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Specific Measures in Support of International Cooperation (INCO)- Mediterranean Partner Countries (MPC)

INECO

Institutional and Economic Instruments for Sustainable Water Management in the Mediterranean Region

Coordination Action

DELIVERABLE NO 3

GOVERNANCE AND WATER MANAGEMENT STRUCTURES IN THE MEDITERRANEAN BASIN

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Author(s) and main contributors	Ms. Eleni Manoli (NTUA) Mr. Thanos Aggelis-Dimakis (NTUA) Prof. Dionysis Assimacopoulos (NTUA) Dr. Ioannis Glekas (Aeoliki Ltd, Cyprus) Mr. Charis Omorphos (WDD, Cyprus) Mr. Ahmed Bouzid (CITET, Tunisia) Mr. Belgacem Hanchi (CITET, Tunisia) Dr. Fathy El Gamal (WMRI, Egypt) Prof. Samy El-Fellaly (MALR, Egypt) Prof. Magdy Abou Rayan (IC, Egypt) Mr. Claude Tabbal (C&D, Lebanon) Ms. Roula Sleiman (C&D, Lebanon) Mr. Malek Haddad (SIC, Syrian Arab Republic) Mr. Khatim Kherraz (ABHCSM, Algeria) Dr. Abderrahmane Affia (ISKANE, Morocco)		
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Contents

Preface

"Governance and Water Management Structures in the Mediterranean basin" is the 3rd Deliverable of the INECO Project (Institutional and Economic Instruments for Sustainable Water Management in the Mediterranean Region, Contract No: INCO-CT-2006-517673). The Deliverable summarizes the work undertaken within the framework of Work Package 3 of the INECO project, on the "Identification of responsible WM authorities, institutional structures, policies and water allocation mechanisms". The overall objectives of this Work Package were to:

- Identify and establish contacts with national actors, water management authorities, end-user associations and other stakeholders.
- Present the current situation on water resources use and management.
- Adequately describe and identify water allocation mechanisms and water rights in a regional and national context.
- Present the current legislative and institutional framework and create an inventory of existing water laws, regulations and related environmental legislation.

As such, the work undertaken within the framework of WP 3 evolved around the analysis of legislative and institutional frameworks with regard to the formulation of water management policies and capacity building mechanisms. Further issues that were addressed involved analysing responsibility allocation issues for water management, planning and allocation, and the identification of financing issues and the constraints that they impose on integrated planning. Additionally, this report provides an overview of focal water management problems in the participating countries, and outlines commonalities with regard to their underlying causes.

The Deliverable is structured in two parts:

- **Part I** is divided in two sections: Section 1 provides an overview of the INECO frameowkr, approach and phases, and elaborates on the institutional analysis and the identification of focal water management problems outlined in Part II of the report. Section 2 performs a brief overview of the current water governance challenges faced in the MENA region, and outlines commonalities and gaps among the focal water management problems analysed within the framework of the project.
- **Part II** contains the reports, elaborated by the Regional Partners of the project. Contributions contain information on (a) the current situation regarding water exploitation and use in the corresponding countries, (b) an analysis of the institutional framework governing the water sector, (c) a description of constraints and focal water management problems experienced at the national and/or regional levels, and (d) the outcomes of Stakeholder Analysis performed within the framework of the Project. Stakeholder contact details are provided as a separate Appendix to this Deliverable.

The report has been compiled and edited by the Environmental and Energy Management Research Unit of the School of Chemical Engineering of the National Technical University of Athens, Greece, and includes contributions from:

- Aeoliki Ltd and the Water Development Department of the Ministry of Agriculture, Natural Resources and the Environment (Cyprus);
- The Tunis International Center for Environmental Technologies (Tunisia);

- International Consultants – Egypt, and the Ministry of Agriculture and Land Reclamation (Egypt);
- Conseil et Developpement s.a.l (Lebanon);
- Studies and Integration Consulting (Syria);
- Agence de Bassin Hydrographique Constantinois-Seybousse-Mellegue (Algeria);
- ISKANE Ingenierie (Morocco).

PART I: THE ANALYSIS OF GOVERNANCE AND WATER MANAGEMENT STRUCTURES WITHIN THE FRAMEWORK OF INECO

1 Introduction

1.1 The INECO framework

INECO aims at introducing an interdisciplinary approach to water management, building upon the integration of three major aspects: environment, economics and society. The project's main strategic goal is capacity building, by promoting the constructive engagement of stakeholders in Integrated Water Resources Management.

Integrated Water Resources Management (IWRM) has been defined by the Global Water Partnership (2000), as *"a process promoting the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems"*.

In an ideal IWRM situation, water resources are managed on (sub-) basin level in a globally sustainable way, balancing different aspects, i.e. technical, financial, social, economic, institutional and environmental. At the same time, the water-related interests of all stakeholders are considered in decision making on water use, while all stakeholders and interested parties have access to relevant information and are aware of the potential of the water source and the impact of their use on the other stakeholders. Decisions on water use and planning are made in a participatory manner, taking into account criteria agreed and goals accepted by all stakeholders.

INECO discusses shared problems in the decision-making process and the deficiencies of the present governance structures around the Mediterranean Basin in Cyprus, Tunisia, Egypt, Lebanon, Syria, Algeria and Morocco. Research focuses on alternative institutional and economic instruments for promoting equity, economic efficiency and environmental sustainability in the sharing, valuing and governing dimensions of water resources management.

During its first year, the Project focused on the selection of focal water management problems in each country. These problems will be the core of the exemplary regionalized analyses foreseen by the project, and are related (directly or indirectly) to three of the water management challenges advocated in The Hague Ministerial Declaration of 2001:

- **Sharing water**, referring to the mechanisms (institutional, regulatory, legislative, economic) in place for water allocation at the river basin level (between uses), at the service provision level (between users) and at the transnational level (if relevant).
- **Valuing water**, referring to the assessment of costs and values in water use, the maximisation of economic efficiency, the implementation of the cost-recovery principle for supporting sustainable water service delivery, and the implementation of the user-pays and beneficiary-pays principles.
- **Governing water wisely**, referring to the provision of an environment that enables IWRM implementation and focusing on the aspects of:
    - Participation of all citizens in the decision-making process, either immediately or through organisations representing their interests;
    - Decentralisation and application of the subsidiarity principle;
    - Transparency of water-related decisions, especially in relation to water allocation, water service revenue and investment capital allocation, and definition of water charges;

- Equity, ensuring that all citizens are being treated equally and have equal opportunities in water use;
- Accountability, with regard to decisions taken;
- Coherence and integration between policies and goals;
- Responsiveness with regard to changes in demand, supply, development goals or extreme hydrological events.

Each challenge suggests different issues that should be addressed within a water management system, and will have diverse impacts at different levels of the local societies. In this perspective, the project analyses instruments according to the deficiencies they would address in each functional level of water systems' management, also described in Figure 1 (Van Hofwegen and Jaspers, 1999):

- The constitutional or water policy and law functional level, which provides the enabling environment for the successful functioning of the system, and includes the development of water policies, institutional policies, including human resources development, normative and executive legislation.
- The organizational or water resource management functional level, which involves the coordination, planning, decision making and policing of water use and users in water systems (river basins and aquifers).
- The operational or water use functional level, which focuses at the use or control of water for specific purposes (e.g. water supply and sanitation, irrigation and drainage, flood protection, hydropower, industrial supplies, water for tourism and the preservation or rehabilitation of ecosystems).

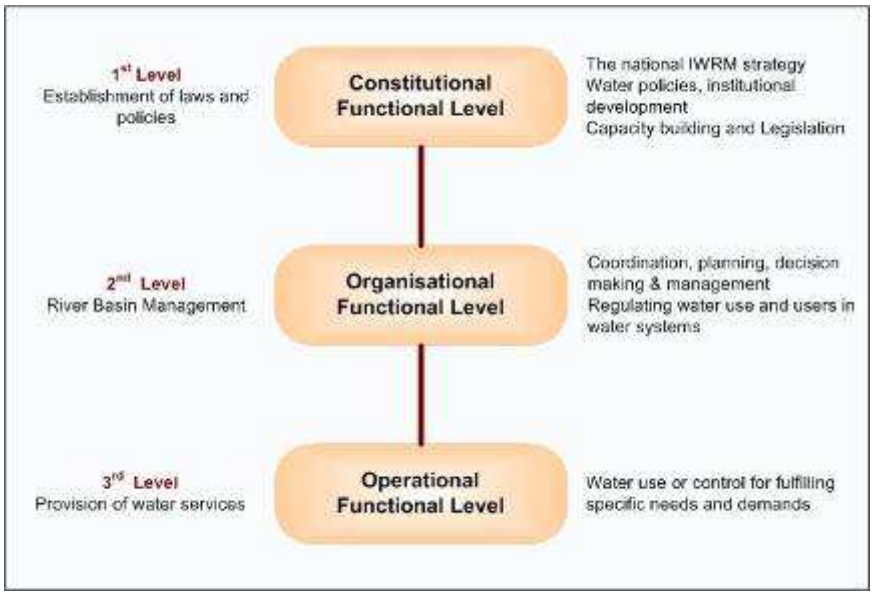

Figure 1: Functional levels in an IWRM framework

The final output of INECO should be viewed as a "social experiment" in capacity building and policy framing; rather than hoping to introduce "solutions" to the water management issues, INECO aims at providing experience and support to local societies towards a shift in their perceptions and subsequently in their water management practices, and at the development a comprehensive, adaptable guideline framework to assist in the process.

1.2 Approach and phases

The overall INECO approach evolves around a cyclic development process, which aims at promoting the shift towards a desired IWRM situation. The final proposal will be a mix of options, determined as the result of a negotiation process, where policy makers, water resources and water utility managers and stakeholders will be involved. The outcome will be determined by technical, financial and political attainability, under prevailing socioeconomic conditions.

The process towards constructive engagement and proposal formulation adopts the Analysis Phase of the Logical Framework Approach, including the following stages:

- **Situation & Problem Analysis:** Identification of stakeholders, their key problems, constraints and opportunities and determination of cause and effect relationship between threats and root causes;
- **Analysis of objectives:** Development of objectives from the identified problems and identification of means to end relationships
- **Strategy analysis:** Definition and evaluation of potential strategies to achieve objectives.

An overview of this framework is provided in Figure 3.

In more detail, the specific steps of the endeavour comprise:

- *Situation Analysis*, through the profiling of significant water management issues, the identification of the current institutional and economic setting, and the identification stakeholders and the profiling of their interests;
- *Problem Analysis*, through the more detailed description of one specific, focal, water management problem, and the identification of problem causes and effects, and current or past water management policies, aiming to address the issue, and lessons learned from their implementation;
- *Objectives Analysis*, by identifying the specific inefficiencies of the current institutional and economic setting, which are directly or indirectly related to the problem, and the preliminary formulation of objectives for problem mitigation, by employing stakeholder analysis and participation. In this step, the selection and potential adaptation of the indicators reviewed relevant to the causes and effects of the problem analysed and adapted to the overall regional/national context is also undertaken.
- *Identification and discussion on alternatives,* through participatory workshops, with the additional aim of formalizing stakeholder commitment to the project, and the additional collection of views on the constitutional, organisational and operational functions of the governance structures, and their influence on the selected water management issue.
- *Formulation of proposals,* concerning the implementation of alternative institutional and economic instruments, and their *evaluation* on the basis of criteria defined by stakeholders;
- *Refinement of proposals,* according to feedback received, *and re-evaluation,* by further discussing implications on affected social groups, and assessing feasibility according to political and social dynamics.

As also depicted in Figure 3, the overall project approach is based on and targets at the engagement of local actors, stakeholders and the general public for:

- Identification and analysis of current water management issues and the formulation of objectives to be achieved, and

- Evaluation of alternative institutional and economic options, which could contribute in the solution of the identified issues.

Towards this end, stakeholder involvement and participation activities are horizontal, spanning the entire duration of the project, as depicted in Figure 2.

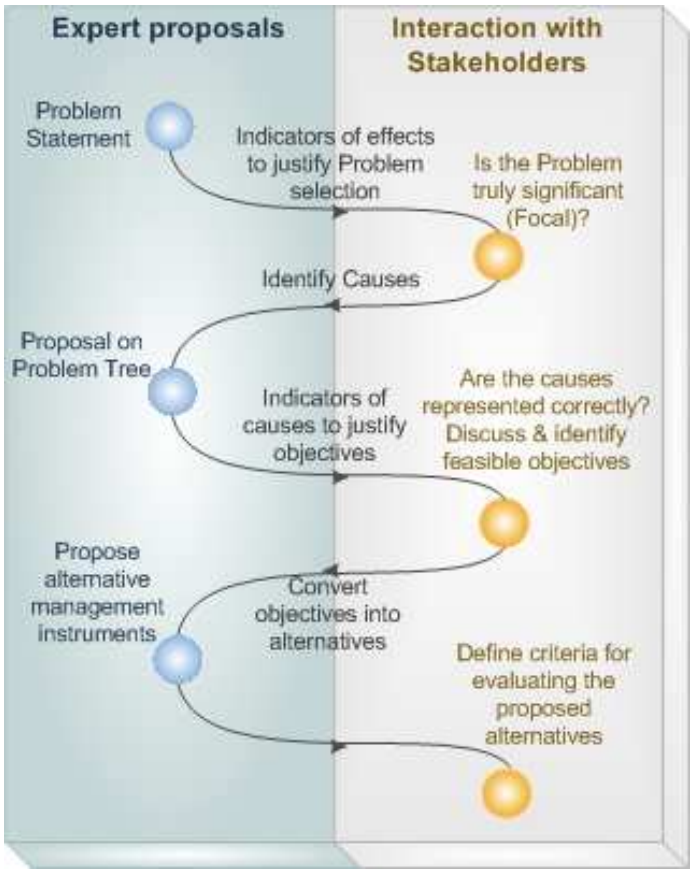

Figure 2: Interaction with stakeholders in the INECO approach

The outlined constructive engagement process aims at maximizing local opportunities for multi-faceted solutions, by fostering the discussion among **all** interested parties before an option (in this case an institutional or economic instrument) is selected. This approach is based on mobilizing stakeholders upfront, and giving the floor to their participation, at the project level, in the development of plans and proposals. Towards this end, the institutional analysis, and the identification of constraints facing the water sector, as outlined in Section 1.3 below and at the individual regional reports of Part II, constitutes the first step in the overall framework, providing valuable input on both institutions and stakeholders to be further involved in project activities, and on the institutional and economic deficiencies associated with the water management issues at hand.

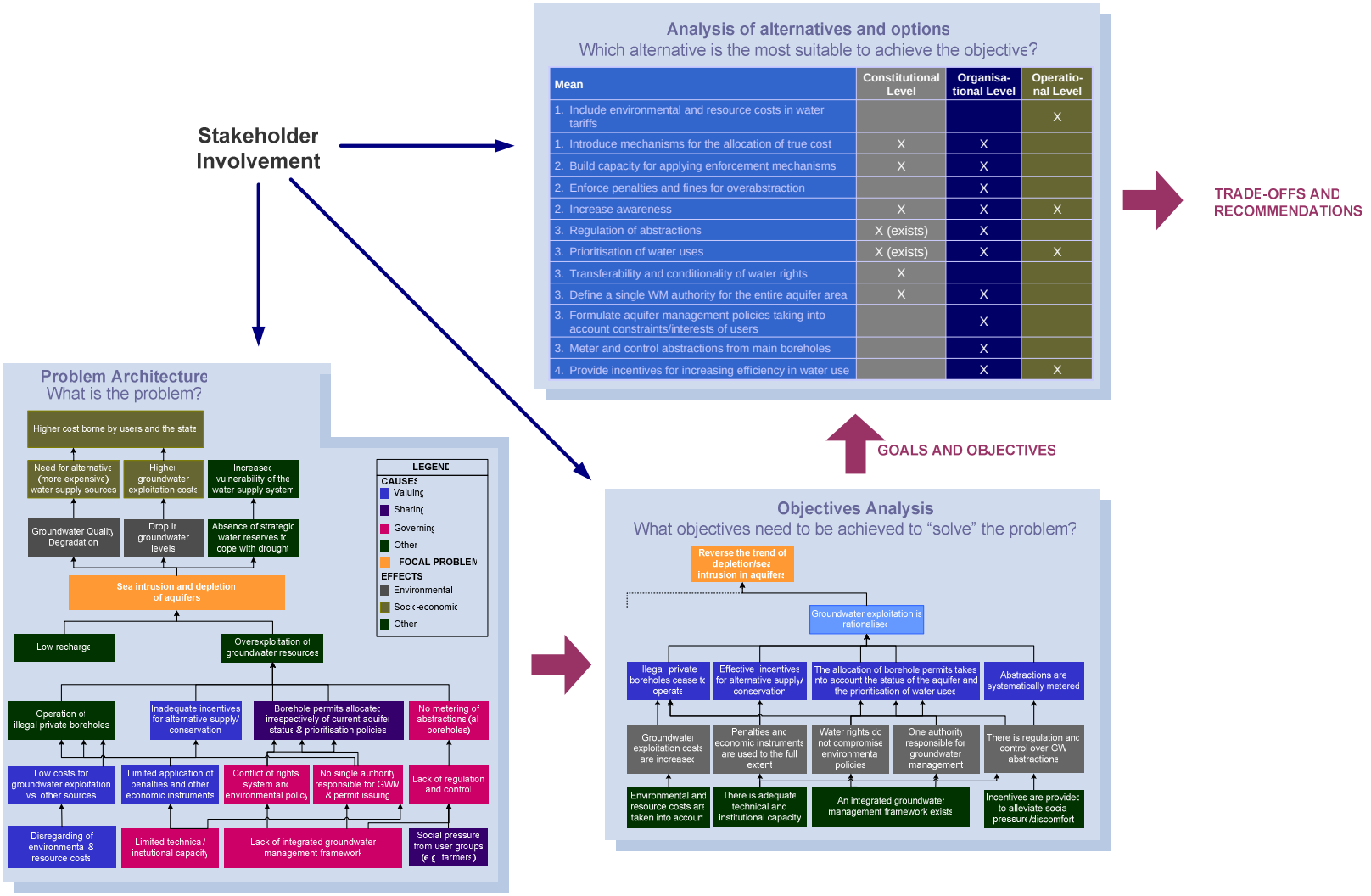

Figure 3: Overview of the INECO approach in for the development of regional analyses

1.3 Situation Analysis: Institutional analysis and identification of constraints facing the water sector

It has been recognized that integrated development and management of water resources, requires, to a large extent, the existence of organized and efficient water authorities, operating within an institutional framework. Such water authorities or institutions should be mandated to take charge of the administrative aspects of all water-related issues in order to ensure successful implementation of the governmental water policy (UN-ESCWA, 1997).

Policies set the framework within which the water resources are managed; they set the objectives, priorities and principles for the management of resources use, allocation, conservation, environmental protection, while aiming at resolving issues related to water quantity and quality - surface and groundwater - coastal and freshwater. On the other hand, governance in the water sector depicts the way the different institutions/organisations/citizen groups collaborate in order to promote integration towards "democratic" decision-making processes, to institutionalise methods of promoting and continuing innovation, and to improve water and wastewater delivery services. Governance is about promoting social justice and strengthening the participatory processes of integrated water resource management; it entails the notion of engaging all interrelated bodies in decision making.

An institution is a rule or norm that mediates interactions or transactions among people and the environment and as organisations they are involved in all levels of decision-making (governmental bodies, NGOs, local/community groups). The roles of such organisations are to:

- Create an organizational and operational framework, and
- Build or improve capacity.

To achieve these goals, several management instruments are engaged, including assessment of natural resources, IWRM plans and strategies, demand management and social change instruments, conflict resolution procedures, regulatory and economic approaches, and information management.

Towards this end, this report outlines the outcomes of the institutional analysis performed within the framework of the project. The objective is to to build a comprehensive profile of the institutions active within the area of interest, based on an extensive analysis of the full range of organisations involved in policy-making and service delivery at the local, regional and national level. Overall, institutional analysis is a tool used to assist in the water management process by:

- Providing an inventory of institutions working with, contributing to and supporting the processes;
- Highlighting the institutions' roles and inter-institutional linkage;
- Determining the relevance and importance of the institutions in water management operations;
- Identifying constraints and opportunities for change in the water management framework.

Since institutions are defined by rules, and rules create boundaries, it becomes necessary to know where the powers and funding to deliver different courses of action reside. Hence, one requirement while seeking to promote constructive engagement and propose alternative water management instruments, is to develop the institutional analysis for each of the different regions, by answering a series of questions, as for example which institution can do what, has which powers and what funding. The relevant domain of action are all those actions which may be adopted in order to deliver sustainable water management at the local, regional, and national level.

