea needs to be abandoned, if it can be continued or if additional studies (feasibility study, environmental impact assessment) are justified.
We must define the entity, the discussion framework, that is to say, the description of the subject of analysis, indicate the limits of the exercise: geographical size, sector, target group. We must also identify the groups involved in the entity: identify key groups, individuals and institutions related to the project or influenced by it; form categories (beneficiaries, target groups, implementers, ...); characterize and analyze the participation of those concerned and identify the impact on the work of the project: eg: the responses of the project, ...)

Preparation Phase

This phase represents an answer to the question ***what to do?*** This involves defining the various components of the project objective (s), results, activities, methods and means:

• **The purpose (s)** represents the expected situation at the end of the project. It is generally accurate. It sets the levels of performance in both qualitative and quantitative terms that a project intends to achieve. Example: Making the average income of rural women of 3,000 CFA per year in 1995 shift to 6,000 CFA in 1997.

• **Results** are also called targets or outputs; they are physical products of the project expressed in quantity, quality and cost. They arise from the transformation process of means and represent the direct product of the investment. Example: Making a water supply borehole for the DWS for the rural community of...

• The **methodology** allows answering the question "how? What technology is appropriate to succeed, to achieve the expected results?

• **Activities** are all the processes and operations which process means to obtain results. We develop for that purpose the matrix of activities by the breaking down of the main project activities, major activities into tasks, and tasks into subtasks. Example: organizing monthly piezometric observation missions.

• Also called inputs, means consisting of human and material resources necessary for the organization of the activities and the achievement of results. Example: a budget of 50,000 FCFA / Piezometric mission; a hydrogeologist and a technician are recruited.

The factors that are behind the success of a project are among others (Figure VIII-1):

•the commitment and responsibility of all partners;
• realistic and clearly defined objectives;
• a clear link between what is done in the project (activities) and what is desired (results);
• ability to manage risks;
• clearly defined roles (a distribution of responsibilities), the "ownership" of the project at the most qualified part, flexibility to adapt the processes / plans if changes occur;
• the participation of the target group when developing the project.

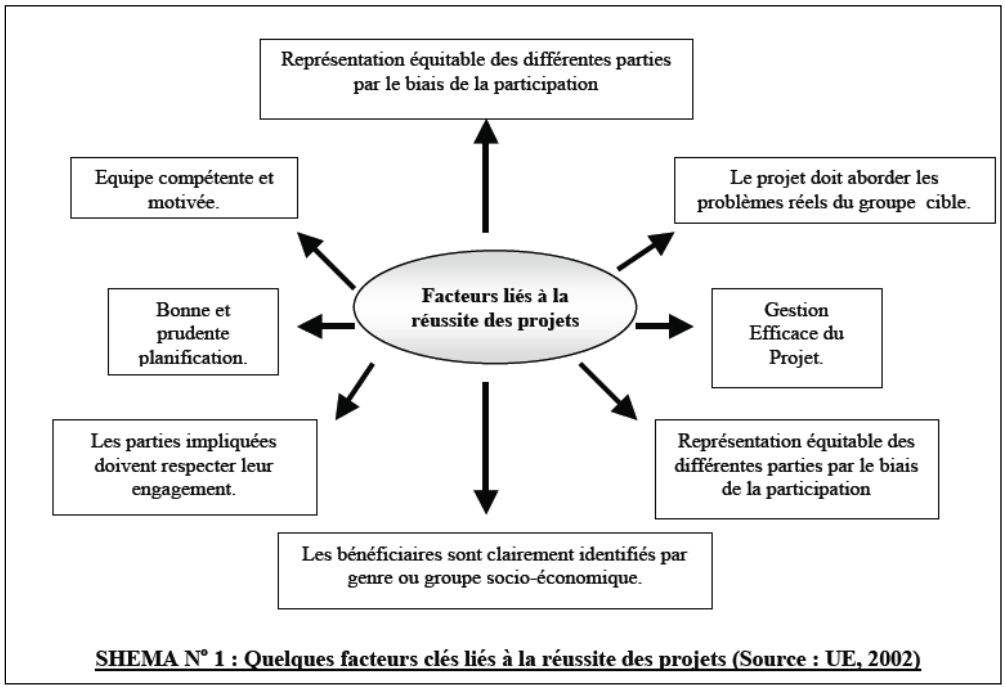

Figure 0-1 : Factors that are behind the success of a project

Implementation and monitoring phase

This is one of the crucial phases of the project cycle (Figure VIII-2), the implementation of the project. It is about *who will do what? When? How and where?* The execution comes after the project is formulated and the decision to undertake taken. It corresponds to the phase of implementation of the project. All the activities of the project must be carried out according to the planning and the schedule of the tasks.