In the above context, information contained and systematized in Part II of this report comprises:

- A brief overview of physical (e.g. climate, geomorphology, geology, river basins) and demographic and economic characteristics and of hydrological balance and water budget elements for the countries and regions analysed within INECO;

- A description of the overall institutional, administrative and financial framework regarding water resource exploitation, management and use, and legislation, through:
    - Administrative & institutional framework mapping, describing the main actors and decision makers at all levels (constitutional, organisational and operational), analyzing their responsibilities and identifying overlaps and conflicts
    - Legislation relevant to water issues (management, pricing, emission limits, private sector involvement, abstraction permits, groundwater exploitation permits etc).
    - The overall financial context regarding water resource exploitation, and the relative importance of private sector involvement in the realisation of water works).
- A classification of constraints facing the water sector at the national/regional level,. Classifying these into four broad categories: (a) natural, (b) technical, (c) financial and (d) administrative and institutional.
- A tentative analysis and classification of major water management issues into three categories of problems, directly or indirectly related to the water management challenges analysed within the project, i.e.
    - **Sharing water,** such as pollution from upstream sources, conflicts in water allocation, insufficient quantity or quality of available resources, transferability of water rights etc.
    - **Valuing water,** such as low cost recovery, low economic efficiency in water allocation, problems on the application of pricing policies, incentives to reduce consumption etc.
    - **Governing water,** such as overlaps in responsibility, investment financing, inconherency and lack of coordination between policies etc.
- The mapping of stakeholder interests and institutions' responsibilities in relation to water management, provision and pricing of water services, and its potential impact, influence and power with regard to the application of institutional and economic instruments.

The overall aim is to identify commonalities and deficiencies among the issues at hand, towards the development of guidelines for sustainable and integrated water management policies in the participating regions.

2 Identifying commonalities in tangible water management problems and their underlying causes

2.1 An overview of water governance and progress towards IWRM in the MENA countries

Water availability in the MENA is unquestionably limited, due to the low rate of natural renewal of both surface and groundwater supplies, unwise sectoral water use and the diminishing of water supplies by increasing pollution. The stress on available water resources is increasing, from the need for further socio-economic development, food security and sufficiency and ecological requirements. Furthermore, the widening gap between water supply and demand is further exacerbated by the lack of water management policies and strategies, supported by effective legal and institutional frameworks, which would enable an integrated approach for the management of scarce resources. In most countries past water development efforts have been mostly supply-oriented, towards the implementation of large hydraulic projects, involving inter-basin transfer for irrigation and/or domestic water supply projects.

With regard to the target of establishing national IWRM plans, most countries have already set policies, plans or strategies that serve as a step towards IWRM. There is still an urgent need to put applicable integrated water management schemes, concepts and principles high on the political agenda in order to enable decision-makers to act effectively as well as in a coordinated manner for developing the required financial and human resources. The overall IWRM approach should be based on formulating policies, strategies and programmes that account for:

- Reliable assessment of water supply, in terms of both quantity and quality;
- Balancing water demand and supply and increasing efficiency in water use;
- Water allocation and mitigation of conflict between sectoral and regional water uses;
- Effective management and stewardship, including private sector participation;
- Food and water security;
- Cost recovery;
- Enhanced institutional arrangements, regulation and legal framework updating and enforcement;
- Financial resources availability;
- Stakeholder participation, and civic awareness amd engagement.

IWRM should be seen as a comprehensive approach to the development and management of water, addressing its management both as a resource and the framework for provision of water services. Towards this end, achieving sustainable water management points to four dimensions, to which effective water governance should be achieved (UN, 2006):

- The social dimension points to the equitable use of water resources. Apart from its temporal and spatial variability, water is also unevenly distributed among various socio-economic sectors and layers of society in both rural and urban environments. How water quality and quantity and related services are allocated and distributed have direct impacts on the quality of life and on livelihood opportunities.
- The economic dimension draws attention to the efficient use of water resources and the role of water in overall economic growth.

- The political empowerment dimension points at granting water stakeholders and citizens at large equal democratic opportunities to influence and monitor political processes and outcomes.
- Finally, the environmental sustainability dimension shows that improved governance allows for enhanced sustainable use of water resources and ecosystem integrity.

However, in many countries, governance has not received the same attention as technical issues. Any water governance system must be able to allocate water to ensure food and security but also be able to assess for whom and what purposes water is provided. According to its broader definition by UNDP, governance addresses the relationship between organizations and social groups involved in water decision-making, both horizontally, across sectors and between urban and rural areas, and vertically, from local to international levels. Operating principles and criteria for achieving effective governance frameworks include (UN, 2003):

- Participation: all citizens, both men and women, should have a voice, directly or through intermediary organizations representing their interests, throughout the processes of policy- and decision-making.
- Transparency: information should flow freely in society. Processes, institutions and information must be directly accessible to those concerned.
- Equity: all groups in society, both men and women, should have the opportunities to improve their well-being.
- Effectiveness and efficiency: processes and institutions should produce results that meet needs while making the best use of resources.
- Rule of law: legal frameworks should be fair and enforced impartially, especially laws on human rights.
- Accountability: governments, the private sector and civil society organizations should be accountable to the public or the interests they are representing.
- Coherency: taking into account the increasing complexity of water resources issues, appropriate policies and actions must be coherent, consistent and easily understood.
- Responsiveness: institutions and processes should serve all stakeholders and respond properly to changes in demand and preferences, or other new circumstances.
- Integration: water governance should enhance and promote integrated and holistic approaches.
- Ethical considerations: water governance has to be based on the ethical principles of the societies in which it functions, for example, by respecting traditional water rights.

According to the recent (2007) World Bank Report on Accountability for Better Water Management in the MENA Region, in several MENA countries, governments and populations are starting to see that the approach of securing supply is reaching its physical and financial limits and that there is need for a new paradigm in water management. Although slow, there is a shift towards a new approach, which considers the entire water cycle in a holistic way, using economic instruments to allocate water according to principles of economic efficiency and developing systems that are flexible in managing variations in supply and demand. Changes include planning that integrates water quality and quantity and considers the entire water system; promotion of demand management; tariff reform for water supply, sanitation, and irrigation; strengthening of government agencies; decentralizing responsibility for delivering water services to financially autonomous utilities; and stronger enforcement of environmental regulations.

Most countries are making considerable technical, policy, and institutional progress within the water sector, manifested also in the implementation of innovative policies and institutional reform. In some countries, there has been a shift from the direct provision of water supply services from governmental agencies or departments to regulation of services provided by independent or privately owned utilities. In many countries across the region, farmers have begun managing irrigation infrastructure and water allocations. Furthermore, in several countries, agencies have been established with the aim to plan and manage water at the river basin level. To implement the new policies, most governments have placed water management under the authority of one single ministry, in order to avoid the fragmentation and overlap of responsibility that existed before.

In terms of institutional and legislative reform, the range of measures, already implemented or under implementation in several MENA countries include for example (UN-ESCWA, 1997):

- The establishment of a Water Resources Council or a Higher Commitee, adopted in many areas to overcome coordination problems and promote collaboration among the different actors, including the private sector and end-user representatives. The council can have the authority to make decisions on water policy objectives, allocate funds on investments and implementing water policies, including pollution control and environmental protection.
- The parallel establishment of a national water commission, with members from ministries with technical and economic interests. This commission would have to ensure, on the national level, institutional cooperation and coordination from the technical and economic standpoints.
- The establishment of basin management authorities at the regional level, with the power to execute projects, develop/implement regional water management plans and monitor water resources.
- The establishment of water users' associations for the administration of water rights, water allocation between local users.
- The establishment of a single unified water institution for enhanced coordination. This centralized water institution could be responsible for functions, such as executing decision, evaluating, controlling, monitoring, inspecting and managing all water resources and water-related activities.

Furthermore, several countries in the region have begun involving stakeholders in public debates about water policy and those of related sectors that affect water management (World Bank, 2007). Such processes are effected either at the river basin level, through river basin agencies, and/or at the central level, through community and non-governmental organizations (NGOs). Furthermore, end-users (e.g. farmers or local communities) are increasingly getting involved in the management of local infrastructure, in an effort to both resolve conflicts at the local level, and to promote the concept of co-ownership of water infrastructure. Additionally, several countries have already begun releasing information on water-related issues, in order to increase transparency and awareness among citizens on what the real problems are and how these are currently being addressed.

However, in many cases, problems are still acute and expected to aggravate in the near future. Issues that still need further investigation and/or implementation of improved policies include:

- Water allocation, as available resources, due to social and political reasons, are still allocated to low-value uses, while at the same time high-value usesremain unmet;
- Interruptions in supply, even in times of high availability are frequent, as a result of the quality of water services provided and the need to renew/rehabilitate/implement infrastructure;

- Vulnerability to droughts and floods remains a problem which will be further exacerbated as a result of climate change;
- Groundwater over-pumping, absence of strategic water reserves and groundwater quality deterioration pose a further stress on available resources, and pinpoint the need for finding alternative water resources, which are, however, of high cost;
- Although there has been considerable investment in water supply and sanitation, a significant part of the population lacks access to basic water services. Furthermore, wastewater treatment remains inadequate, thus posing serious public health risk in several regions.
- Water pollution, due primarily to poor law enforcement, is further contributing to environmental degradation and provokes conflict and water stress.

According to the World Bank review, this lack of results is due primarily to two reasons:

- Reforms have not been fully implemented, primarily due to social and political reasons, such as pressure from specific user-groups. Furthermore, the lack of knowledge on the true cost of maintaining the status quo, combined with poor transparency in financial management, have resulted in deferring decisions and budget allocation to the water sector.
- The water sector is also affected by other policies dealing with e.g. agriculture, trade, finance, social protection. Therefore, in several cases, water management is influenced more by those policies than by the water policy itself.

In the above context, the following section outlines the focal water management problems experienced in the INECO regions and the underlying cross-cutting issues relevant to the "governing", "sharing" and "valuing" challenges associated with them.

2.2 The "Sharing", "Valuing" and "Governing" Dimensions of focal water management problems

Among the outcomes of the 1st year of INECO was the selection of focal water management problems (one in each country), which will form the basis for future analyses of the project regarding the idenfitication and evaluation of institutional and economic instruments in the participating regions. These problems are:

- **Cyprus:** *Aquifer depletion and sea intrusion*, which has resulted from the heavy over-pumping from groundwater aquifers during the past decades, in an effort to address the increased demand for domestic and irrigation purposes and to mitigate drought effects. The problem is further associated with the inability of the current water management framework to promote the use of alternative supply sources, such as treated wastewater, institutional framework overlaps and the inadequate legislation enforcement.
- **Tunisia:** *Aquifer depletion and sea intrusion*, mostly due to uncontrolled abstractions for irrigation purposes and the inadequacy of the presently applied alternatives and disincentives to groundwater overexploitation; water reuse is barely practiced, due to the low quality of treated water, soil types and cropping patterns, and most importantly due to farmer unwillingness to pay for treated wastewater. The problem is further exacerbated by the lack of technical capacity in the agricultural sector, the limited application of water saving methods in irrigation and the current water-intensive cropping patterns.
- **Egypt:** *Water quality deterioration* in the region of the *Bahr Basandeila Canal of the Dakahlia Governorate*, where waste disposal, heavy use of pesticides, inadequate domestic wastewater treatment, and uncontrolled discharge of industrial effluents have transformed the

open waterway to a repository and conveyor of liquid waste. The major water pollution issue, which is common in the entire Nile water distribution network, poses great risks for human health, agricultural production, and the river and coastal ecosystems.

- **Lebanon:** *Increasing water stress* for meeting domestic, agricultural and industrial water demands *in the Damour River Basin*, further exacerbated by upstream pollution, groundwater interbasin transfer, and lack of financial and technical capacity to address infrastructure requirements and enforce legislation on water resource protection.
- **Syria:** *Water pollution in the Barada River Basin (Greater Damascus Area)*, due to the discharge of high loads of industrial and domestic waste and wastewater, which exceed the river's self purification capacity, and the decrease of river flow, resulting from rainfall decrease and use of the Feige Spring for drinking water supply. Water pollution has caused the collapse of the Barada river ecosystem, which also sustains the large forest of "Ghouta", a cultural heritage area and environmental hotspot in the region.
- **Algeria:** *Pollution of the Seybouse River*, which receives large volumes of untreated industrial and domestic effluents posing both direct and indirect risk on human health, agricultural production and the river ecosystem.
- **Morocco:** *Increasing water stress in the Oum Er Rbia River Basin*, resulting from increasing demand and inefficient water use in the agricultural sector, where high losses in irrigation distribution networks combined with the currently adopted irrigation practices (non-efficient irrigation methods and water intensive, non-economically sustainable cropping patterns) contribute to significant water waste.

These problems, although diversified to the local context of water demand, water resource availability and water management orientation, are representative of two major categories of tangible water management problems:

- The widening gap between water supply and demand, resulting from inadequate or ineffective past water management efforts, population and economic growth, combined with the decreasing availability of freshwater supply;
- The deterioration of water quality, threatening ecosystems, increasing water stress, and related to increased health risk and the need to ensure adequate and safe drinking water and provision of improved sanitation services.

Although diverse, the cases analysed within INECO present commonalities on the underlying causes of focal water management problems, which beyond the technical challenge, call for improved decision-making, effective governance, improved application of economic instruments, and increased public awareness and participation. Table 1 attempts to summarize the underlying causes of those problems, and relate them to the “Governing”, “Valuing” and “Sharing” challenges, which form the backbone of the project’s roadmap. Further details on the analysed issues are presented in Part II of this Deliverable. The matrix demonstrates that, although potential solutions to water problems are in most cases well known they have often not been implemented due to common underlying causes:

- Organisational problems, related to the lack of funds, facilities, capacity and procedures, but also to inadequate legal imperatives and administrative guidelines;
- Social perception issues, linked to both the lack of a societal understanding by decision and policy makers, of the underlying causes to water-related issues, but also to limited awareness and participation of stakeholders and user-groups.

Table 1: A tentative classification of the causes of focal water management problems analysed within INECO

Country/Region	Sharing water			Valuing water			Governing water				
	S1	S2	S3	V1	V2	V3	G1	G2	G3	G4	G5
Cyprus	+	+			+				+	+	+
Tunisia		+		+	+		+	+	+		
Bahr-Basandeila Region, Egypt		+	+	+	+		+		+		+
Damour River Basin, Lebanon	+	+	+	+	+		+		+		+
Barada River Basin, Syria		+	+	+	+		+	+	+	+	+
Oum Er Rbia River Basin, Morocco	+	+		+	+		+	+			
Seybouse River Basin, Algeria		+		+	+		+	+		+	

Table notes

Sharing Causes	Valuing causes	Governing causes
S.1: Water allocation conflicts S.2: Ineffective management of shared resources S.3: No access to basic water services	V.1: Low recovery of water service costs V.2: Ineffective application of the polluter-pays principle V.3: Inefficient water allocation	G.1: No financing/planning for technical solutions & water works G.2: Limited/no public participation and awareness G.3: Inability/unwillingness to enforce legislation G.4: Overlaps in responsibility G.5: Lack of human resources

2.3 Instead of conclusions: Towards the definition of a typology of institutional frameworks

Institutional mapping and the analysis of the overall governance structure in the participating countries is considered also a first step towards the next project phases, which foresee the development of a typology of the institutional, social and economic conditions at the regions analysed. The typology will be further used to identify commonalities and gaps regarding water management operations and decision-making processes at the:

- Constitutional functional level, focusing on the central organizational structure and the framework for the development of national water policies;
- Organisational functional level, addressing patterns and processes adopted for dealing with conflicts between uses and users, coordination of water use and rules for water allocation at the management unit (river basin or administrative region);
- Operational functional level, addressing issues related to the provision of water services, water use and control for specific purposes, needs and demands such as domestic water supply and sanitation, irrigation and drainage flood protection, hydropower, industrial supplies, tourism, wastewater treatment etc.

Furthermore, the elaborated typology will form the basis for development of guidelines, aimed at addressing the necessary institutional, legal, decision-making and operational framework of water resources management. Guidelines will integrate the particular socio-economic environment and traditional practices of water management in the analysed Mediterranean regions, focusing primarily on the aspect of public participation and the institutional mobilisation and capacity building required for the application of economic instruments and transparency of water and cost allocation.

On the basis of the analysis conducted, and information collected during the previous phases of the project, the guidelines will define the institutional prerequisites for the application of alternative economic instruments that could enable a more transparent, equitable, environmentally and economically sustainable allocation of resources, adapting the lessons learned from previous and current research efforts and from the implementation of INECO.

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PART II: INDIVIDUAL REGIONAL REPORTS

INSTITUTIONAL ANALYSIS AND FOCAL WATER MANAGEMENT PROBLEMS IN CYPRUS

Prepared by Aeoliki Ltd, in collaboration with the Water Development Department, Ministry of Agriculture, Natural Resources and the Environment, Cyprus

1 Overview of the region

1.1 Location

Cyprus is situated at the north-eastern part of the Mediterranean Basin, 33° east of Greenwich and 35° north of the Equator. It is the third largest island in the Mediterranean, with an area of 9,251 km^2, of which 47% is arable land, 19% is forest land and the remainder 34% is uncultivated.

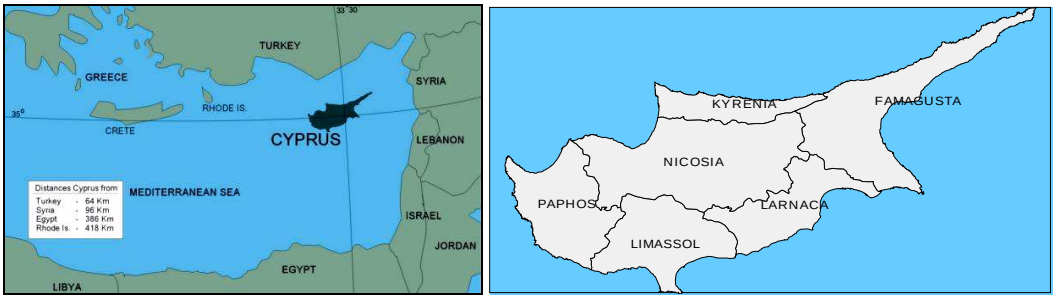


Figure 4: Cyprus and neighbouring countries

Cyprus is divided into six administrative districts: Nicosia, Famagusta, Limassol, Paphos, Larnaca and Kyrenia (Figure 4). At local administrational level in Cyprus, urban residential populations and their localities fall under the jurisdiction of Municipalities, and smaller rural villages and settlements under Local Authorities (until recently termed 'Village Boards' or 'Improvement Boards').

Table 2: Country overview

INFORMATION	INDICATOR/ Units	DATA	SOURCE
Geographic characteristics	Area (km^2)	9,252	Forest Dept.
	Surface water area (km^2)	37.63	Forest Dept.
	Dams	13.48	Forest Dept.
	Lakes	22.92	Forest Dept.
	Reservoirs - Ponds	1.23	Forest Dept.
	Land use – Arable (%)	26.5	Forest Dept.
	Land use - permanent crops (%)	2.1	Forest Dept.
	Land use – urban (%)	4.7	Forest Dept.
	Land use – wetlands (%)	0. 36	Forest Dept.
	Land use - protected areas (%)	2.22	Forest Dept.
	Natural forests	1.7	Forest Dept.
	Natural reserves	0.52	Forest Dept.
	Land use – other (%)	8.9	Forest Dept.
	NATURA	8.9	Forest Dept.
Socio-Demographic indicators	Total Population (number of people)	703,529	Census 2001
	Urban Population (number of people)	485,304	Census 2001
	Rural Population (number of people)	235,402	Census 2001

INFORMATION	INDICATOR/ Units	DATA	SOURCE
	Population growth rate (%)	1.3	Census 2001
	Population density (Number of people / km2)	76.04	Census 2001
Economy	GDP (mil €/y)	12,542	Main Economic Indicators 2005
	GDP per capita (€/head)	17,000	Main Economic Indicators 2005
	GDP in the Tertiary sector (including Services) (%)	4.5	Main Economic Indicators 2005
	GDP in the Agricultural sector (%)	-3.6	Main Economic Indicators 2005
	GDP in the Secondary Sector (including industrial sector) (%)	2.7	Main Economic Indicators 2005
	Labour force by primary sector (%)	7.8	Labour Statistics 2003
	Labour force by secondary sector (%)	21.1	Labour Statistics 2003
	Labour force by tertiary sector (%)	71.1	Labour Statistics 2003
	Unemployment (%)	3.5	Labour Statistics 2003

In municipalities, the local policy is formulated by the Municipal Council (elected by the citizens to a term of five years), led by the Mayor who is the legal representative (who is also elected by the citizens to a five-year term).

The municipality is responsible for the management of the municipal zone, which includes construction and maintenance of buildings, parks and public gardens, street lighting, the protection of public health with waste collection, sanitation and waste disposal and treatment, and the protection of the environment. Where budget permits, municipalities are also responsible for promoting their area through the development of tourism, arts and sports.

1.2 Main physical characteristics

The geomorphology of Cyprus is dominated by two mountain massifs: the Troodos range in the central, southern and western parts of the island, and the Pentadaktylos range which runs in parallel to the northern coastline (Figure 5). Situated between the two mountain ranges is the Mesaoria Plain. The coastline comprises a mixture of low hills, rocky areas, cliffs and narrow plains. Wider plains exist around river estuaries.

The central part of the Troodos Massif (covering approximately 3,500 km^2 and rising in the west to nearly 2,000 m) consists of igneous rocks (Troodos Ophiolite Complex). The southern and southwestern fringes consist of autochthonous sedimentary rocks.

The central and highest part of the ophiolite complex consists of ultramafic rocks (harzburgites, serpentinites) and plutonic rocks (dunites, wehrlites, pyroxenites, gabbros and plagiogranites). Bordering this is the Sheeted Dyke Complex and, downhill the volcanic rocks (pillow lavas). Autochthonous sedimentary rocks dominate the southern and southwestern periphery with alternating layers of chalks and marls (Lefkara, Pachna and Kalavassos Formations).

The Pentadaktylos Mountain Range has retained its limestone covering over the ages. The two mountain ranges were originally separated by a shallow sea, the bed of which is now the Messaoria (or middle) plain, a fertile agricultural region with the capital city of Nicosia situated at its centre. The highest peak within the Pentadaktylos Mountain Range is Kyparissovouno (1,024 m), followed by Boufavento (955 m) and Gialas (935m). These mountains consist mostly of allochthonous recrystallized limestones, dolomites and marble.

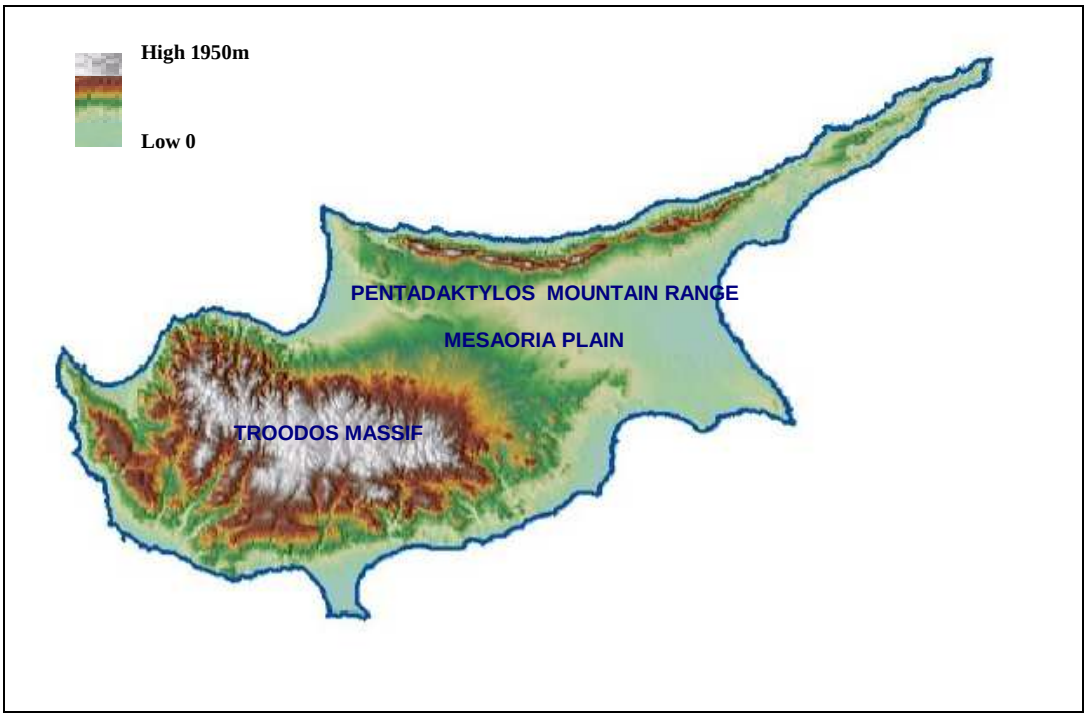


Figure 5: Topography of Cyprus

The Mesaoria Plain (covering 2,500 km^2) sits between the two mountain ranges and extends from Morfou Bay to Ammochostos Bay. The topography is dominated by flat or softly undulating areas and scattered, characteristically flat-topped or conical-shaped hills. The altitude reaches up to 300 m. The plain consists mainly of marls, calcarenites, sands and gravels (Lefkosia, Athalassa, Kakkaristra and Apalos Formations) as well as alluvial deposits.

1.3 Land

Approximately 47% of the island area is arable land whereas 34% is uncultivated. Some 19% is covered by forest, most of which is owned by the state. In the Government controlled areas, the total agricultural land is approximately 200,000 ha of which 45% are cultivated by annual crops and 21% to perennial crops. Some 5% are under fallow and as grazing land, 25% is uncultivated and some 4% is classified as scrub and deserted. Some 37,000 ha are irrigated, covering approximately 25% of the cultivated land (crop and fallow) and account for 60-70% of the total crop production value.

1.4 Climate

Cyprus has an intense Mediterranean climate with the typical seasonal rhythm strongly marked with respect to temperature, precipitation and weather in general. Hot dry summers from mid-May to mid-September and rainy, rather changeable, winters from November to mid-March are separated by short autumn and spring seasons of rapid change in weather

conditions. At latitude 35° North, Longitude 33° East, Cyprus has a change in day length from 9.8 hours in December to 14.5 hours in June.

The central Troodos massif, rising to 1951 metres a.m.s.l., and to a less extent the long narrow Kyrenia mountain range, with peaks of about 1000 metres a.m.s.l., play an important part in the meteorology of Cyprus. The predominantly clear skies and high sunshine give large seasonal and daily differences between temperatures of the sea and the interior of the island that also cause considerable local effects especially near the coastline.

During the summer, the island is mainly under the influence of a shallow trough of low pressure extending from the great continental depression centered over southwest Asia. It is a season of high temperatures with almost cloudless skies. Precipitation is almost negligible but sometimes isolated thunderstorms give precipitation amounting to less than 5% of the total in the average year.

During the winter Cyprus is near the track of fairly frequent small depressions that cross the Mediterranean Sea from west to east between the continental anticyclone of Eurasia and the generally low-pressure belt of North Africa. These depressions give periods of disturbed weather usually lasting from one to three days and produce most of the annual precipitation. The average precipitation from December to February is about 60% of the annual total.

The total yearly average precipitation is about 500 mm (period 1961-1990). A lowest value of 182 mm was observed in 1972/73 and a highest of 759 mm occurred in 1968/69. Statistical analysis of precipitation in Cyprus reveals a drop in the last 30 years. The mean annual precipitation increases up the southwestern windward slopes from 450 mm to nearly 1,100 mm at the top of the central massif of Troodos (Figure 6). On the leeward slopes, precipitation decreases steadily northwards and eastwards to between 300 and 350 mm in the central plain and the flat south eastern parts (the Kokkinochoria area) of the island (Rossel, 2001).

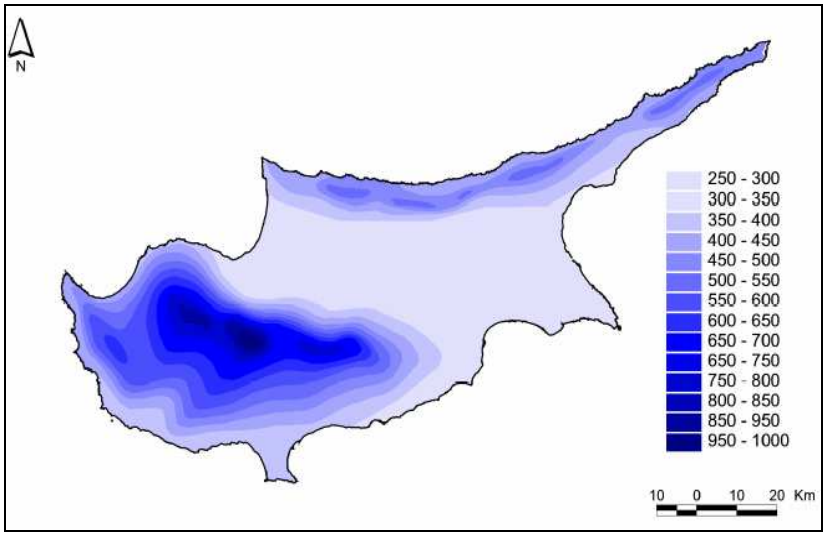


Figure 6: Mean annual precipitation in mm over the period 1971 - 2000

Cyprus can be divided in four main topo-climatic regions:

(a) The high altitude areas (500 to 1950 m. amsl) of the Troodos mountain range that dominates the central part of the island, corresponding to 18% of the total area. The mean annual precipitation is 690 mm, varying from 400 to 700 mm at elevations of 500 m, to 1100 mm at the mountain peak. The mean annual evaporation varies from

1,400 to 1,700 mm at 500 m elevation to 1000 mm at the top. According to the Penmann-Monteith classification, the region, with an average aridity index of 0.54, can be classified as *"dry sub-humid"*.

(b) The slopes of the Troodos mountain range at altitudes of 200 to 500 m amsl (27% of the total island area), with a mean rainfall of 300 to 500 mm at the lower elevation and 400 to 700 mm at the higher elevations. The rainfall rate is higher at the western and southern slopes. Similarly, the annual evaporation varies from 1600 to 1900 mm at lower elevations to 1400 and 1700 mm at the higher ones. The region has an average aridity index of 0.3, and can be classified as *"semi-arid"*.

(c) The Mesaoria Plain dominating the central eastern part of the island (20% of the island) at elevations of 0 to 200 m amsl, with corresponding annual rainfall in the range of 290 to 350 mm, and an annual evaporation rate of 1650 to 1850 mm. The area can be classified as "arid", with an aridity index of 0.18.

(d) The coastal areas at 0 to 200 m elevation amsl, including also the Pentadactylos mountain range along the northern part of the island (35% of the island). The mean annual rainfall varies between 350 and 400 mm in the south-eastern and southern areas and between 450 to 500 mm in the western and northern areas. The mean annual evaporation is in the range of 1700 to 2000 mm. These areas can be classified as *"semi-arid"*, with an aridity index of 0.23.

The overall average aridity index is 0.295, classifying the entire island as *Semi-arid.*

1.5 Major socio-economic characteristics

Cyprus has a population of 703,529 inhabitants, with an estimated annual growth rate of 0.54% (Department of Statistics, July 2005 estimates). More than 50% (485,304) are urban residents, whereas 218,225 are rural residents. The capital of the country is Lefkosia (Nicosia) with a population of 213,500. The second biggest city is Lemessos (Limassol) with a population of 161,200[1]. Figure 4 presents the distribution of population gender and age in 2001.

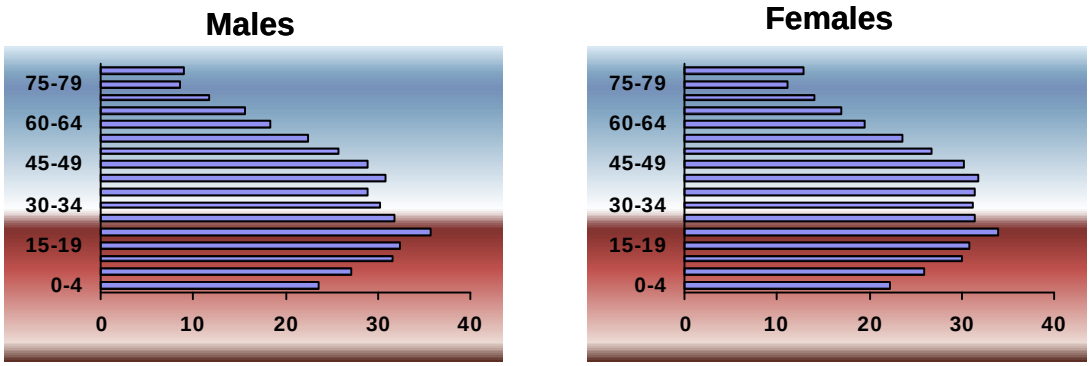


Figure 7: Population by Age and Gender (2001)

The Cypriot economy can be considered strong, with a GDP of 26.2 billion € in 2004, but is still susceptible to external shocks. Although the most important economic activity in the past was agriculture, at present the agricultural sector is declining and the economy is now dominated by the service sector, mainly tourism and financial services. Erratic economic

1 www.visitcyprus.org.cy

growth rates over the past decade reflect this reliance on tourism, which often fluctuates with political instability in the region and economic conditions in Western Europe.

At present, the economic policy in Cyprus is focused on meeting within the next two years the criteria to join the European Exchange Rate Mechanism (ERM2). However, slow growth in tourism activities and poor fiscal management have resulted in growing budget deficits since 2001.

Overall, the Cypriot economy continued to expand through 2004 and it was the first time since 2000 that it recorded a higher growth rate compared to the previous year. Growth in some key sectors over 2004:

- The sector of Agriculture, Hunting and Forestry is exhibiting a negative growth rate of –0.5% in its value added, compared to 5.6% in 2003.
- Construction continued its expansion for a fourth consecutive year, recording a marginally reduced 5.2% growth in 2004, compared to 5.3% in 2003.
- The sectors of Wholesale and Retail trade, Transport Storage and Communication and Financial Intermediation recorded exceptionally high growth rates in 2004. Hotels and Restaurants is the only activity in the tertiary sector that shows a negative growth rate for a third consecutive year. In particular, the negative growth rate in 2004 is estimated at –2.8% with –4.2% negative growth rate in 2003.

The main agricultural products of the country include cereal grains, olives, citrus, potatoes, and cotton; as well as deciduous fruits and wine grapes. Sheep, goats, poultry, pigs, and some cattle are bred. There is also a strong manufacturing economy (processed foods and beverages, paper, chemicals, textiles, metal products, and refined petroleum). Mineral resources include copper, pyrites, chrome, asbestos, and gypsum. Timber production is also considered to be important.[2]

Due to the small domestic market size and the open nature of the economy of Cyprus, access to international markets is considered to be of high economic importance. As a result, trade has always been one of the most important economic sectors, contributing considerably to the economic growth of the country. In 2003 exports accounted for about 7% of the total GDP. During the same year, the value of foreign trade was 4.750 mil. €, showing a decrease of 7% with regard to 2002. This reduction was mainly due to the decrease in domestic exports, which declined by 7%, reaching 366 mil. € in 2003, in comparison to 395 mil. € in 2002. Total imports also decreased by 7%, falling to 3.934 mil. € in 2003 from 4.228 mil. € in 2002. Exports of manufactured products (i.e. industrial products of manufacturing origin) constitute the bulk of domestic exports, representing 58% of total exports in 2003. The most important products exported during 2003 were pharmaceuticals (66.3 mil. €), clothing (17 mil. €), cement (15.3 mil. €), cigarettes (12 mil. €), paper products (10.2 mil. €), plastic products (6.8 mil. €) and furniture (6.8 mil. €). In 2003, exports of raw and processed agricultural products accounted for 21% and 16% of total domestic exports respectively. Exports of raw agricultural products increased to 75 mil. € from 63 mil. € in 2002. Citrus fruit and potatoes were the most important products, with exports valued at 32.3 mil. € and £25.5 mil. €, respectively. Exports of processed agricultural products remained at about the same levels in

2 www.encyclopedia.com

2003, corresponding to 56.1 mil. €. The most important processed agricultural products exported were halloumi cheese, wines and fruit and vegetable juices.

The countries of the European Union are the most important markets for Cyprus, corresponding to 54% (199 mil. €) of exports in 2003. The major EU export market is the United Kingdom, followed by Greece, Germany and the Netherlands. The Arab Countries are the second most important market group, corresponding to 17% of exports in 2003. The major markets in this group are Jordan, Lebanon, the United Arab Emirates, Saudi Arabia, Kuwait and Egypt.

Imports of intermediate inputs (raw materials) and consumer goods make up for most of total imports, accounting for 31% and 29% of the total imports, respectively. Other imported products are by transport equipment (14%), capital goods (11%), and fuels and lubricants (10%). In 2003, the imports of raw materials (intermediate inputs) reached 1,234 mil. € (1,232.5 mil €. in 2002). The majority of imports were raw materials for the manufacturing sector. Imports of consumer goods declined to 1,132.2 mil. € compared to 1,213.8 mil. € in 2002. Imports of capital goods reached in 2003 447.1 mil. € from 420 mil. € in 2002. Imports of transport equipment and parts declined and reached 556 mil. € in 2003 compared to 675 mil. € in 2002. Passenger motor vehicles accounted for nearly half of the total transport equipment imports, followed by motor vehicles for the transport of goods and parts for transport equipment. The value of imports of fuels and lubricants declined to 385.9 mil. € from 459mil. € in 2002.

Tourism is central to the Cypriot economy. Revenue from tourism reached 193 mil. € in June 2005 compared to 186 mil. € in June 2004, recording an increase of 3,7%. For the period January-June 2005, revenue from tourism was estimated at 633 mil. € compared to 629 mil. € in the corresponding period of 2004, recording an increase of 0.6%[3]. During 2003, hotels and restaurants experienced a reduction both in terms of economic output and value added. This is due to a decrease in the number of tourists visiting Cyprus and to the number of overnight stays. Consequently, the value added in real terms declined further by 3.3% (the decrease recorded in 2002 was 6.4%). Of the total value added, 38.5% corresponds to hotels, 11.8% to hotel apartments, 22.1% to restaurants and taverns, 6,9% to cafeterias and coffee shops, 5.8% to night clubs and cabarets, 4.3% to fast-food outlets and take-away restaurants and 10.6% to other eating and drinking places. Employment in restaurants and hotels decreased by 0.5% in 2003 compared to the previous year and reached 32,234 persons, accounting for 9.5% of the total economically active population and 10.2% of the total gainfully employed population.

Civil aircraft landings increased during 2000 and totalled 26,540 compared to 24,860 in 1999. Passenger arrivals through airports increased to 3,066,077 in 2000 compared to 2,776,360 in 1999. Civil aircraft landings increased during 2003 and totalled 29,177, compared to 28,810 in 2002. Passenger arrivals through airports decreased to 3,041,409 in 2003, compared to 3,105,818 in 2002.[4]

3 www.mof.gov.cy/mof/cystat/statistics.nsf
4 www.mof.gov.cy/mof/cystat/statistics.nsf/All/

1.6 Water Resources: Hydrology and Human Impacts

1.6.1 Surface Water

Following the definitions of the Water Framework Directive, Cyprus has been identified as one River Basin District.

Hydrographically the island is subdivided into 9 hydrological regions, including 70 watersheds and 387 subwatersheds. The area under the control of the Cypriot Government includes 47 watersheds. Cyprus falls within Ecoregion 6 (the Mediterranean sea), on System A, "Ecoregions for transitional and coastal waters, and the Ecoregion 26: Cyprus on System A, "Ecoregions for rivers and lakes" (Republic of Cyprus Law, 13(I)/2004).

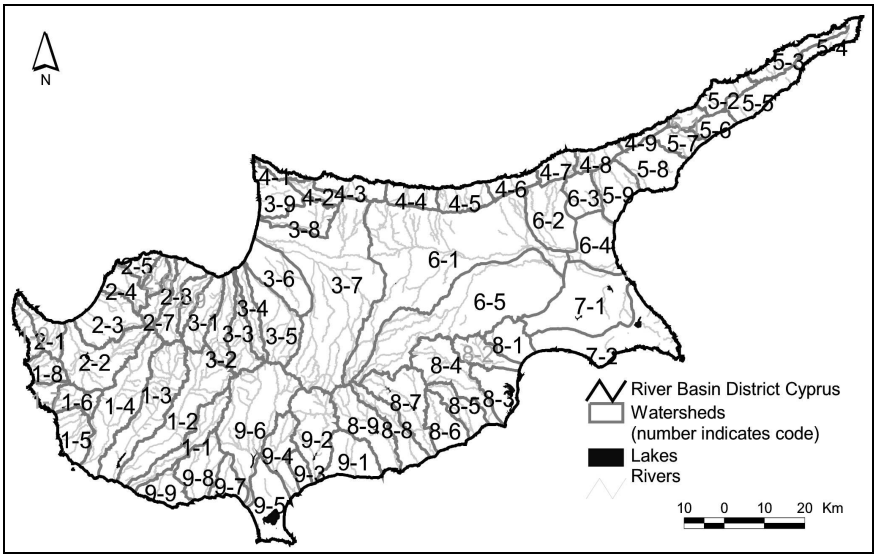


Figure 8: The river basin district of Cyprus, including watersheds and rivers

As described in detail in Section 1.4, the average annual rainfall is about 500 mm, ranging from 300 mm in the central plain and the southeastern parts of the island, up to 1,100 mm at the top of the Troodos mountains (Figure 6). The variation in rainfall is not only regional but also inter-annual and often two and even three-year consecutive droughts are observed. Evapotranspiration is high, and on an annual basis, corresponds to about 80% of precipitation. In general, full irrigation is necessary from late spring to late autumn to sustain production of crops requiring water during this period.