The monitoring of implementation is a set of activities within the framework of a project designed to ascertain whether the means (resources) available are used according to the schedule and project budget and if they give the expected results. Monitoring also aims to identify problems that may arise during implementation and to provide adequate solutions. The evaluation consists in determining to what extent and with what degree of success (or failure) the desired objectives have been reached. It is performed to compare the achievements with the expectations and learn from past experience in order to improve the formulation and implementation of similar projects in the future.

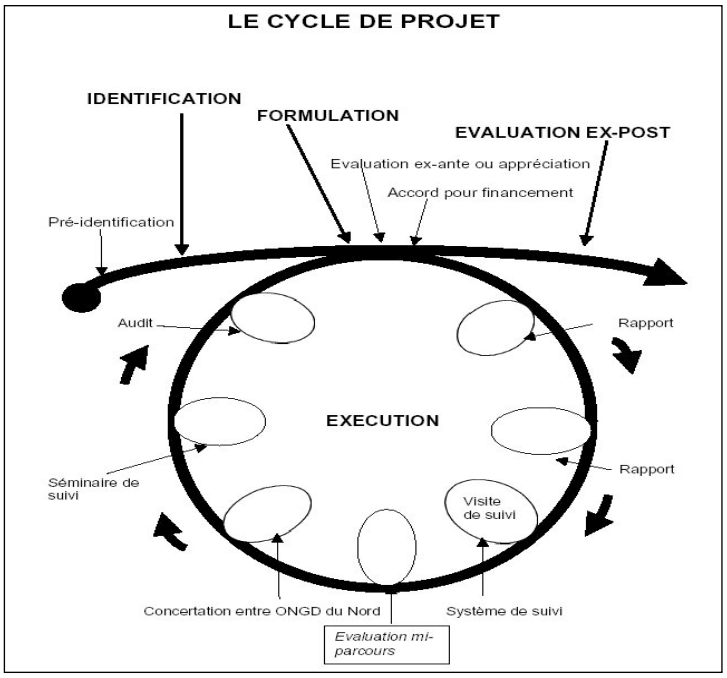

Figure 0-2 : Execution in the project cycle

2. *The logical framework*

3.1 Definition and background

The logical framework is a tool which use aims at a good project formulation. It is a management tool that specifies the different components of a project. It can also introduce and explain in brief, the purpose, objectives, outcomes, activities, resource needs, indicators, sources and methods of verification.

The Logical Framework Approach (LFA) is a method of analysis and a set of tools to facilitate planning and management of a project. It provides an integrated set of concepts, used as elements of an iterative process designed to facilitate structured and systematic analysis of a project idea or program.

The LFA method allows to analyze and organize information in a structured manner, so that important issues are raised, weaknesses identified and that decision makers be able to make informed decisions based on better understanding of the rationale for the project, the sought objectives and the means by which these objectives will be achieved.

The basic idea of LFA is for services and goods produced by the project to meet the needs of individuals (target group). This means that what is important is not the resources available to this project or why they are used for (roads, wells, education), the important thing is that these resources allow to achieve, in terms of changes, transformation of development

context, that is to say the final outcome / objectives. Example: a decrease of malaria among children, or the opportunity for an entrepreneur to develop his activities.

The logical framework is a logical representation explaining how the development objective can be achieved by taking into account the causal relation of the generation of the results, the implicit assumptions and risk factors. It provides a common vision and clear link between objectives, outputs and activities. This link gives the overall consistency of the program: why I do this? To achieve this objective.

The LFA is one of the numerous good planning methods used for the planning of a project focused on objectives. Already in the early '60s, planners began to use the LFA , and since the method spread worldwide. The UN, EU, CIDA, USAID, German GTZ, Norwegian Cooperation are just some of the organizations working to ensure that their partners use the LFA when planning a project. These organizations apply this method to examine, monitor and evaluate projects and programs. It was developed from experiments on the factors enabling or not a project to succeed. Project evaluations have shown that some of them are crucial for the successful achievement of objectives.