Most rivers originate from the Troodos area. The seasonal distribution of surface runoff follows the seasonal distribution of precipitation, with minimum values during the summer months and maximum values during the winter. As a result of the Eastern Mediterranean climate with long hot summers and a low mean annual precipitation, there are no rivers with perennial flow along their entire length. Most rivers flow 3 to 4 months a year and are dry during the rest of the year. Only the upstream parts of some rivers in the Troodos areas have a continuous flow (rivers of Xeros, Diarizos, Kargotis, Marathasa, Kouris and Germasogeia). Twenty four catchments can be considered of medium size (100 to 1000 km^2). All others are classified as small (10 to 100 km^2). There are only 5 natural lakes which are brackish or salt. The rest of the surface water bodies are man-made, resulting from river damming or creation of storage basins.

The average annual water crop for this period (1961 – 1990) amounts to 780 hm^3. Some 65%, or 510 hm^3, of the total annual water crop corresponds to surface runoff (Table 3). Of the total

surface runoff only 45% (230 hm^3 or 29% of the total water crop) is lost to sea, a fact that reveals the high level of surface runoff utilization and control achieved in Cyprus over the last 35 years. Of the total sea outflow, a large proportion corresponds to overland flow and flow from minor streams, which cannot be regulated or controlled.

Since 1960, attention was turned to the systematic study and construction of water development works, both for storage and recharge purposes. After a comprehensive survey of the island's water resources, a long-term plan for the construction of major development projects was followed, involving the construction of a large number of dams. The current total storage capacity of surface reservoirs has reached 307.5 hm^3 of water from a mere 6 hm^3 in 1960, and will reach 325.5 hm^3 with the completion of the Kannaviou dam. This is a truly impressive achievement when compared to other countries of the same size and level of development as Cyprus. The yield of these reservoirs is about 130-150 hm^3/yr, however, this value is now seldom reached due to the decline in rainfall and hence in runoff.

Table 3: Surface runoff for each Hydrologic Region

Region		Catchment	Average	Surface	Surface Water Use (hm^3)			
No	**Name**	**Area (km^2)**	**Rainfall (mm)**	**Runoff (hm^3)**	**Spate Irrig.**	**From dams**	**To recharge**	**Outflow to sea**
1	Pafos	1188	627	125	9	47	20	48
2	Tylliria	745	585	59	2	10	7	39
3	Morfou	1585	429	96	7	6	42	41
4	Kyrenia	455	490	16	0	0	9	7
5	Karpasia	685	463	22	0	0	3	19
6	Mesaoria	1840	381	53	4	6	41	2
7	S.E. Mesaoria	546	341	4	0	1	0	3
8	Larnaka	1050	439	39	4	18	10	7
9	Lemesos	1155	555	96	11	64	9	12
Total		**9249**		**508**	**37**	**152**	**141**	**178**
Island-wide average			**478**					

At present, in Cyprus there are 106 dams and ponds: 35 large dams with a capacity of 286.1 hm^3 of water, of which 4 are groundwater recharge-flood protection dams, 42 small dams with a capacity of 16.1 hm^3 of which 32 are recharge-flood protection dams, and 26 ponds with a capacity of 2.5 hm^3. Eighty-one percent (81%) of the dams, i.e. 85 in number, are earth fill or rock fill.

The remaining 19%, i.e. 20 in number, are concrete dams. Generally, these reservoirs are able to hold two to three times the average annual flow of a stream.

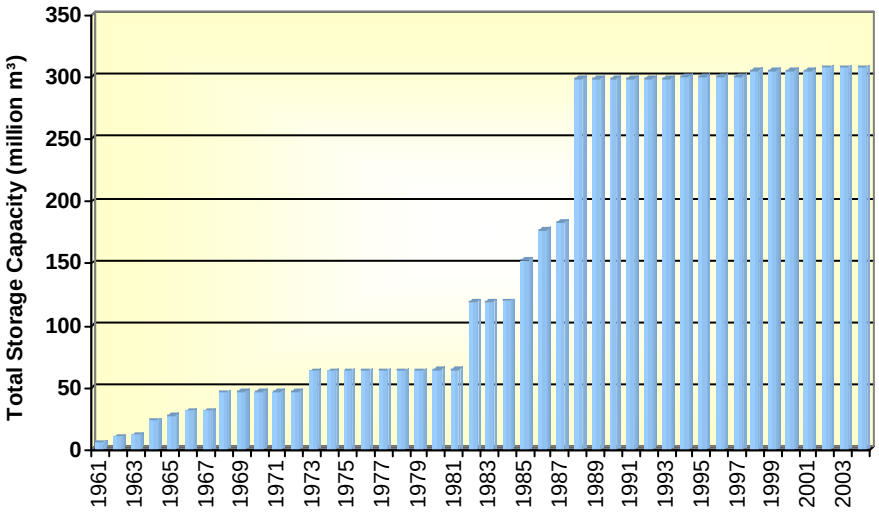


Figure 9: Dam construction (1961 – 2004)

1.6.2 Groundwater

Most of the aquifers are phreatic, developed in river or coastal alluvial deposits. These are the biggest and the most dynamic aquifers, replenished mainly by river flows and rainfall. During the last decade almost all aquifers exhibit trends of depletion. Frequent droughts have reduced the direct and indirect groundwater recharge, while the construction of dams has resulted in reduced recharge of the downstream aquifers. At the same time, farmers, in their effort to maintain the agricultural production levels, have continued extracting the same quantities of groundwater, and in most cases have even increased these quantities. All these adverse conditions have resulted in saline water intrusion and hence quality deterioration of coastal aquifers and the depletion of inland aquifers.

Direct recharge (from rainfall) of the island's aquifers is of the order of 270 hm^3 . An additional recharge of 140 hm^3 corresponds to surface runoff, which infiltrates into riverbed aquifers and coastal alluvial fans (Table 4). Part of this replenishment is extracted through wells and boreholes, and the remainder goes to the sea. 8 % or 40 hm^3 of surface runoff is diverted for irrigation in late winter or early spring, and especially during the wet season. Where pumping exceeds recharge, a deficit of 10% or 40 hm^3, is created in certain aquifers. The result of the long-term over-pumping has been the sea intrusion in certain major coastal aquifers.

Table 4: Groundwater replenishment (surface runoff and directly from rainfall) and use

Region		Ground Water Recharge (hm^3)			Use by (hm^3)		Deficit (hm^3)
No	**Name**	**Streams**	**Direct**	**Total**	**Pumping**	**to sea**	
1	Pafos	20	46	66	18	47	0
2	Tylliria	7	23	30	11	20	0
3	Morfou	42	30	72	89	11	29
4	Kyrenia	9	19	28	11	17	0
5	Karpasia	3	26	29	2	27	0
6	Mesaoria	41	47	88	28	60	0
7	S.E. Mesaoria	0	11	11	35	1	25
8	Larnaka	10	34	44	14	31	0
9	Lemesos	9	37	47	35	15	3
Total		**141**	**273**	**415**	**243**	**229**	**57**

The present level of abstractions from all aquifers is estimated at 130 hm^3/yr, of which 10 hm^3/yr are available through artificial recharge. The average yield of abstractions for domestic water supply during the period of 1991 – 2000 was approximately 25 hm^3/year, for irrigation about 102 hm^3/yr and for industrial use around 2.5-3.0 hm^3/yr. During the last years, annual abstraction for domestic water supply decreased to a level of 18-20 hm^3.

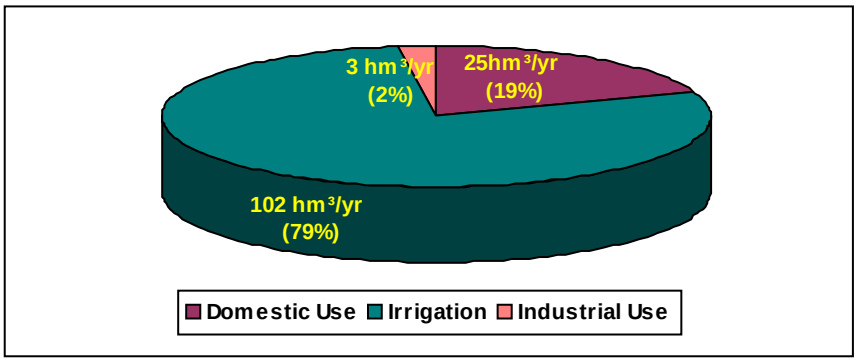


Figure 10: Groundwater abstractions per use (1991 – 2000)

The total recommended abstraction from all groundwater bodies is estimated to 80 hm^3/yr, This estimate is based on the water balance of each aquifer and the annual replenishment rate. During the last decade, almost all groundwater bodies with the exception of the riverbed coastal ones are being overexploited. Of the 19 groundwater bodies in Cyprus (Figure 11), 17 have significant abstractions, which can be considered as "over-pumping". The total "over-pumping" is approximately 33 hm^3/yr, and is encountered in all major aquifers of the country. In general, the groundwater resources in Cyprus are overexploited by 40% of their sustainable extraction.

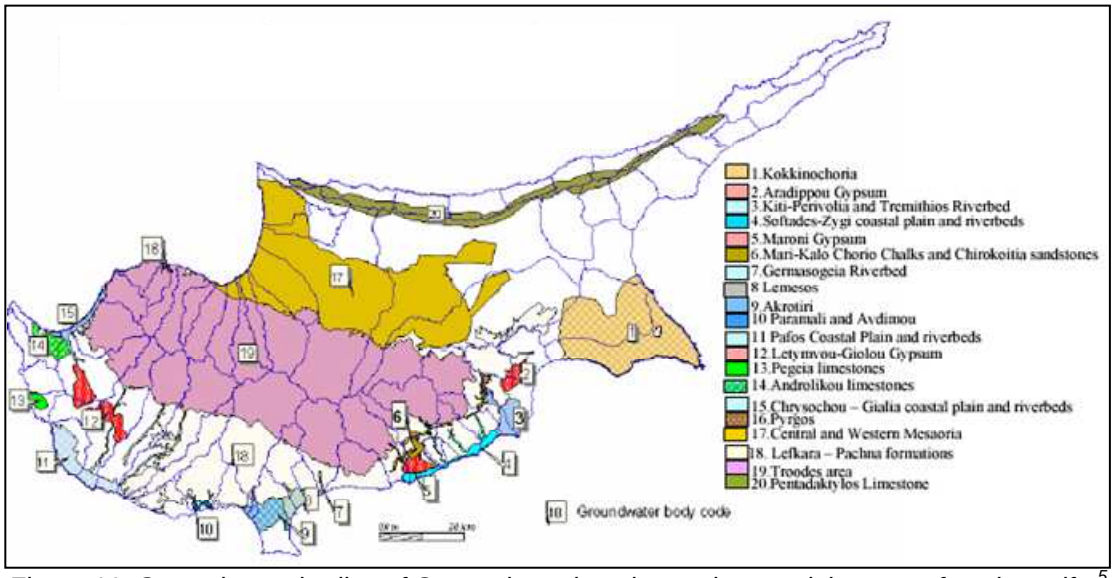


Figure 11: Groundwater bodies of Cyprus based on the geology and the type of each aquifer[5]

1.6.3 Major water development works

It is widely accepted that in the last 46 years there has been a revolution in the water supply industry of the island. Since 1960, the year of Independence, the number of dams has risen from 21 to 106. Additionally, from 1962 to 2006 the number of large dams increased from 10 to 36. The total area corresponding to irrigated agriculture has increased from 1,600 ha to almost 21,000 ha. In 1960, most villages relied on communal springs. Now, approximately 60 villages are serviced by central domestic water supply systems, either by exploiting the local water resources or connected to the Cyprus Major Water Works. Water development schemes became numerous and larger as time passed by. Figure 12 presents a map of Cyprus depicting the major water development works.

A large part of the island water demand is now met through inter-basin water transfer schemes, which also involve the conjunctive use of surface and groundwater. Water development schemes are in their majority multipurpose, addressing demands for irrigation, domestic and industrial purposes.

Very recently, the water economy started to shift towards the development of non-conventional water resources. Desalination plants were installed, with the aim to eliminate the dependency of large urban and tourist centres on rainfall for drinking water supply. The Government's water policy is not restricted to the issue of desalination plants alone but also focuses on the exploitation of other non-conventional water sources, such as recycled water for irrigation.

[5] Modified from the map of aquifers of Cyprus -Assessment of Groundwater Resources WDD/FAO A. Georgiou 2002 and G.S.D data.

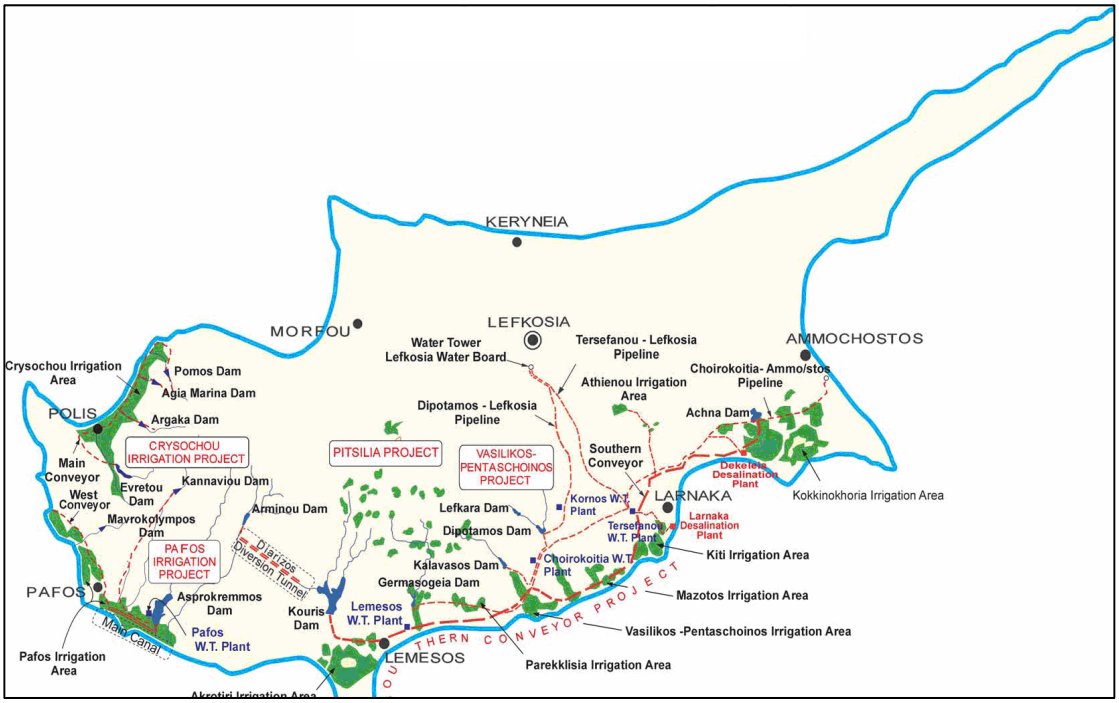


Figure 12: The major water works of Cyprus

2 Management Challenges: Stewardship and Governance

2.1 Ownership and responsibility for water management

Overall, bulk water supply provision for domestic use falls under the responsibility of the Water Development Department (WDD) of the Ministry of Agriculture, Natural Resources and the Environment. WDD is responsible for the construction, operation, administration and management of all Government Water Works, related to freshwater provision.

On the user level, domestic water supplies are managed by the Town Water Boards in the major metropolitan areas of Nicosia, Larnaca, and Limassol, by Municipal Authorities in other municipalities, and by Community Boards for village water supplies. The operation of Water Boards and Community Boards is governed by the *"Water Supply (Municipal & Areas) Law (Cap 350)"*. This law provides for the establishment of Water Boards and control and management of water supplies in municipal and other purposes, e.g. breaking open streets, entry onto land, installation of pipes, etc. Boards have the power to impose water rates or charges for the supply of water, but only after the approval of the Council of Ministers and the Parliament of the Republic of Cyprus. Water sources managed by the Boards can be developed by themselves or consist of bulk supplies from the Government.

Irrigation water supply in Cyprus is managed by local Irrigation Divisions formed of landowners, at a lesser extent by Irrigation Associations formed of water-rights owners. Almost half of irrigation demand is supplied directly by the Government (WDD).

2.2 Ministries, authorities and institutions at national level with a role in water management

At the policy level, the water administration rests with the Council of Ministers that is formed jointly by four Ministries: Agriculture, Finance, Interior and Commerce. At the executive level, powers are divided between two ministries, the Ministry of Agriculture, Natural Resources and Environment (MANR&E) and the Ministry of Interior. The former has technical responsibility for water resources policy, assessment and monitoring, but also for development of water resources and the bulk sale of water to end-users. The latter is responsible for the enforcement of water-related laws, including the issue of groundwater permits. Its representatives act as the chairmen of Municipal Water Boards, Village Water Commissions and local irrigation associations, known as Irrigation Divisions.

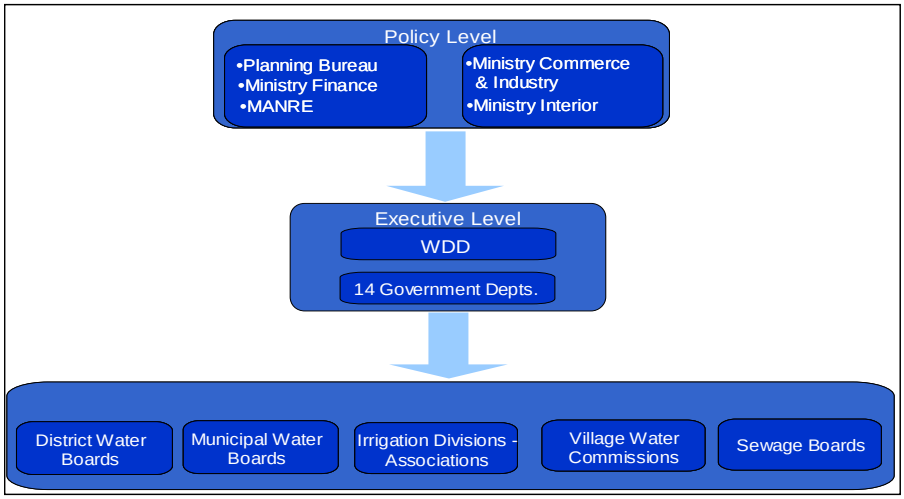


Figure 13: The administrative, institutional and political setting of the region

The Water Development Department (WDD), which is one of the departments of the Ministry of Agriculture National Resources and Environment (MANR&E), is responsible for implementing the water policy of the Ministry, with the overall objective of pursuing the rational development and management of water resources.

At the regional level, the District Administration under the Ministry of Interior plays a key role in the implementation and enforcement of water-related laws, including the issue of groundwater permits. All municipal water supplies and non-government irrigation schemes are in principle under the jurisdiction of the Ministry of Interior. Other government departments are also involved at various aspects of the water industry of the island (Figure 13).

Responsibility for water administration at the local level is in the hands of the Municipal Water Boards and Village Commissions for domestic water supply, the Irrigation Divisions, Irrigation Associations, Waterworks Committees and WDD for irrigation, and the Sewerage Boards for wastewater collection and treatment. All these organizations, except WDD are under the jurisdiction of the Ministry of Interior.

At the user level, farmers have the right to form Irrigation Divisions and Associations to construct and manage irrigation schemes. Villages also have the right to establish their own Commissions for developing local resources for domestic water supply.

The authorities/organisations which play a key role in the management of the water resources in the region are presented in Table 5 and Figure 14. Table 5 presents the water resources planning matrix.

Table 5: Responsibilities in water management

Authority	Name	Role/Main Activities in relation to water management
Governmental Institutions		
Ministries	Water Development Department (WDD) - Ministry of Agriculture, Natural Resources and the Environment	It has technical responsibility for water resources policy, assessment and monitoring, and for development of water resources and for the bulk sale of water to end-users.
	District Administration - Ministry of the Interior	It plays a key role in the implementation and enforcement of water-related laws including the issue of groundwater permits. All municipal water supplies and non-government irrigation schemes are in principle under the jurisdiction of the Ministry of Interior
Municipalities	Local Municipalities and Communities, Union of Communities	Responsible for water administration at local level
Other	The Department of Agriculture	It is a section of the Ministry of Agriculture, Natural Resources and Environment. The Department of Agriculture runs extension services that advise farmers on irrigation methods, fertilizers and other issues.
	Environmental Service	It is a section of the Ministry of Agriculture, Natural Resources and Environment.
Public Utilities		
Water Utility	Water Boards (WB)	Provide waterworks and sewage services
Waste water Utility	Sewerage Boards (SB)	

Table 6: Water resources planning matrix

ACTIVITY	WDD	District Administration	Sewerage Boards	Water Boards	Dept. Of Agriculture	Environmental Service
Surface water						
Use	X	X		X	X	X
Storage	X			X		
Groundwater recharge	X					
Diversion	X					
Quality monitoring	X			X		X
Assessment	X			X	X	X
Ground water						
Use	X	X		X		
Storage	X					
Recharge	X					
Quality monitoring	X			X		X
Assessment	X			X		X
Well permits		X				
Irrigation network						
Rehabilitation	X					
Modernisation	X					
Reuse						
Drainage water	X		X		X	X
Wastewater	X		X		X	X
Desalination						
Introduction of technology	X					
Efficient water utilisation	X					
Domestic	X					
Industrial	X					

ACTIVITY	WDD	District Administration	Sewerage Boards	Water Boards	Dept. Of Agriculture	Environmental Service
Agricultural	X					
Legislation						
Regulation and codes	X			X	X	X
Standards	X			X	X	X
Policy setting	X					X
Water allocation	X			X		
Project financing	X					
Project design	X					
Project implementation	X					
Operation and Maintenance	X		X	X		
Pricing (tariffs)	X					
Enforcement	X					
Water data records	X		X	X	X	

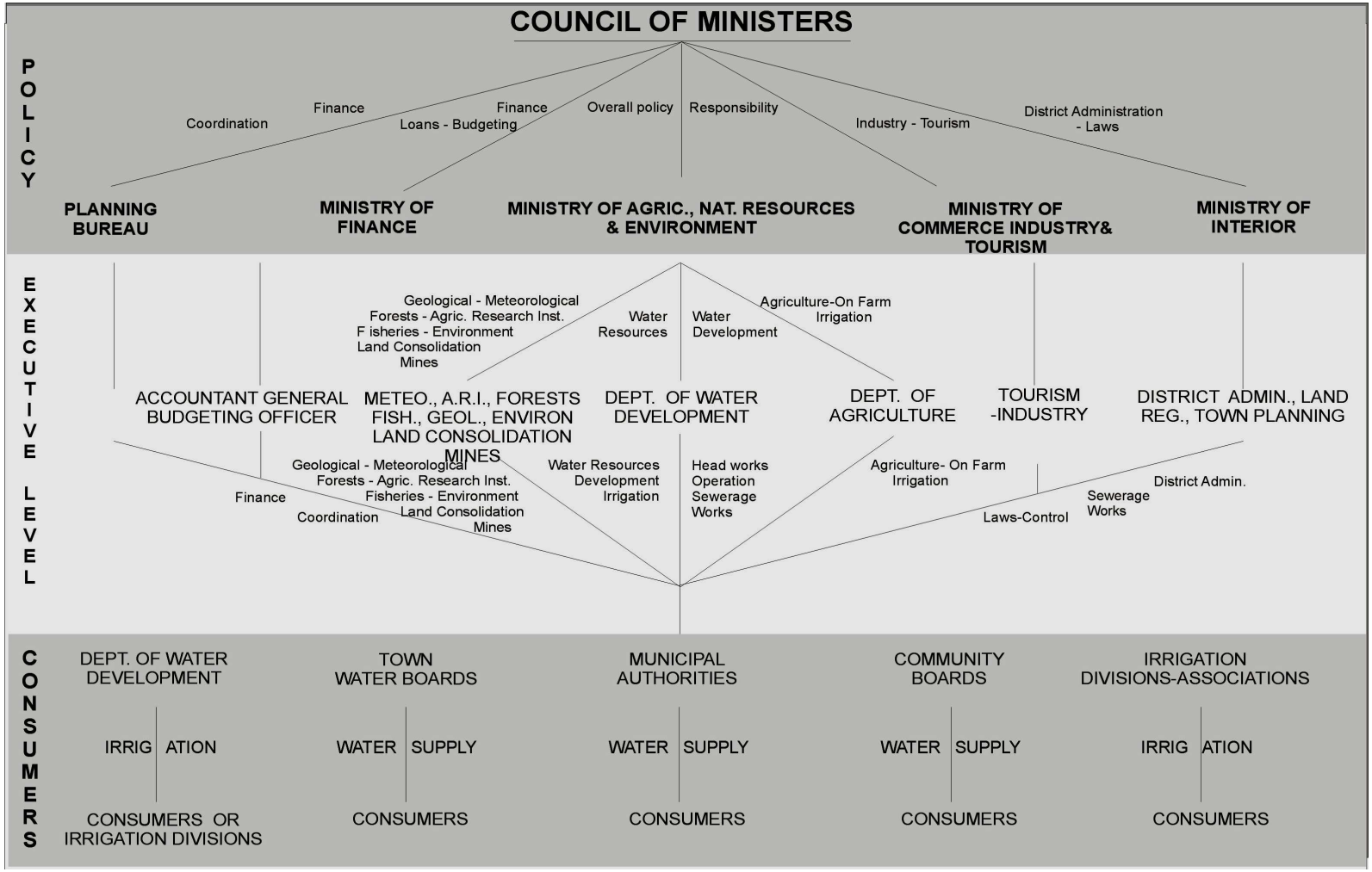


Figure 14: The Organisational Chart for Water Resources Management

2.3 Provision of water services & Financing of Water Sector Investments

2.3.1 Overview

The policy control of water resource management in Cyprus is at present divided between the Ministry of Interior, the Ministry of Agriculture, Natural Resources and Environment, the Ministry of Finance and the Planning Bureau. Water services in Cyprus can be classified into two broad categories:

- Services provided on the *freshwater supply side*, i.e. services related to the abstraction of freshwater, impoundment, storage, treatment, the production of desalinated water, water distribution;
- Services provided on the *wastewater side*, i.e. services related to drainage, sewerage collection, treatment, and provision of recycled water (effluent after tertiary treatment).

Table 7 summarises the water services, policy responsibilities and investment responsibilities, while a detailed analysis is presented in the following sections.

Table 7: Water services and responsibilities

Service	**Responsibility (Policy)**	**Responsibility (Investments)**
Surface water abstraction, storage, treatment	Water Development Department	Water Development Department
Water desalination	Water Development Department	Private Sector
Groundwater abstraction	Town Water Boards (in the major metropolitan areas), Municipal Authorities (in smaller municipalities), Community Boards (in villages), Irrigation Divisions/Associations Individual Users Water Development Department	Town Water Boards (in the major metropolitan areas), Municipal Authorities (in smaller municipalities), Community Boards (in villages), Irrigation Divisions/Associations Individual Users Water Development Department
Water distribution in urban and rural areas	Town Water Boards Municipal Authorities Community Boards	Town Water Boards Municipal Authorities Community Boards
Water distribution to irrigation	Water Development Department Irrigation Divisions (landowner's associations) Irrigation Associations (water rights owners associations)	Water Development Department Irrigation Divisions (landowner's associations) Irrigation Associations (water rights owners associations)
Wastewater collection and secondary treatment in urban and rural areas	Sewerage Boards	Sewerage Boards
Tertiary wastewater treatment and recycled water provision	Water Development Department	Water Development Department
Industrial wastewater treatment	Environmental Service Water Development Department	Individual Users Water Development Department

The Government, through the Government Water Works that are administered by the Water Development Department, is the main service providing freshwater in Cyprus, providing services

to both domestic users, through the provision of bulk water quantities to Water Boards, Municipal Authorities and Community Boards, and through the provision of irrigation freshwater on a retail basis to farmers, or on a bulk basis to irrigation Divisions and Associations.

The financing of the Government woaterworks, the Irrigation Division projects, the village water supplies and the town water supplies are made either through Government funds or through loans from International Financing Institutions, such as the World Bank, The Kuwait Fund or the European Investment Bank. In case of sewage projects constructed by the Sewage Boards or for works carried out by the Water Boards, the plans are prepared and implemented by the respective organizations, and their financing is done by the organizations themselves. Recently, the Build, Own, Operate and Transfer (BOOT) financing method was adopted for the construction and operation of the two desalination plants of the island. This method provides that the successful Contractor will design and construct the plant with its own fiancial resources and then will own and operate the plant for ten years and sell water (agreed minimum quantities) of a specified quality, to the Government at a rate ficxed after international tendering. On the other hand the Government is oblidged to buy the specific minimum qwuantities of water. At the end of the ten-year period the plant ownership shall be tranfered to the Government at no additional cost, with the Government having the right to buy the plant before the end of the ten year period, as it was the case with the Dhekelia desalination plant.

2.3.2 Domestic Water Supply

Currently, the Government Water Works cover more that 80% of the total domestic demand for potable water and industrial demand. Water is supplied on a bulk basis to the Town Water Boards (Nicosia, Limassol, Larnaca, Famagusta, and Pafos), Municipal Authorities and Community Boards. The share of water supplied by Water Boards through the development of own resources is very low (approximately 1% for the Nicosia Water Board and less than 30% for other Water Boards). Water resources allocated to domestic use provided either by the WDD or by the Water Boards or individual users include:

- Surface water from dams, treated in water treatment plants;
- Groundwater, from public and private boreholes.

Recently, desalinated water is purchased by the Government on the basis of Build-Own-Operate-Transfer (BOOT) contracts from private companies, which have undertaken the construction and operation of the two major desalination plants of Dhekelia and Larnaca airport.

Water Boards, Municipalities and Community Boards are responsible for the water distribution works within the boundaries of their jurisdiction.

2.3.3 Irrigation Water Supply

Almost half of irrigation demand is supplied directly by Government, through the Government Water Works. Approximately 60% of the irrigation demand occurs within the Government Irrigation Schemes supplied by:

- Surface water from the pertinent dams, which constitutes the main water supply source;
- Groundwater, abstracted from public and private boreholes;
- Recycled water, which is partly stored in Polemidhia dam and consecutively used in the Germasogeia / Polemidhia Irrigation Scheme.

Irrigation water supplies in Cyprus are managed by local Irrigation Divisions, formed by landowners, and to a lesser extent by Irrigation Associations formed by water-rights owners. The Government through the WDD provides freshwater or recycled water irrigation water on a retail basis to farmers, or on a bulk basis to Irrigation Divisions and Associations.

2.3.4 Wastewater collection and treatment

Currently in Cyprus, the Sewerage Boards of Limassol-Amathus, the Joint Venture of Sewerage Boards of Ayia Napa and Paralimni, the Sewerage Board of Pafos, the Sewerage Board of Larnaca and the Sewerage Board of Nicosia constitute the main service providers in the field of sewerage collection, wastewater treatment and drainage.

Most industries are self-supplied in terms of wastewater treatment, since according to the current institutional framework industries should pre-treat their effluents before discharging to the sewerage system. However, a number of industries, characterised as significant with respect to their effluents, discharge to the Government Central Wastewater Treatment Plant of Vathia Gonia of the Nicosia District and to the treatment plant of Vati in the district of Limassol. Charges are estimated individually, according to the type and volume of effluents.

2.3.5 Recycled water

Recycled water is a resource that has been given increasing attention during the last few years, due to water supply restrictions applied to irrigation use. According to the current institutional framework, the services of sewage collection and secondary wastewater treatment fall under the responsibility of Sewerage Boards. However, the sewerage projects that have been developed include in addition to the sewage networks, a centralised treatment plant at tertiary degree of purification. By Decision of the Council of Ministers, the cost of the tertiary treatment of the treated effluent (both capital and operation and maintenance), which renders the water suitable for irrigation of almost all cultivations, except for green leaf vegetables, is undertaken by the Government. The Government has then the right to direct such water to its systems for the irrigation of tree plantations or hotel gardens, as well as any other use requiring non-potable water.

2.4 Legislation

Cyprus, as Member State of the EU, has the responsibility to review the status and particularities of its water resources and develop its own national implementation strategy for the Water Framework Directive (2000/60/EC). In Cyprus the provisions of the Water Framework Directive have been transposed into national legislation through the Water Protection and Management Law 13(I)/2004, which was adopted by the House of Representatives on February 5, 2004.

The Water Development Department (WDD) is responsible for implementing the legislative requirements relating to water resources. The main objective of the policy is the rational development and management of the water resources of Cyprus. In this context, the responsibilities of the WDD are wide and diverse as follows:

- The collection, processing and classification of hydrological, hydrogeological, geotechnical and other data necessary for the study, maintenance and safety of the water development works;

- The study, design, construction, operation and maintenance of works, such as dams, ponds, irrigation, domestic water supply and sewerage schemes, water treatment works, sewage treatment and desalination plants; and
- The protection of water resources from pollution.

The "Water Protection and Management Law[13(I)/2004]" provides for the elimination or reduction and control of water pollution in Cyprus, for the best possible protection of natural water resources and the health and well-being of the population. It also provides for the protection and improvement of the environment and the animal and plant life in water. The Law defines "what is waste" and vests power in the MANRE and the Environmental Service to control the disposal of wastewater into the surface or underground water environment. Additionally, the law contains provisions for the protection of the natural water sources from the disposal of wastes and the pollution of water from industrial and domestic sources of pollution and wastewater treatment plants. The MANRE and the Minister of Social Insurance and Labour (MSIL) can issue permits for the disposal of wastes or treated wastes defining the method, quantities, frequency of disposal, location and the concentration of pollutants. The Ministers can also appoint "Inspectors" for the examination of applications and the enforcement of conditions and control of the permits.

The "Water Protection and Management Law" provides also for the creation of the "Directorate for Integrated Water Management" within the Government, to undertake the management of the water resources of Cyprus. The major issues addressed are:

- The definition of **one** responsible authority for the development and management of water resources, i.e. the Minister at the political level and the Directorate Director at the technical and legislative level;
- The compliance with European standards and the consideration of both qualitative and quantitative parameters for water quality;
- The formulation of an Advisory Committee and the "Directorate for Integrated Water Management" which will advise the MANRE on water resources management issues; and
- The consideration of the European Union Framework Directive and other European directives related to water resources.

This creation of the "Directorate for Integrated Water Management" is promoted by the "Responsibilities of the Directorate for Integrated Water Management Law", which is expected to be adopted by the House of Representatives in the near future [6].

Additionally, there are six other important water laws in force, and 15 other laws that include provisions related to water. They form the basis of resource development, interaction between the government and users, and the establishment of local water bodies. The legislation addressing groundwater abstraction can be considered as particularly deficient, when taking into account the significant degradation of several aquifers. Illegal drilling of wells has been a quite common phenomenon, with one case where almost 47% of wells were drilled without a permit. The responsibility for monitoring compliance and illegal well drilling and control lies within the District Officer of the Ministry of Interior. Table 8 presents the most important legislation for water resources management and protection.

[6] The respective Bill is expected to be approved by the Council of Ministers in 2007 and then it will be presented in the House of Representatives to be transposed to the "Responsibilities of the Directorate for Integrated Water Management Law"

Table 8: Water laws and regulations

REFERENCE	FOCUS	CONTENT	SOURCE
Water Protection and Management Law 13(I)/2004	Reduction and control of water pollution	The Water Protection and Management Law provides for the elimination or reduction and control of water pollution in Cyprus, for the best protection of natural water resources and the health and well being of the population. It also provides for the protection and improvement of the environment and the animal and plant life in water.	Official Gazette of the Cyprus Government
The Government Waterworks Law (Cap 341)	Groundwater and Surface Waters	The law governs more than 98% of the natural water resources of the island and vests underground water and all surface water running to waste from any river, spring or water course and all other waste water to the State. The law also empowers the Council of Ministers to plan, design, construct, operate and maintain any waterworks for the purpose of taking or utilizing water, or replenishing an aquifer or land drainage or protecting land from floods, pollution, or erosion using if necessary compulsory purchase powers, and to sell water at a price calculated according to provisions of the law and the approval of the Parliament. It does not provide anything on drought but provisions of the law give power to the Government to deal under emergency situations including drought.	Official Gazette of the Cyprus Government
Wells Law (Cap 351)	Wells, Boreholes, Sunks	The basic law gives the power to the District Offices to issue permits for the sinking or constructing of wells or drilling of boreholes for the abstraction of ground water. This law was partly improved by the Water Supply (Special Measures) Law of 1964, which gave to the Government the power to declare and define special measure areas for groundwater protection against overexploitation.	Official Gazette of the Cyprus Government

REFERENCE	FOCUS	CONTENT	SOURCE
The Irrigation Division (Villages) Law (Cap 342)	Irrigation Water	This law is administered by the respective District Officer who is empowered to form Irrigation Divisions, at his own instance or upon the written request of not less than 10 land proprietors, for the purpose of carrying out irrigation works. Under this law the water and the waterworks are linked to the land and not to the proprietors. This law is the third most important law and widely applied for the construction of minor irrigation schemes. The Government pronmotes the construction of simple, small irrigation projects through this law by providing subsidy to the capital costs and for the maintenance of works constructed under this law. Committees elected by the members of the Irrigation Division govern the irrigation Divisions. The Committee is responsible for the construction, maintenance, operation and management of the irrigation scheme including the selling of water and collecting the bills. The selling price of water is fixed by the committee and approved by the Distric Officer.	Official Gazette of the Cyprus Government
Water Supply (Special Measures) Law (32/64, 35/65, 17/75)	Water shortage / deficiency	The law empowers the Council of Ministers to declare an area under control on the condition that due to exceptional circumstances a serious shortage or water deficiency exists or is likely to exist in the area, and that special measures for the conservation of water resources and maintenance of water supplies are necessary for the public interest. Under the Special Measures Law the Director of the WDD is empowered to refuse the issue of a permit for the sinking or construction of wells or drilling of boreholes for the abstraction of groundwater if such action is to affect qualitatively and quantitatively the groundwater. This is the second most important law dealing with the protection of the groundwater.	Official Gazette of the Cyprus Government
The Irrigation (Private Water) Association Law (Cap 115)	Irrigation Water	The law gives the opportunity for at least 7 owners that have water rights to form an Association for the construction, improvement, maintenance or repair of any irrigation works related to their common water, including the selling of water and collecting the bills.The selling price of water is fixed by the committee and approved by the District Officer. The Government policy is not to promote the development of privately qwned water rights and for this purpose it limits the subsidy on such waterworks.	Official Gazette of the Cyprus Government

REFERENCE	FOCUS	CONTENT	SOURCE
The Water Supply (Municipal and Other Areas) Law (Cap 350)	Drinking Water	The law provides for the establishment of Water Boards for the control and management of water supplies in municipal and other areas, under the chairmanship of the District Officer. The law allows the creation of semi-governmental organisations (Water Bords) responsible for the development, treatment, distribution and selling of potable water within the boundaries of inhabited areas fixed by the Council of Ministers, for domestic and industrial purposes including tourism and recreational. The selling price of water is fixed by the Council of Ministers and approved by the Parliament.	Official Gazette of the Cyprus Government
Water (Domestic Purposes) Villages Supplies Law (Cap 349)	Drinking Water	The law provides for the establishment of Village Water Commissions for village water supply. A Village Commission is charged with providing adequate supply of pure and wholesome water for the domestic purposes of the village and to maintain such supply and any water works connected therewith in clean and good condition and repair. The District Officer administers this law, and all requests for studies and construction of water works are submitted to the WDD, which designs and implements the water projects. The responsibility for the management, operation and maintenance of the small schemes is with the village water commission headed by the District Officer.	Official Gazette of the Cyprus Government
Public Rivers Protection law (Cap 82)	Public Rivers	Under this law, certain offences may be prescribed in relation to rivers declared to be 'public' by the President by Order in Council. Such offences include break down or damaging any bank or wall of a river. Similarly by notice in the Gazette, the District Officer can prohibit certain acts, such as the removal of materials from the bed, bank or wall of a river, the dumping of rubble or waste in a river.	Official Gazette of the Cyprus Government
Sewage and Drainage Law	Sewage effrluent and drainage water	This law provides for the creation of Sewage Boards for the collection, treatment and disposal of sewage effluent and drainage water (flood) from areas defined by the Council of Ministers as "Sewage and Drainage Law Areas". The Sewage Boards are responsible for the planning, design, construction, operation and maintenance of all works required. The Board is responsible for the construction, maintenance, operation and management of the sewage schemes including the collection of the bills for the services offerd. He service cost charged to the beneficiaries is made up of two componenets, the fixed cost, which represents the capital cost and the variable costs, which represents the mainenace, operation, energy and management costs.	Official Gazette of the Cyprus Government

The most important law with regard to the management of water resources in the country is the Government Waterworks Law. Nevertheless, it can be considered that the law fails its purpose, since it does not explicitly define one single administrative authority having the effective and overall responsibility for the management of water resources and waterworks. Instead, the law bears the fragmentary nature of responsibility, which is a great impediment to the effective water resources management.

Water management in Cyprus has met difficulties due to the inherent legal and institutional framework. Most of these problems have been on the discussion table in the past 40 years, and many proposals and legislation formulations have been forwarded for ratification. Nevertheless, the entry of Cyprus in the European Union gave a new impetus for addressing these problems; however, up to this moment no final decisions have been taken.

Most problems arise from the fragmentation of jurisdiction in the planning, design, implementation and control of water resources management. The WDD is responsible at the executive level for water management at the technical level and to this effect the situation is very satisfactory. However, effective decision-making, implementation of project and enforcement is made difficult, as legal and management responsibilities rest with the District Office of the Ministry for the Interior. These difficulties lead to considerable delays in project authorization, implementation and effective overall water management. Through various laws, the District officer is the controlling authority at the user level. The WDD and the Department of Agriculture assist the District Officer, as advisors in technical matters. This is not considered as a satisfactory arrangement because there is no single agency responsibility. When there is conflict of interest and purpose, the technical departments are unable to support the implementation of agricultural policies (even though agricultural policies should be a major criterion in approving irrigation water works) and to define domestic supply allocation.