3.3 The hierarchy of project objectives

A project, in general, has various objectives connected to one another and each is an element of the chain end-resources. The objectives of a given lower level can achieve a higher level, this last one, another objective of the next level and so on.

The hierarchy of objectives can thus present the goal and objectives of a project in an explicit and understandable way, while showing the causal relationships between them. According to Robert Anthony (former head of management planning in the Ministry of Defense, 1965), there are three levels of objectives in the planning of a strategy.

- **Policy objectives:** at higher or national level corresponding to the impact of a project or program on the population. The policy objectives reflect the change in the community level of life.

- **Strategic objectives:** average or sectoral level corresponding to the impacts of the project on a sector or subsector.

- **Operational objectives:** level of performance or projects, they relate to the results obtained through the physical activities and resources deployed.

The definition and clarification of objectives at national, sectoral and project level allow all the actors to have the same understanding of the results to reach. The classification of objectives follows a logical progression, taking into account time factor (Table VIII-1), the first level of objectives (short term) will be reached before the second level (medium term), the second level before the third (long term).

Table 0-1 : Example of overall ranking

Time horizon	Level of objectives	Project objectives
Long term	Policy objectives	General objective
Medium term	Strategic objectives	Specific objective
Short term	Operational objectives	Results
		Activities
		Means

3.4The logical framework matrix

The LFA allows us to draw a matrix called the Logical Framework (Table VIII-2) with four columns and four or five lines (depending on the organizations). It clarifies the logical connections between the key objectives (policy, strategic and operational) and establishes a hierarchy. The reading of the logical framework matrix is done in column (vertical logic) and in line (horizontal approach).

The elements of the vertical logic or logical intervention (reading from bottom to top) allow to prioritize objectives into long-term, medium and short term targets. The column of the narrative summary describes the causal relationships between different levels of objectives while critical conditions column or assumptions identify external conditions that must be taken into account for a successful implementation. The prioritization of objectives is an important step in the construction of the logical framework matrix.

Critical conditions describe conditions, events or elements on which the project team has no control and which are necessary to ensure the success of the project. They are evaluated according to their probabilities of occurrence and should not include factors dependent on the manager (eg punctuality of staff) or disasters (floods, droughts, epidemics, etc..). They are important factors to achieve different levels of objectives and to determine the degree of project risk.

Table 0-2 : Example of matrix

Level of objectives	Narrative summary	objectively verifiable indicators	Means of verification	Assumptions/ critical conditions
3rd level	Overall Objective			External factors necessary to achieve the overall objective?
2nd level	Specific Objectives			Achieved results, what are the external factors necessary to achieve the SO?
1st level	Results			Once the activities are started what are the external factors necessary to produce results?
	Activities			External factors necessary to start?
	Means			Critical conditions

The horizontal logic allows identifying for each level of the vertical logic, the specific results to obtain as well as necessary means by which we can obtain the data. The elements of the horizontal logic serve to clarify the quantity and quality objectives on a time horizon. They also allow to measure for each level, objectives achievement. The identification of results is done through objectively verifiable indicators (OVI) and means of verification (MV).

Objectively Verifiable Indicators (OVI)

OVIs are specific mechanisms through which one can obtain quantitative and qualitative data on the achievement of project objectives. OVIs clearly identify and define the objective expressed by specifying the expected results. Indicators are operational descriptions (quantity, quality, target group and location) of our project objectives and results and that can be measured reliably with limited financial and human resources.

Means of Verification (MV)

The means of verification are the specific mechanisms through which one can obtain quantitative data on the level of achievement of project objectives. They facilitate the identification of the sources as well as the suitable means to use to obtain the appropriate data for the future evaluation of the project. The MV provide reliable, accessible data and at reasonable costs.

The precise formulation of the source of verification, informs on the feasibility and the indicator's cost in human and / or financial resources; it must contain:

- format: eg report, form, survey, accounting, etc..
- who: Who should provide information
- when: Date and intervals for information

Example: **Format**: Hydrometric database of the Department of Planning and Management of Water Resources, **Who**: The computer department manager, **When**: At the end of the third hydrologic cycle of the project monitoring and evaluation phase.