As however, presently changes are being considered, a restructuring of the water industry in Cyprus into a more unified set up or single institution is expected. Some existing laws will need to be reviewed and a new water code will have to be enacted, covering all functions associated with water in its widest context.

3 Identifying Focal Problems in Water Management

3.1 Constraints facing the water sector

Water management in the island has met difficulties due to several constraints, summarized in Table 9. Constraints can be grouped in four major categories (natural, technical, financial, administrative and institutional), and are further explained in the following paragraphs.

Table 9: Constraints in water resources management

CATEGORY	CONSTRAINTS
Natural	Reduction of available water resources
Technical	Non-effective exploitation of many water developments
	Linkage between sources of surface water and groundwater
	Excessive use of dam water due to reluctance in the use of tertiary treated effluent
	The currently adopted cropping patterns
	Water losses in domestic water distribution network
Financial	High investment costs for new water development schemes
Administrative and Institutional	The effective and efficient allocation of the limited water resources in time and space and to the various uses
	The difficulties in water pricing, especially their approval and definition of subsidy for irrigation water
	The weakness of existing institutional and organizational structures
	Identification of conflicting points between the Cypriot water policy and the EU's water policy and their successful harmonization
	The reduced interest of farmers towards agriculture due to lack of labour and lack of effective marketing of agricultural produce
	The need for integrated water management, in particular the linkages between irrigation and municipal demand and supply
	The need for demand management through water conserving technologies, pricing, public awareness and water allocation and regulation

3.1.1 Natural Constraints

Reduction of available water resources due to prolonged droughts and climate change

Figure 15 presents the annual rainfall in the island for the last 30 years. The statistical analysis of records available over the period of hydrological years 1916/17-1999/2000 demonstrates that the precipitation time series display a step change or shift around 1970. The time series can be divided into two separate stationary periods, with the mean precipitation of the period 1987-2002 being lower than the mean precipitation of period 1916-1987.

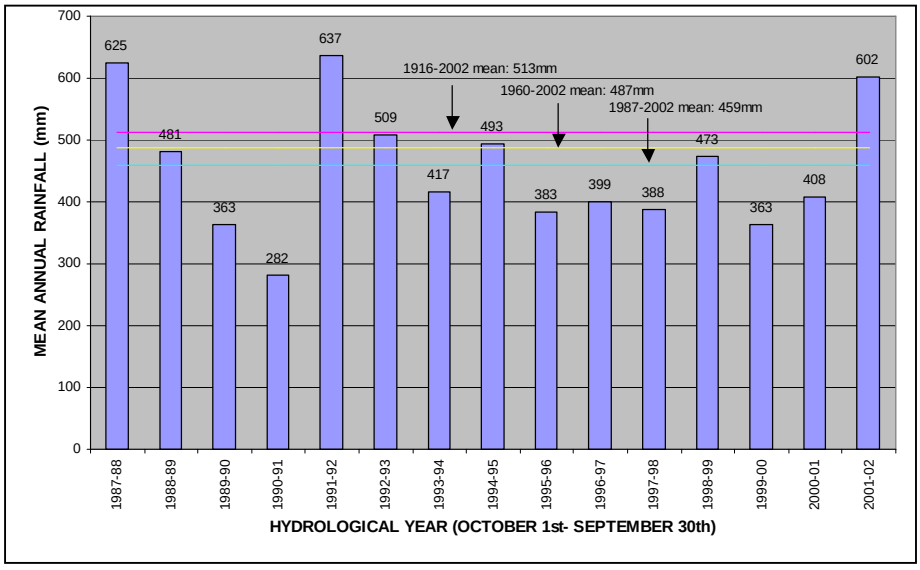


Figure 15: Mean annual rainfall for Cyprus (1987 – 2002)

Figure 16 presents the differences between the monthly mean of the two periods, for the whole island. From the figure, it can be educed that the decrease ranges from 20 to 140 mm and is observed mainly during the period December to February.

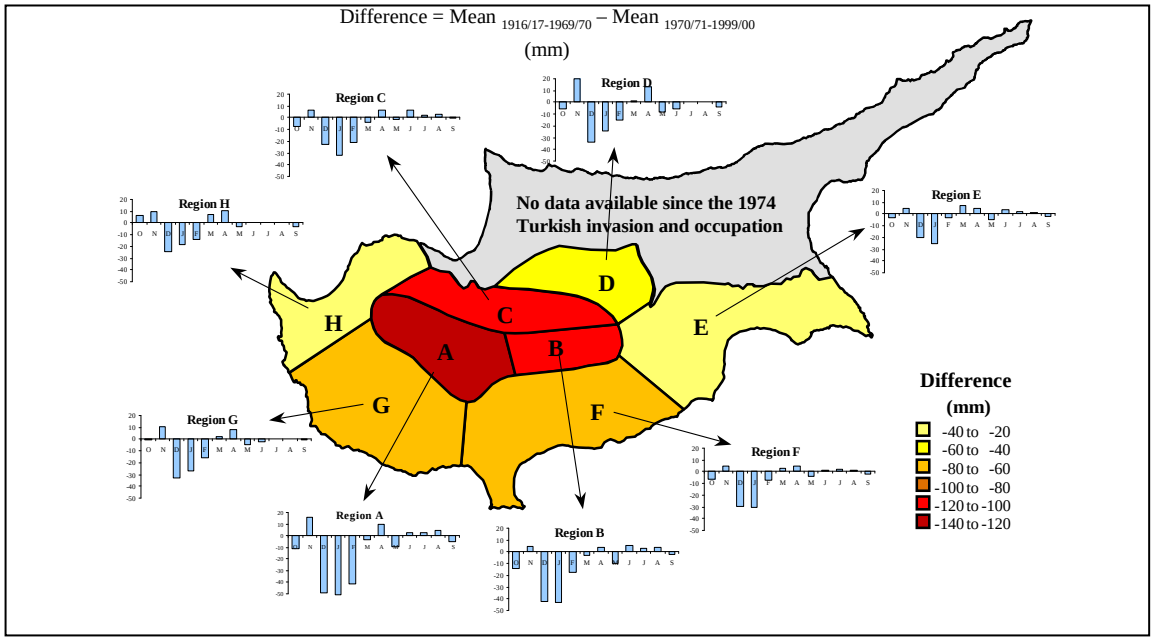


Figure 16: Differences between the mean of monthly precipitation for the two periods (1916-1970 and 1971-2000)

3.1.2 Technical Constraints

Impacts to aquifer recharge resulting from dam construction

One of the impacts related to the construction of a large number of dams, was the significant reduction of natural recharge in downstream riverbed aquifers, due to the cut-off effect. At present, this reduction is compensated through dam releases aiming at artificial recharge. However, this has not been the case in the past few years, due to the adverse hydrological conditions (Table 10).

Table 10: Artificial recharge from dams (2000 – 2004)

Dam	Artificial Recharge (hm^3)				
	2000	2001	2002	2003	2004
Kouris	0.071	0.07	2.6	1	1.9
Germasogia	2.56	4.3	7.6	6.6	6.2
Arminou			3.5	5.2	2.4
TOTAL			**13.7**	**12.8**	**10.5**

The currently adopted cropping patterns

The current cropping patterns include water intensive crops such as citrus (70,893 da; water demand 51.9 hm^3), deciduous (24,809 da; water demand 17.3 hm^3), olive trees (19,847 da; water demand 8.5 hm^3) and annual crops (fodders – potatoes – greenhouses – open field vegetables) (118,724 da; water demand 65.5 hm^3) posing a heavy burden on the water demand in the area. These cropping patterns should be substituted with less water demanding crops such as flowers, aromatic plants and winter crops which rely more on rainfall.

Water losses in domestic water distribution networks (mainly in the rural areas);

Water losses in the domestic water distribution networks, mainly in the rural areas, are quite high in the region. The unaccounted water in the main urban domestic supply distribution networks is estimated to be 15 to 20% and about 20 to 30% in the rural areas. Therefore, an additional effort should be made for detecting and replacing defective pipes and for establishing a more conscious attitude towards precious water.

3.1.3 Financial Constraints

High investment costs for new water development schemes

At present, all economically attractive sites for dam construction have been exploited. From the engineering side, it is possible to construct more; however the venture would entail significant investments, and it is estimated that the resulting water cost would be higher than the water cost corresponding to the already developed infrastructure. Additionally, the cost of utilizing alternative water sources, such as desalination or recycled water is even higher.

3.1.4 Administrative and Institutional Constraints

Ineffective and inefficient allocation of limited water resources

Almost 60% of available water resources are currently used in the agricultural sector, which has a minor contribution (less than 5%) in the overall national wealth. The issue is further complicated by the traditional two-tiered nature of water rights: users of water systems owned by the Government pay the established tariff, while owners of wells do not pay. Under such conditions, an increase in water tariffs of the public systems is bound to encourage further overexploitation and mismanagement of groundwater. The concept of equity among farmers depending on surface water distribution and those depending on groundwater does not exist. The realization of a policy of uniform water rates over the island remains a difficult problem.

Difficulties in water pricing, especially with regard to the approval of tariffs and the definition of subsidies for irrigation water

The introduction of higher irrigation water prices, always provokes opposition of the politically strong agricultural lobby in spite of the fact that the increase is accompanied by various compensational financial measures. The lobby's argument is that agriculture is important because it ensures the supply of strategic food and raw materials to the nation and for social and even envirobnmental considerations agriculture should be further subsidized and nor penalized with higher water prices.

Weaknesses of existing institutional and organizational structures

The co-operation between different agencies and services for the management of water resources can be considered adequate when taking into account the different approaches and goals set by each. However, the fragmentation of responsibility has caused many problems in all sectors. With one department being in charge for water management at the executive level (WDD), the technical situation is very good. However, effective decision-making, implementation of works and legislation enforcement remain difficult, as legal and management responsibilities are allocated to the District Officers. These difficulties lead to considerable delays in project authorization, implementation and overall water management.

Through various laws, the District Officer is the controlling authority at the user level. The WDD and the Department of Agriculture assist the District Officer in an advisory capacity on technical matters. This cannot be considered as a satisfactory arrangement, because multiple authorities are responsible.

For example, the District Officer by Law, is responsible for the issue of drilling and water use permits. Usually but not always, the advice of the Water Development Department is requested. This has repercussions both on the management of the aquifers but also on agricultural activities. The District Officer (Ministry of Interior) is the chairman of the Irrigation Divisions and the Town Water Boards, while the representative of the Water Development Department participates as advisor. Although there is generally good cooperation among the District Officer and the Technical Departments of the Ministry of Agriculture, Natural Resources and Environment, frequent conflicts of interest do not allow for the implementation of clear policies. This in turn may result to a non-sustainable management of scarce water resources.

It is broadly recognized that this fragmentation, especially at user level where the WDD is only an advisor, has many disadvantages. This situation is expected to change with the creation of the "Directorate for Integrated Water Management", as it was discussed in **Section 2.4**, which will be the only national authority with the responsibility to undertake the management of the water resources of Cyprus.

Identification of conflicting points between the Cypriot water policy and the EU's water policy-Harmonisation issues

The implementation of the Water Framework Directive (WFD) in Cyprus is in progress. Specifically, an implementation programme has been prepared, where required actions has been defined according to the milestones set by the EU.

Contacts have been established with each EC Working Group, with the intention of monitoring the work carried out. Particular importance has been given to the first stages of the implementation of the Directive, which are considered crucial and important for its effective

implementation. The responsible authority for the implementation of the Directive is the Ministry of Agriculture Natural Resources and Environment.

The two "Lead Agencies" which will methodically implement the requirements of the Directive are the Water Development Department and the Environmental Service. Other departments will be involved according to the issues under consideration.

The most significant implementation problems which are foreseen in relation to the existing conditions in Cyprus include:

- Insufficient quantitative and qualitative data which are required for the initial crucial steps in implementing the Directive;
- Lack of a rationally organised national network for monitoring and collection of information, as well as the lack of a unified database;
- Difficulties in the co-ordination among the responsible authorities and all the other involved agencies;
- Limitation of sufficient expertise and appropriate human potential and necessary technological means;
- The attitude of water users;
- High implementation costs;
- Fragmentation of responsibilities, jurisdiction and lack of a unified Water Authority;
- Particular difficulties due to extended periods of drought and the fact that the WFD is more adapted to the large water basins of Europe.
- The reduced interest of farmers towards agriculture due to lack of labour and lack of effective marketing of agricultural produce;
- The need for integrated water management, in particular the linkages between irrigation and municipal demand and supply;
- The need for demand management through water conserving technologies, pricing, public awareness and water allocation and regulation.

3.2 Identification of focal problems

3.2.1 Sharing water

Pollution from upstream sources

Three are the main problems related to the environmental condition of surface waters:

- Discharges of dangerous substances (industrial pollution),
- Oxygen demanding and microbial pollution compounds, and
- Nutrient pollution from agricultural sources.

These are further explained in the following paragraphs.

Discharges of toxic substances

Toxic substances may potentially affect the water bodies which are subjected to pressures from :

- Intensive industrial activities,
- Waste disposal sites,
- Mines (abandoned or active), and
- Storm water discharges near the large cities and in industrial areas.

The size of industries in Cyprus, according to their production rate and consequently to their wastewater flow rate, is rather small to moderate, when compared to the size of corresponding industries in most European countries. Nevertheless, a large number of small or medium size industries are spread all over the country. As can be expected, most of them are developed in areas near major cities, Nicosia, Limassol, Larnaca and Pafos.

Another potential source that could cause pollution of surface waters and is mainly related to the presence of heavy metals (e.g. Fe, Cu, Zn, Mg, Ni), are the mines (either abandoned or in operation spread all over the island). These are located at Skouriotissa (sub-catchment 3-3-4), the Kato and Ano Amiandos villages (sub-cathment 9-6-3), Kalavasos (sub-catchment 8-9-7), Sia and Mathiatis (sub-catchment 8-4-1), Kapedes (sub-catchment 6-5-2), Agrokipia (sub-catchment 3-7-2), sub-catchment 3-3-1, sub-catchment 3-5-4 and sub-catchment 2-3-4. Those dump accumulations areas are drained by a deep stream flowing first into Trimiklini dam and finally in Kouris dam reservoir. The main water quality problems of water bodies receiving those effluents and drains are related to acidity, heavy metals (Fe, Cu, Zn, Mg, Ni), high salinity and high chemical oxygen demand, which reduce concentrations of dissolved oxygen.

With respect to solid waste, current practice involves mostly uncontrolled or in some cases semi-controlled dumping of municipal solid wastes in more than 80 waste disposal sites spread over the country. The waste disposal sites can contribute to the pollution of surface waters, although the pressure is more significant to groundwater. In cases where the waste disposal sites are close to surface water bodies the impact is increased. The water bodies potentially at risk are located to watersheds of Chapotami (1-1), Diarizos (1-2), Xeros (1-3, 2-4, 3-6, 8-6), Chrysochou (2-2), Kochina 2-5), Serahis (3-7),Gialias (6-5), Ammochostos (7-1), Liopetri (7-2), Tremithos (8-4), Germasogeia (9-2), Garilis (9-4), Kouris (9-6), Avdimou (9-8).

Storm water discharges may also have a significant influence to the surface water quality near the large cities, Nicosia, Limassol, Larnaca, and Pafos, the industrial areas of each watershed and the national airport of Larnaca. The water bodies under pressure are located to the sub-basins 6-1-2, 8-3-2,, and 9-4-4.

In Cyprus the EC Directive 76/464 related to the protection of the aquatic environment from the discharge of dangerous substances is in force, as well as the daughter directives, which specify water quality objectives for dangerous compounds (e.g. lead, cadmium, hexachlorobenzene), which have to be eliminated in the future.

Based on both the analysis of pressures and monitoring data[7], only some rivers can be considered at the risk (no dams/lakes or coastal waters) of failing the objectives of the WFD due to the presence of toxic substances.

Oxygen demanding and microbial pollution compounds

Oxygen depletion may occur in water bodies, which are subjected to pressures from urbanized, highly-populated areas and from livestock breeding at farms, which are located close to surface water bodies. Furthermore, the sanitary landfills and specifically the organic matter that finds its way to leach, as well as the industrial activity from the industries that produce and dispose conventional pollutants can also affect the water quality in the recipient water bodies in their vicinity.

[7] Implementation of Articles 5&6 of the Water Framework Directive 2000/60/EC, Volume 4 "Analysis of Impacts", WDD December 2005

Based on both the analysis of pressures and monitoring data, both rivers (Xeros, Pediaios, Gialias, Voroklini, Aradippou, Tremithos, Argaki tou Pyrgou, Germasogia, Garylis, Akrotiri, Kouris) and dams/lakes (Polemidia dam) are at the risk of failing the objectives of the WFD due to oxygen depletion.. These risks mainly originate from the following sources:

- The 5 urban centres (Nicosia, Limassol Limassol, Larnaca, Pafos, Agia Napa) which affect watersheds 3-6, 6-1, 6-5, 8-1, 8-2, 8-4, 9-1, 9-2, 9-4, 9-5 and 9-6;
- The waste disposal sites of Kotsiatis, Vati, Agia Marinouda, Larnaca and Agia Napa, which affects watersheds 6-1, 6-5, 9-5, 1-4, 8-1, and 7-2 (Figure 17);
- Industrial activity near the urban sites and the industrial areas (Figure 18).

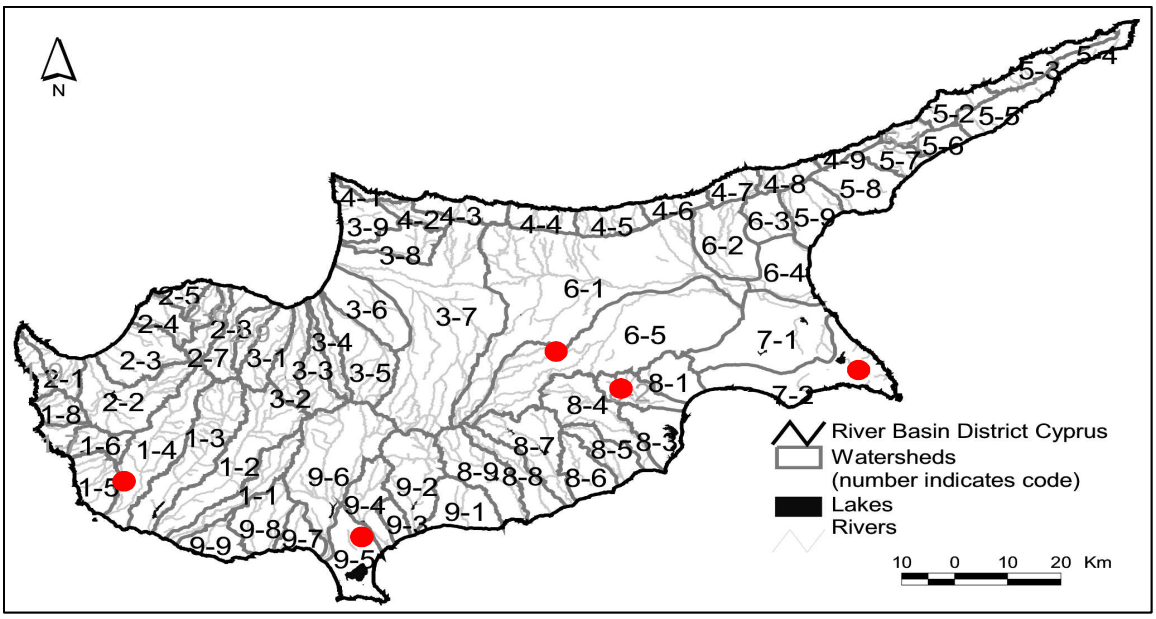


Figure 17: Waste disposal sites in Cyprus

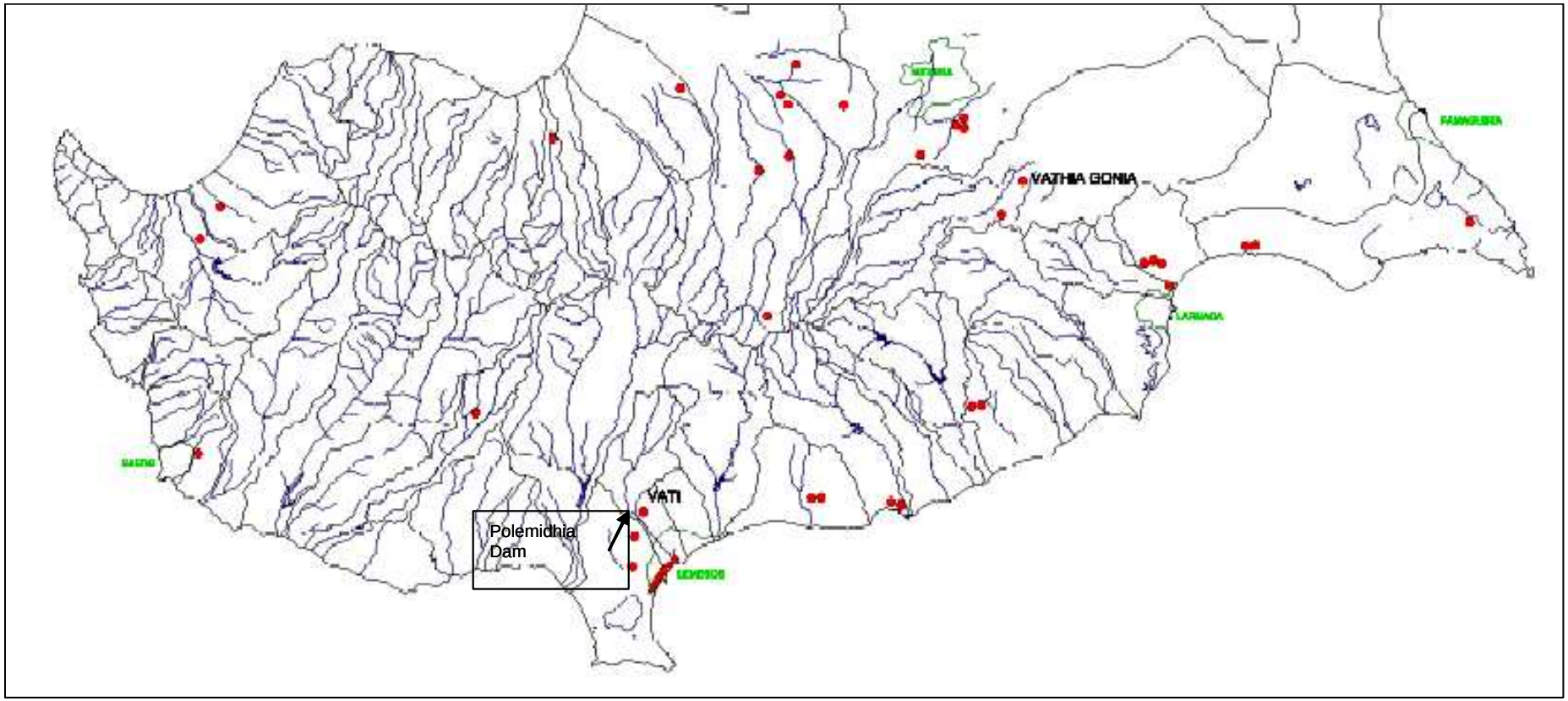


Figure 18: Significant industrial point sources

Nutrient pollution from agricultural sources

Nitrogen and phosphorus pollution may potentially affect tose water bodies which are subjected to pressures from agricultural activities (cultivation of land or livestock breeding). Based on both the analysis of pressures and monitoring data, the areas with increased loads of nitrogen and phosphorous are located in the eastern part of Cyprus. In this part, the cultivated land corresponds to approximately 70% of the total cultivated land of the country. On the other hand, the central and western part of the country consists mainly of forests, which account for 73% of the total forest area of the island and therefore are characterized by significantly lower nutrient loads. More specifically, increased loads prevail in basins 1-3, 3-6, 3-7, 6-1, 6-5, 7-1, 7-2, 8-1, 8-2, 8-4, 8-7, 9-2, 9-4, 9-5, and 9-6.

Areas with intensive animal breeding activities are also located in the eastern part of the island, and influence basins 3-6, 3-7, 6-5, 7-2, 9-4 and 9-5. Breeding of pigs is more intensive in 8 villages, where 70% of the pig population is concentrated: Orounta, Aradippou, Kato Moni, Meniko, Paliometocho, Monagroulli, Akaki, and Tersefanou. In the Larnaca region the recorded intensive animal breeding is related to all livestock types.

On the basis of both nutrient load and monitoring data analyses, rivers (Kargotis, Xeros, Serachis, Pediaios, Gialias, Voroklini, Aradipopou, Tremithos, Germasogia, Akrotiri and Kouris rivers), dams/lakes (Asprokremmos, Achna, Germasogia, Polemidia and Kouris dams) and coastal waters (Limassol, East of Limassol, Vassilikos, Cape Pyla to Paralimni) face the risk of failing the objectives of the WFD due to nutrient pollution. Those risks affect watersheds 1-3, 3-3, 3-6, 3-7, 6-1, 6-5, 7-1, 7-2, 8-1, 8-2, 8-4, 8-8, 8-9, 9-1, 9-2, 9-3, 9-4, 9-5 and 9-6.

Insufficient water quantity

The significant drivers and pressures that are connected to water quantity are summarized in Table 11, and are further analysed in the following paragraphs.

Table 11: The significant pressures related to water availability in Cyprus

Pressure	Importance [8]	Description
Droughts and climate change	Very Important	Water scarcity is exacerbated by large inter-annual variations that can result in two, or even three, consecutive years of drought with rainfall below 300mm. During the last 30 years a considerable reduction of mean annual rainfall has been experienced in the island (approx. 20%) resulting in a 45% reduction of runoff.
Uneven distribution of rainfall	Important	The variation of rainfall is not only regional but also annual. Average annual rainfall is 500 mm but varies from 300 mm in the central plains and the SE parts of the island to 1100 mm in the Troodos mountains nad 550 mm in the Kyrenia mountains
Conflicts between urban and agricultural use	Less important	Competing demand and the dynamic competitive tension between agriculture, urban growth including tourism, and the environment are challenging the existing water management practices in the island. The subsidized water price for irrigation water compared to the full cost recovery for domestic supply does not promote healthy competition and water conservation measures.
Increased water demand for irrigation and tourism during summer	Very important	There is a pronounced seasonality of demand peaking in the summer period due to increased irrigation requirements and influx of tourists. Certain tourist destination areas experience considerable stress in meeting the water demand. Tourism affects the demand for water and sewerage infrastructure. 93% of beds are concentrated along the coast. Tourist water demand accounts for 21% of total domestic, municipal and industrial water demand.
Inter-basin water transfer	Important	The built water infrastructure involves extensive inter-basin transfers in the south – south-eastern part of the island (the South Conveyor Project - SCP) and in the southwest to western part of the island (Pafos Irrigation Project) allowing considerable flexibility in the water management in most areas of the island.
Illegal drilling and over-pumping	Very important	The present level of abstraction for all Cyprus is estimated to be 130 hm^3/year, whilst the total recommended abstraction is estimated top be approx. 80 hm^3/year. As a result during the last decade almost all the groundwater bodies, except the river bedded coastal water bodies are being overexploited

[8] According to the WFD reporting guidance, all significant pressures should be addressed according to their importance within the River Basin District (RBD) : Very Important, Important, Less Important.

Pressure	Importance [8]	Description
Non-effective exploitation of many water development schemes	Important	The need to achieve a sufficiently high internal rate of return to have a sound project to finance, was accomplished by including new lands for irrigation, creating thus a water demand that did not exist at the initial stage of the project design The need to achieve a sufficiently high internal rate of return to have a sound project to finance, accomplished by including new lands for irrigation, creating thus a water demand that did not exist before.
Excessive use of fresh water for irrigation due to the reluctance in use of tertiary treated water	Important	Recycled wastewater acceptance for irrigation is far from certain yet, especially when there is alternative water available: early acceptance by the farmers to use tertiary treated effluent (because of the drought period) subsided in the last few years because of the availability of fresh water from the dams.

Drought problems

Cyprus experiences droughts quite often. Statistical analysis of annual rainfall inland-wide (Figure 15) shows that "dry years" (390 – 470 mm) and "most dry" years (390 mm and less) can be expected to occur every five years. Dealing with drought includes measures to reduce water supply to users, conserve water and increase water availability. Water allocation mechanisms under drought conditions have been set up to provide priority to maintaining domestic and municipal water supplies. The second priority is to maintain supplies to perennial crops at 80% of the recommended application levels. Seasonal vegetable crops are of third priority. Farmers are compensated for the resulting production losses.

During the dry period 1996-2000, a severe shortage in the supply of water was experienced in all sectors, due to consecutive years of low rainfall. The available water in the major dams had reached critical low levels and priority was given for the domestic needs. It has been estimated that the available supplies of water during this period from all the sources at the areas covered by the Government Water Works was on average 87.6 hm^3, while the demand for water was calculated to be on average 136 hm^3, of which 65 hm^3 corresponded to towns and villages and 80 hm^3 to irrigation (Figure 19).

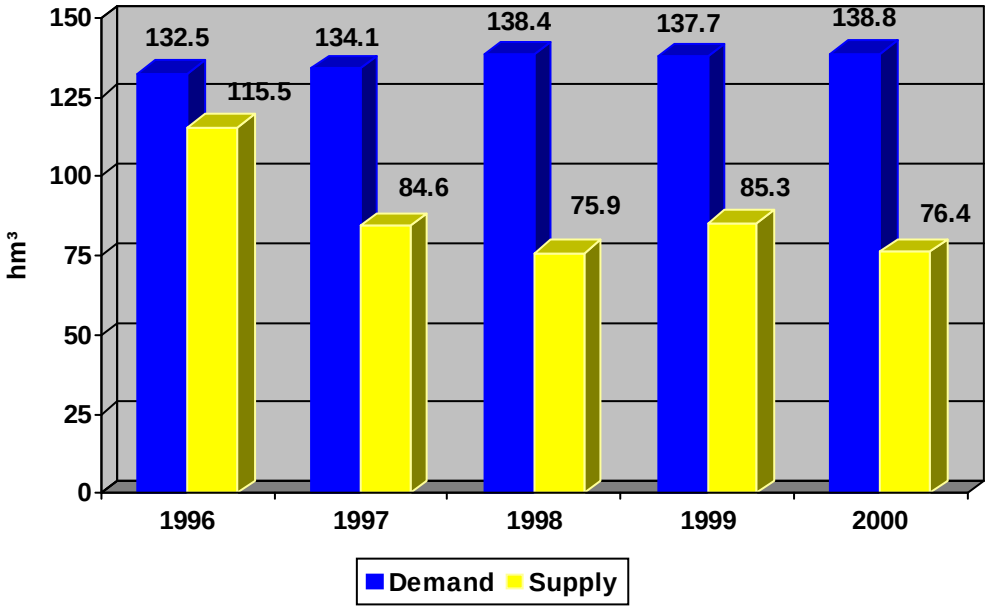


Figure 19: Water demand & supply balance, 1996 – 2000

Due to the limited availability of water resources, priority was given to cover the domestic needs and in agriculture priority to permanent crops, covering only portion of their water demand. The water allocated to farmers was in the range of 30% to 70% of the normal demand, depending on the type of crop and the availability of water in each project. In some projects the vegetable area was significantly reduced, in order to save water and cover part of the needs of the permanent crops. Various measures were implemented to face the drought situation, such as water supply restrictions, demand management and supply enhancement measures.

Water supply restrictions were imposed on all sectors, leading to a rationalization of water consumption. Eventually, the water shortage was (Savvides, FAO, 2002):

- 23,4% in the domestic sector;
- 37,6% on average in the agricultural sector;
  - 49% within the Government projects (20% for the Pafos scheme in the west and 29% for the SCP in the south and southeast).
  - 20% for agriculture outside Government Irrigation Schemes (assumed value).
- 23,4% in the industry and animal breeding activities.

These measures raised a number of objections from various social groups, and especially by:

- Agricultural organizations, which demanded that the farmers should be compensated by the Government for the lost income to the unavailability or shortage of water,
- Hotel owners, who demanded that the tourist industry should bear either none or a very small restriction of water supply, and
- Environmental organizations which argued that reducing the quantity and timing of supply of water may not be an effective measure, especially when compared to the dangers these measures inherently have.

The adopted **demand management measures** addressed to the two major water uses, i.e. the domestic and the irrigation sectors:

- *Domestic sector:*

- Subsidies for undertaking measures that could save good quality potable water (private borehole drilling, installation of gray water recycling systems in houses, schools, etc.);
- Distribution (free of charge) of sealed plastic bags to be used as displacers in toilet flush tanks;
- Reduction of the "unaccounted for water" in the distribution systems;
- Amendment and strict implementation of Law 1/91, which prohibits the use of hosepipe for the washing of cars and pavements;
- Education and awareness campaigns for the need to conserve water.

- *Irrigation sector:*
  - Subsidies for the installation of rain water collection systems at the roofs of the greenhouses;
  - Subsidies for the installation and use of improved irrigation systems;
  - Application of a quota system for the allocation of government irrigation water in combination with penalty charges for over consumption;
  - No supply of water to new irrigation areas;
  - Educational campaigns for better water use and adoption of new less water-demanding crops.

The adopted supply enhancement measures were:

- Desalination:
  - Expansion of the capacity of existing desalination plant of Dhekelia from 25,000 m^3/day to 40,000 m^3/day;
  - Acceleration of the process to built and operate a new desalination plant (west of Larnaca) with a capacity of 52,000 m^3/day.

  The main aim of the policy towards desalination was to eliminate the dependency of urban centres and tourist areas on the unpredictability of rainfall, and thus ensure that water is provided on a continuous basis to households. The environmental NGOs, however, were against this measure due to the high water production costs and environmental concerns.
- Use of recycled water for irrigation. Farmers were initially reluctant to use recycled water for irrigation, as this was the first time recycled water was being used commercially at such large scale. However, the acute water scarcity faded out the objections.
- Emergency measures to temporarily increase the supply of water for drinking purposes in urban and rural areas. This included the sinking of wells, the requisition of private boreholes and water transfer using pipes or trucks.

Uneven distribution of rainfall

Figure 20 displays the mean annual precipitation over the 1970/71-1999/2000 period. As previously explained, the maximum precipitation levels are recorded in the Troodos mountainous area with values reaching 1000 mm/year at the top. The area receiving more than 600 mm of rainfall per year is limited to elevations greater than 500 metres a.m.s.l. on the south-western slope of the mountain and to elevations greater than 800 metres a.m.s.l. on the north-eastern slope.

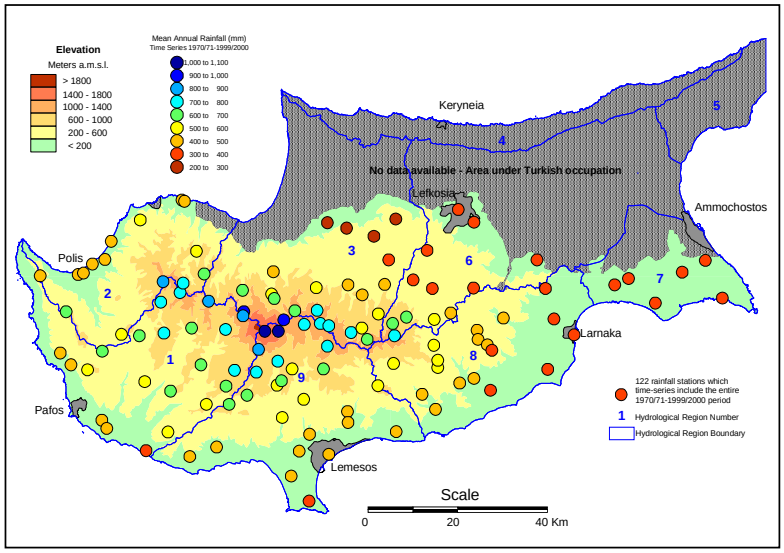


Figure 20: 1970/71-1999/2000 mean annual precipitation in mm

The distribution of the precipitation through the year is similar all over the island (Figure 21). Precipitation is recorded during the winter months, whereas the summer months are dry. Mean precipitation increases quickly from August to a maximum in December in the eastern hydrological regions (6, 7, 8). In the central (3, 9) and western (1, 2) hydrological regions the mean precipitation reaches the maximum levels in December and January. The decrease of the mean precipitation is slower than the increase, it spans over eight months from December-January to a minimum in July-August.

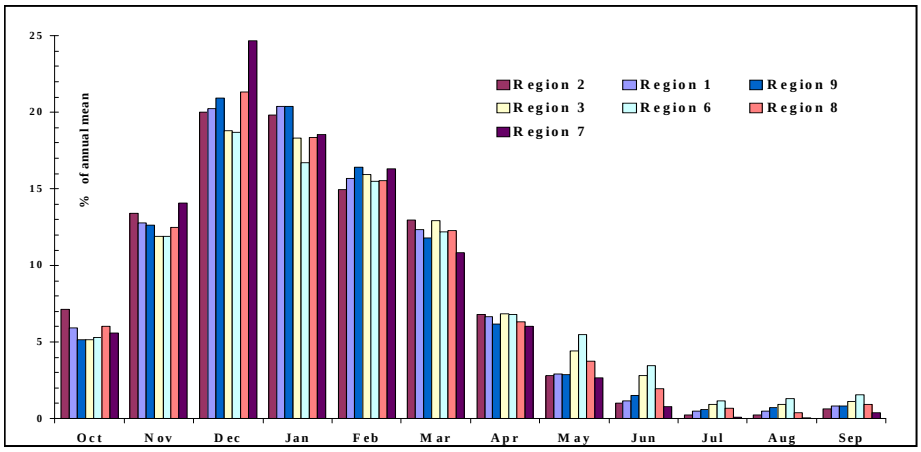


Figure 21: Average distribution of monthly precipitation through the year for the period 1971-2000.

Conflicts between urban and agricultural use

Domestic use and irrigation are the two main water-consuming sectors in Cyprus. Irrigated agriculture accounts for about 69% of the total water demand whereas the domestic use, which also includes the tourist and industrial demands, corresponds to 25% of the total.

Table 12 presents the projected annual water demand in hm^3 for the years 2005, 2010 and 2020. The estimates are based on the following assumptions for the per capita demand:

- 215 l/cap/d for main towns,
- 180 l/cap/d for villages, and
- 465 l/cap/d for tourist demand.

Table 12: Projected annual water demand by main sectors (2000 – 2020)

Demand sector/Year	2000	2005	2010	2020
Agricultural Demand	182.4	182.4	182.4	182.4
Annual Crops	71.5	71.5	71.5	71.5
Permanent Crops	102.9	102.9	102.9	102.9
Domestic Demand	68.2	73.1	88.5	107.3
Inhabitants	50.6	55.1	59.6	69.5
Tourism	14.1	18.0	22.9	30.8
Industry	3.5	5.,0	6.0	7.0
Environment	12.5	14.0	16.0	20.0
TOTAL (hm^3/yr)	**263.1**	**274.5**	**286.9**	**309.7**

Although agriculture is the major water-consuming sector, it has a small contribution in the national GDP (2.9% in 2004). On the other hand, tourism activities which consume only about 6% of the total water demand, contributes to the GDP by over 20%.

As a result, and especially during drought periods, major conflicts arise between the urban and the agricultural sector, which in turn result to serious competition for the allocation of scarce water resources. The situation is worsened by the subsidized water price for irrigation water when compared to the full financial cost recovery for domestic supply, as it is strongly believed that this practice does not promote healthy competition and water conservation measures.

Increased water demand for irrigation and tourism during the summer period

There is a pronounced seasonality of domestic and irrigation water demand, which both peak during in the summer period, due to increased influx of tourists and the increased needs for irrigation respectively (Figure 22).

This pronounced seasonality of water demand for both uses poses a serious problem to the ability of the national water system to cover the water needs.

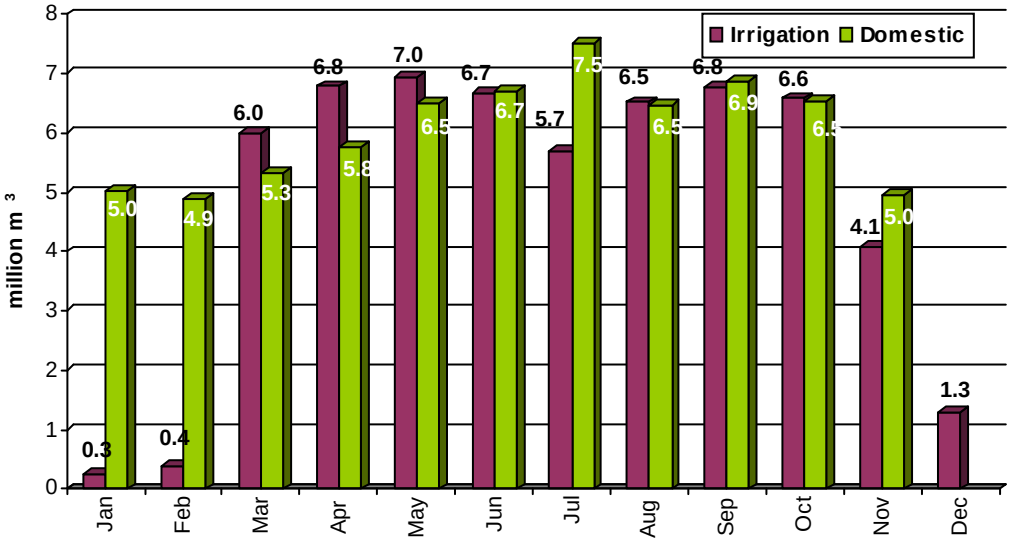


Figure 22: Seasonal water demand (irrigation and domestic water) for the areas supplied by the Government Water Works

Inter-basin water transfer

Existing water infrastructure involves large inter-basin transfers in the South-South-eastern (South Conveyor Project - SCP) and in the South West-Western (Pafos Irrigation Project) parts of the island (Figure 23). This allows for considerable flexibility in water management and allocation in most areas.