3.5 Developing the logical framework

The data to be entered in the logical framework matrix generally come from the situation analysis or even a thorough diagnostic. The stakeholder analysis, the causes and the consequences and the formulation of objectives are prerequisites for the development of the logical framework.

The problem tree is a proposed tool for the analysis of the situation of the population identified for the future project. Also called cause and effect diagram (or cause to effect), it is used in areas as diverse as climate diagnostic, prevention and research of the causes of climate change. It is a participatory decision-making tool used in identifying and formulating projects in general.

The approach consists in the analysis (Figure VIII-3) of the main problems using sheets (brainstorming) by a community constituted into groups with similar characteristics. Problems must be listed (that appear because of lack, insufficiency, absence, excess) and which are often interconnected by relations of cause and effect, thereby constituting a system that can be represented by a tree (problems tree).

The tree has a trunk (or main issue), a root system (roots representing the various causes) and a crown representing the branches and branchlets (the effects or consequences of the core problem).

Box 8.1: Qualities and formulation of an OVI

An OVI must be objectively verifiable (measurable and or observable), relevant, explicit in terms of quantity, quality and time, and Independent.

An indicator can measure the project performance *(progress of the project or activity), the project's impact (the effects that the project has generated for the target population or the socio-economic environment).*

The measure can be:

- *Quantitative: the number of children rehabilitated*
- *Qualitative: the average duration of rehabilitation*
- *Behavioral: Early introduction of mother weaning food*
- *Direct: average income (or minimum) in case of young people one year after the end of their training*
- *Indirect: the number of youth with a motorbike*

Formulation of an OVI must specify:

- *The target group (s) to whom we apply the indicator (for whom?) for example moderately malnourished children from 0.5 to 3 years*
- *Quantity: What is the quantity of the «product" of our intervention (how much?) Eg prevalence rates, number of children, etc.*
- *Quality (how, what?) eg the provision of drinking water,*
- *Time (when does one measure) and / or duration (for how long does the "product" lasts) eg three years after the construction of the dam*
- *The place (where?) city x*

Example: specific objectives: controlling the flow of Soungrougrou river after three hydrological cycles (OVI: low flows increased from 0 m^3 to 10 m^3 / s).

The construction of the objectives tree is based on an approach allowing to describe a future state to be reached after having found solutions to problems already identified. One will have to:

• reformulate all the negative states of the problem tree into desirable positive states, realistic and achievable,
• formulate solutions in the form of objectives;
• if necessary, reformulate certain goals, eliminate targets that are not relevant and desirable; add new objectives if necessary to achieve the higher level target;
• make sure of the consistency of the objectives.

> ***Box 8.2: The concept of objectives***
> ***The overall objective*** *goes beyond the project; several projects can contribute to the same overall objective. It is a future positive state of a higher level that the intervention will help achieve*
> ***The specific objective*** *is the operational objective to be achieved by the project. It is a positive future state characterized by sustainable benefits for the group targeted by the intervention and which first fruits must appear during the intervention. What is described here is:*
> *•The nature of the expected success: a description of the expected situation*
> *• The conditions for success: what to achieve? results? with what means?*
> *• The consistency between problems to solve and the objectives to achieve?*

In the development of a logical framework, the main steps consist in :

• identifying the project's specific objective (s)
• defining the outcomes allowing to achieve each specific objective
• determining the activities necessary to obtain each result
• formulating the overall objective to which the project contributes
• defining the critical conditions for each level beginning with the activities
• determining the OVI for each level

• identifying each OVI means of verification
• validating the logical framework.

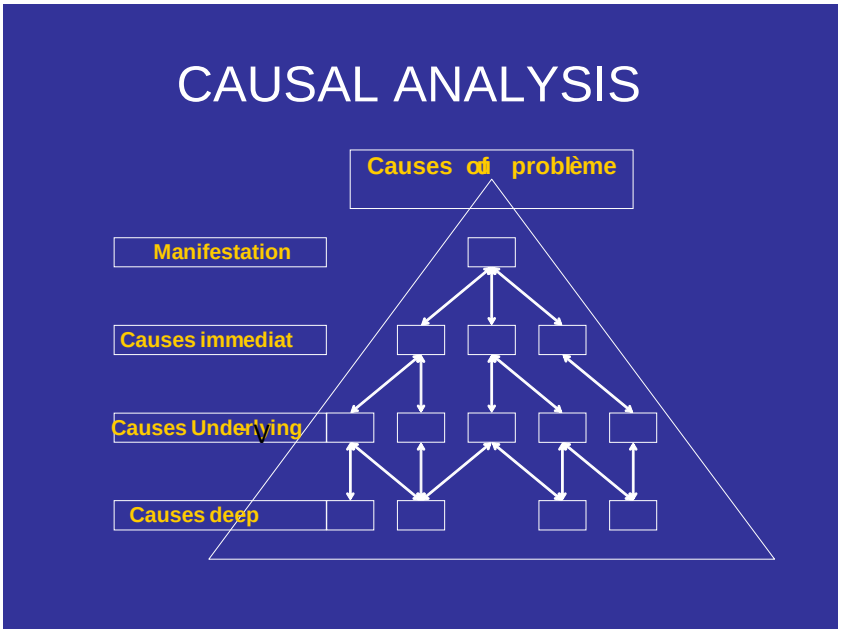

Figure 0-3 : Causal analysis

4. Taking into account EIA

The Environmental Impact Assessment is a procedure which allows to determine the effects, both positive and negative that the implementation or execution of a project may have on the environment. It examines the consequences, both positive and negative a proposed project may have on the environment and ensures that these effects are properly taken into account in the project design.

The EIA assesses biophysical impacts, human impacts and also includes social impacts, economic impacts, impacts on health and risk analysis. It assesses the impact of projects, individually, as well as the cumulative effects generated by the addition of several projects or activities within the same scope.

The goals of the EIA is to initially avoid that human actions (projects and activities) contribute to the degradation of the physical environment. Today they consist in:

- ensuring the integration of projects in a given environment and contributing to development,
- choosing a project option, location and appropriate technology for the environment but also economically viable
- identifying and assessing environmental issues or major concerns that may weigh in favour or disfavour of a project (health, public safety, quality of life, the exploitation of exceptional or protected resources or areas and traditional lifestyles).
- identifying the impacts of development activities on the environment, and developing a plan to mitigate adverse effects.
- selecting the best action in the light of its impacts.
- having the perception of people vis-à-vis the project and encourage them to support the project or not.

- informing the public of project characteristics, of changes that will occur and of predictable effects on quality of life and have them participate in decision making
- providing a more comprehensive and complete evaluation of the cost of a project and helping limit or eliminate the recurrent costs associated with repairing damage to the environment.
- facilitating and improving the quality of decisions.

EIA includes:

- The non-technical summary or executive summary (the text is accessible and understandable by the public);
- The methodology used at each stage of the study;
- The context of the project (the project and its objectives, the project justification in terms of solving problems or unmet needs, potential markets, the interests and concerns of stakeholders, the main ecological constraints of the milieu, some technical and economic requirements);
- The identification of the promoter, the consultant or mandated consulting firm;

• The project description (identification of activities and project alternatives, characteristics of variants, comparative analysis of alternatives, choosing the best option)
• Analysis of the initial status / situation analysis / analysis of the receiving environment;
• Impacts evaluation (evaluation of alternatives, evaluation of impacts of the chosen option);
• The risks of technological accidents and hazards linked to the project (possible accidents, safety measures, emergency measures and if necessary emergency plan);
• The plan for environmental management (monitoring program, follow-up program and training plan);
• Appendices

In conducting the EIA of a project, special attention is paid to aquatic environments when they are in the project scope or area of study, they must be under surveillance: the function of a wetland, banks protection in the case of road projects, protection of water bodies and streams (waste and various discharges).

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Exercise: Project for the management and development of water resources

Purpose: write a draft integrated management project for water resources with a logical framework
Duration: 120 min

Activities
Identify a promising project on:
• the involvement of stakeholders in the management of a watershed
• Gender mainstreaming in the management of water resources
• the implementation of adaptation measures to climate change
• the establishment of DWSS services in rural area
• etc..
Draft the main project (to be finalized later) and especially finalize a logical framework and suggest ways for funding