The Southern Conveyor Project covers the water demand for over 40% of Cyprus. The project is a multi-basin, multi-unit, and multi-purpose development scheme, which involves the exploitation of both surface and groundwater. Its aim is to collect, store and redistribute the runoff surplus of the south coast, for providing water for irrigation and domestic use to 80% of the population in the southern and eastern areas. The SCP project also supplies water to the urban centre of Nicosia in the central part of the island. Water availability in the SCP amounts to 65 hm^3. Of this amount 26 hm^3 is allocated to domestic use and 32 hm^3 to irrigation. The principal infrastructure of SCP includes:

(a) The Kouris dam, with a capacity of 115 hm^3;
(b) The Dhiarizos diversion (14.5 km), which transfers 21 hm^3/year from the Dhiarizos river to the Kouris dam;
(c) The 110 km long Main Conveyor from the Kouris dam to the Akhna terminal reservoir;
(d) The Akhna terminal reservoir with a capacity of 6 hm^3;
(e) The Germasogeia dam with a capacity of 13.5 hm^3;
(f) The tertiary treatment plant of Lemesos with a capacity of 13 hm^3. Outflows are used for irrigation, and potentially for the artificial recharge of the Akrotiri aquifer;
(g) Irrigated areas of 13500 ha, with pressurized distribution networks;
(h) Two drinking water treatment plants (with a capacity of 100,000m^3/d) which supply potable water to several urban and tourist areas; and
(i) A telemetry system to monitor and operate the system.

The Pafos Irrigation Project, one of the major projects of Cyprus, had the main objective to develop water resources in the Pafos district for the irrigation of the coastal plain between Khapotami river and Ayios Yeorgios Peyias. Its construction was realized during the period 1976-1983, and included Asprokremmos dam (capacity of 53 hm^3) on Xeropotamos river, the main canal and the western main conveyor, pumping stations, reservoirs, irrigation networks and borehole schemes. At present, water from Asprokremmos dam is also used for domestic supply, with water being treated in the respective water treatment plant. The project will also incorporate the dam of Kannaviou (Ezousa river, capacity of 18 hm^3), initiating operation in 2008.

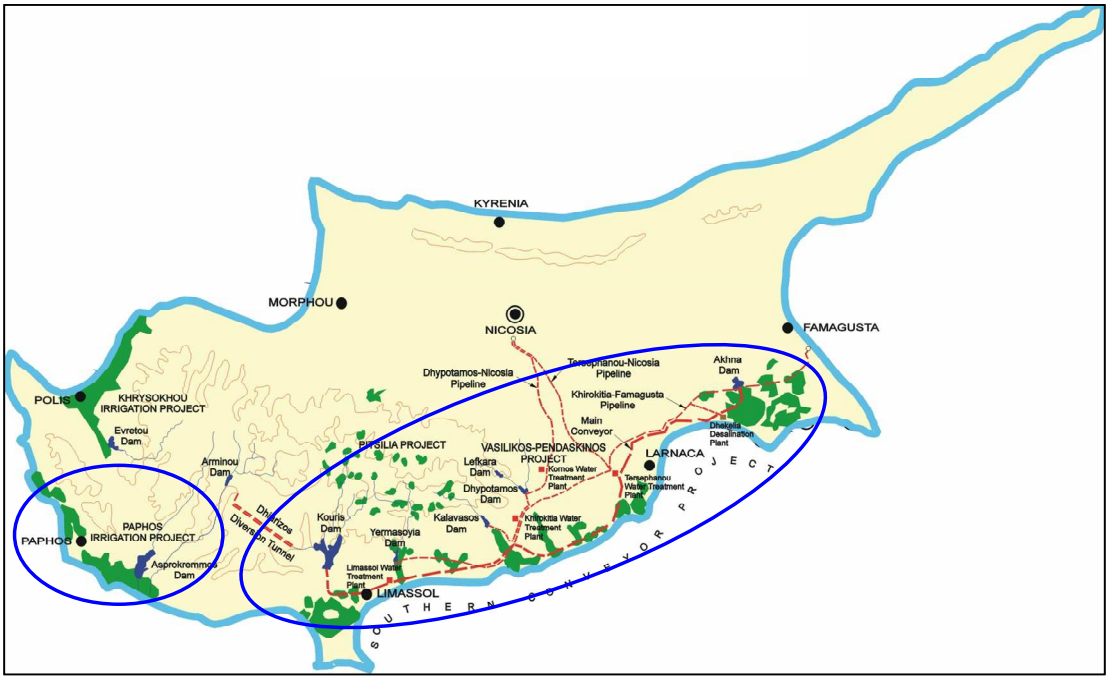


Figure 23: Major Water Development Works in Cyprus

However, especially during the drought periods conflicts and demonstrations arise against inter-basin transfers of water. Local farmers demand full coverage of their water needs before any transfer is made.

Illegal drilling and over-pumping

Illegal borehole drilling and over-pumping is a major issue, especially in the South-Eastern part of the island, where groundwater reserves are low, but income from potato production is high. The continuous over-pumping of aquifer reserves to meet water requirements for sustaining agriculture during the prolonged drought of 1996-2000 has resulted to their depletion and significant sea intrusion in coastal aquifers, has diminished of available reserves and has reduced the yield of wells. Additionally, the extensive construction of big surface reservoirs has exacerbated the problem, as the natural recharge to the coastal aquifers has been reduced, without being followed by an equal reduction of pumping.

The present level of abstraction in Cyprus is around 130 hm^3/yr while the total recommended abstraction is estimated at 80 hm^3/yr at the most. As a result, during the past decade, almost all groundwater bodies, except for riverbed coastal ones are being overexploited (Figure 24).

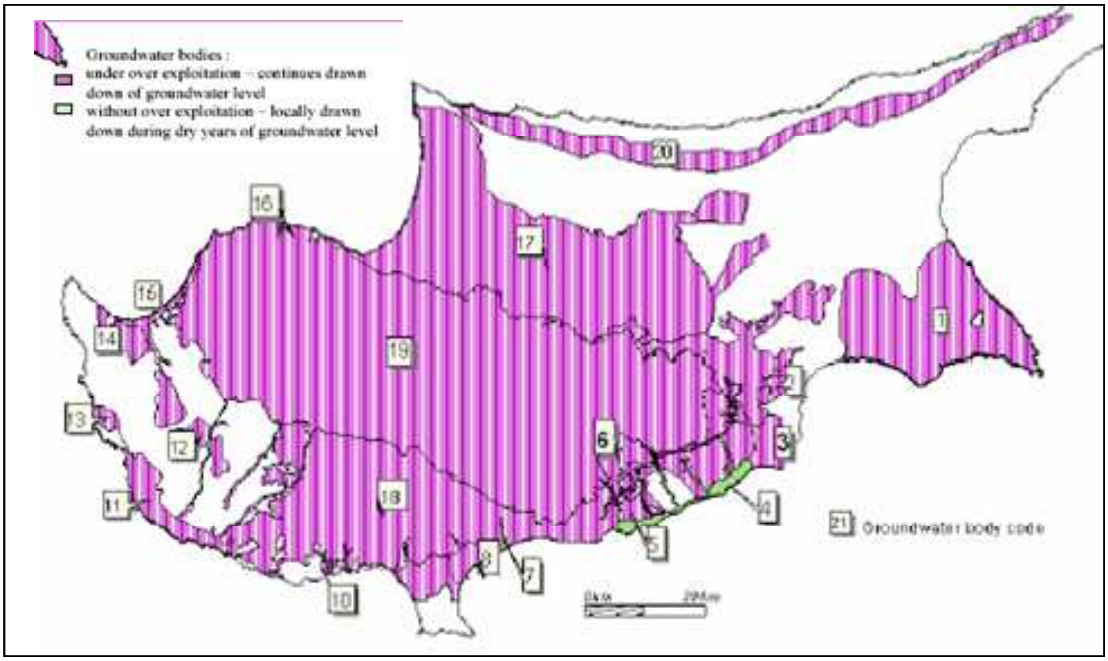


Figure 24: Overexploited groundwater bodies

The majority of groundwater bodies experiences a substantial reduction in the yield of wells, which in some cases is of the order of 1/10th of the yield during the previous decade. This is the case for the Kokkinochoria aquifer (Aquifer 1 in Figure 24), where approximately some 5000 boreholes are in operation today. The yield of those boreholes has been reduced from the average of 10 m^3/h in 1980 to 1-2 m^3/h in 2000. During the decade 1991-2000, the average yield of boreholes used for domestic water supply is estimated to be approximately 25 hm^3/yr. However, in the past few years there has been a reduction of the order of 5-7 hm^3/yr, with the yield reaching a level of 18 – 20 hm^3/yr.

Non-effective exploitation of many water development schemes

The existing water infrastructure has been the result of master-plans, extensive and comprehensive feasibility studies and sound workmanship.

The implementation of Government Irrigation Schemes resulted in the development of irrigation in certain regions, which in turn created a water demand that did not exist before. This development was based on the need to achieve a sufficiently high internal rate of return, in order to have an economically sound project to finance. However, this policy should have been more prudent in view of the arid to semi-arid nature of the climate of the island. In addition, the design of water works did not take into account the drought periods experienced in 1931-33 and 1970-73, assuming that the 40-year interval of average/wet hydrological years was sufficient for the evaluation of the yield of the projects.

Therefore, the design and evaluation of projects was based on the assumption of higher yields and consequently larger areas that could be irrigated by each. Of course, these decisions were not only based on economic evaluation but also on pressures by political lobbies and the local farmers. Further to that, the evaluation did not consider the change of cropping patterns, which resulted in the adoption of water-intensive crops (bananas compared to table grapes). The devastating results from the above planning were felt during the intense drought experienced from 1990 and onwards.

In other cases, the decrease of employment in the agricultural sector and the boost in the tourist industry in certain areas did not allow for the development of agriculture as planned; thus the use of water works was limited. The phenomenon was aggravated by the reduced export prices for certain agricultural products, a fact that also proved that the market studies performed during the feasibility studies were not exhaustive or insightful enough.

Excessive use of dam water due to the reluctance in using tertiary treated effluent

Recycled water is a rapidly emerging alternative water source for Cyprus. Its use was initiated in 1998, when approximately 1.3 hm^3 were used in the area of Limassol. Since then, its production and use has increased, and at the end of 2004 almost 5 hm^3 were used, replacing equal quantities of fresh water (Figure 25).

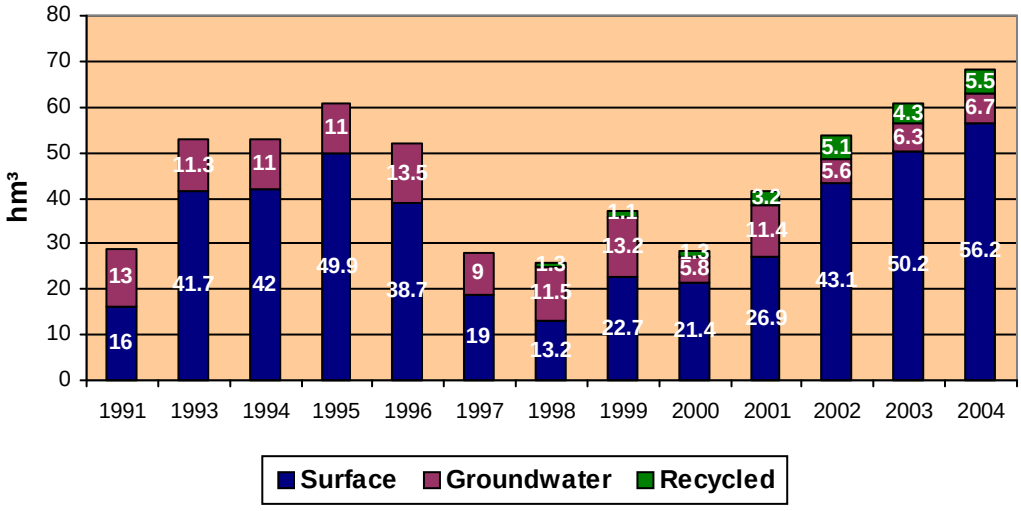


Figure 25: Irrigation supply sources used in the Government Irrigation Schemes for the period 1991 – 2004 (WDD, 2004)

However, the acceptance of treated effluent in irrigated agriculture is far from certain, especially when alternative sources are available. The early positive response of farmers, due to the drought of the recent years, subsided after 2001, because of the high availability of fresh water from the storage reservoirs.

The most serious problems are experienced during the winter months, when irrigation demand is minimum or zero. The intention of the Water Development Department is to store the quantities of recycled water produced during the winter either in storage reservoirs (Polemidhia and Ypsonas reservoir in Limassol) or in aquifers (artificial recharge of the Akrotiri aquifer in Limassol and the Ezousas riverbed aquifer in Pafos), so that it can be used during the peak summer period.

The recharge of the Ezousas aquifer is being implemented since 2003. However, this was not the case for Akrotiri aquifer, due to the objections of the Episkopi Local Authority. As a result, large quantities of recycled water were rejected in the sea of Limassol, depriving the water system of a precious resource.

Therefore, at this point there is wide recognition of the need for alternative policies which could strengthen the role of the recycled water in enhancing the urban and rural environment (green areas, parks, forestation), supporting agricultural water needs, and in recharging groundwater reserves.

3.2.2 Valuing water

Cost Recovery

The Government, through the Government Water Works that are administered by the Water Development Department, is the main service providing freshwater in Cyprus, providing services to both domestic users, through the provision of bulk water quantities to Water Boards, Municipal Authorities and Community Boards, and through the provision of irrigation freshwater on a retail basis to farmers, or on a bulk basis to irrigation Divisions and Associations.

The WFD describes that the assessment of cost recovery and incentive pricing is required at the river basin district scale for each category of identified water service. Since Cyprus has been identified as one river basin district[9] data for financial costs and cost recovery rates are available at that level. Total costs for water services of abstraction, construction, regulation and conveyance of surface waters, by means of large dams, channels and pipelines, and water purchases from desalination units, as well as groundwater resources provided by the WDD have been estimated for 2005 to 42.1 million C£.

The cost recovery of water services is analysed for different uses, by considering storage and main transportation, distribution, sewage collection, waste water treatment and the environmental and resource cost. The analysed water services include:

- **Freshwater provision to domestic use and irrigation**, through the Government Water Works[10]. The analysis for this case is conducted for all Government Water Works within the river basin district[11]. It should be noted that, according to the current institutional framework, costs (and tariffs) for freshwater provision through the Government Water Works constitute the major factor regulating the imposed end-user costs, while the Government Water Works currently supply, more than 70% of the total freshwater within the river basin district. Domestic uses in this case include both households and industries, since both are serviced through the same conveyance and distribution networks;
- **Urban wastewater collection and treatment** provided by the Sewerage Boards of Limassol-Amathous, Pafos, Ayia Napa, Paralimni and Larnaca;
- **Re cycled water provision** for irrigation, through the Government Water Works.

The results that will be presented in the following do not address water distribution through Water Boards, Municipalities and Community Boards for domestic water supply and Irrigation Divisions for irrigation water supply, as well as self-supplied services such as private (mostly groundwater) abstractions, industrial wastewater treatment and domestic septic treatment, for which no data exist.

[9] WDD, "Implementation of Articles 5&6 of the Water Framework Directive 2000/60/EC – Characterisation of surface water body types", Vol. 1 – Dec. 2004

[10] WDD, "Implementation of Articles 5&6 of the Water Framework Directive 2000/60/EC – Assessment of the current levels of cost recovery of water services", Vol. 12, WFD December 2004

[11] Cyprus is considered as one river basin district. Financial costs and cost recovery levels are estimated at the level of the river basin district.

For **domestic water provision** (households, tourism, industries) through the Government Water Works :

- Financial costs show an increasing trend, mainly due to the increase of operation and maintenance costs. Although several instruments have been realised during the period 2001 – 2005, their contribution to the total cost is surprassed by the augmentation of running costs, attributed to the high share of desalinated water in domestic supply sources;
- Environmental costs have minor contribution in the total costs, since groundwater abstractions from Government water works are only complementary for public domestic supplies;
- Resource costs show a continuous decline, due to the increasing water availability conditions, which minimises benefits foregone from agricultural water use;
- After the tariff increase effected in 01/01/2004, cost recovery of financial costs is improved, expected to reach approximately 73.1% in 2005.

For **irrigation freshwater provision** through the Government Water Works :

- Financial costs seem to be stabilised, since in most Government Projects no additional investments have been realised during 2001 – 2005. At the same time, operation and maintenance costs are more or less constant;
- Environmental costs make a minor contribution to the total cost, since groundwater abstractions from Government water works are only complementary, and surface water from dams is the main water resource used;
- Resource costs are equal to zero, since from 2002 and onwards no deficit is experienced in domestic water supply;
- Currently after the price increase, recovery of financial costs has considerably improved, reaching 67.4% in 2004, and projected to approximately to 77% in 2005. Cost recovery is expected to improve further by 2007, when irrigation tariffs will reach the final price of 0.11C£ /m^3.

For **urban wastewater collection and treatment** by the examined Sewerage Boards:

- Cost recovery seems to be adequate; high rates ensure to a minimum extent the sustainability of the services provided and a possibility to finance system expansions without incurring extremely high additional costs to consumers;
- It is generally recommended that a more detailed assessment is undertaken after the completion of the majority of the projected sewerage and wastewater treatment projects, in order to be able to assess cost recovery on the river basin district scale;

For **recycled water provision** through the Government Works :

- Recovery of financial costs is low, expecting to reach only 15.1% by 2005. However, the assessment has not taken into account the environmental benefits of recycled water use, such as the reduction of urban effluent discharges, and the mitigation of water stress conditions.

In general after the pricing reform effected by the Government of the Republic of Cyprus, recovery of costs for freshwater provision has improved considerably. However, full cost recovery is still not=achieved, a fact that contributes considerably to the prolonging of the non-rational (from an economic point of view) use of the scarce water resources; the water

consumption in the agricultural sector (with a contribution of only 4% to the GDP) is 75%, whereas in the industrial sector (22.5% contribution to GDP) the water consumption is only 1.5%.

Productivity of water uses per sector

In the global debate about increasing water scarcity, agriculture is often associated with inefficient, wasteful water use[12]. This is supported by its poor performance in terms of "water use efficiency", a term that was defined as the ratio between the irrigation water absorbed by the plants and the amount of water actually withdrawn from its source for the purpose of irrigation. The word efficiency, when its value is significant below 100%, implies that water is being wasted. However, from a water balance perspective, water not taken up and transpired by the crop plants, even if unnecessarily withdrawn from its natural course, is not necessarily wasted. Unused water may be used further downstream in the irrigation system, it can flow back to the river or contribute to the recharge of aquifers. Renewable freshwater is only effectively lost when it evaporates from the soil, is fatally polluted or when it joins a saltwater body.

This fact does not, by itself, deny justification of programmes aimed at increasing water use efficiently in irrigation. The adoption of water-saving technologies and improved water management is justified by the needs of higher equity within irrigation schemes, higher reliability of water service, reduced energy cost in cases when pumping is required, and when water withdrawal jeopardises the sustainability of the ecosystems. Rather than water use efficiency, the concept of water productivity is now widely accepted as a measure of performance in agricultural use. By definition, productivity represents the output of any production process expressed per unit of given input, in this case water. In agriculture, several types of output can be considered. In strict commodity production vision, the output is usually expressed in volumes or value for a given agricultural production.

Figure 26[13] shows, for a selection of crops, an estimate of water requirements in m^3 per hectare and the value obtained per m^3 of water. It is evident that crops with high water requirements, such as colokasia and fodder, yield a low value per m^3 of water. Figure 26 shows, for the same selection of crops, the cost of water, other costs (labour, financial, etc.) and the benefit per hectare of the farmer. None of the crops presented in the example appears to be particularly sensitive to the cost of water. The water-greedy colokasia preents a high benefit for a relatively small cost. Greenhouse tomatoes appear to be profitable and little affected by the cost of water but the high incidence of other costs suggests that the farmer may be running high risks. Therefore, in this case, a shift in market prices could lead to a situation similar to that of french beans (large non-water cost and financial loss). Citrus, which account for 32% of irrigation water demand, exhibit a low value-in-use of water and modest net benefits, and invites to closer scrutiny in agricultural water policy.

Consequently, in a context of growing water scarcity and increasing water prices, a mix of policies should foster agronomical research and extension services, addressing a large diversity of suitable crops. For the majority of small-scale farmers, support to collective

[12] FAO and IFAD, Water : A Shared Responsibility, Chapter 7 : Water for food, agriculture and rural livelihoods.

[13] Water Development Department & FAO, Reassessment of the Island's Water Resources and Demand, Synthesis Report, June 2002

marketing arrangements can help to improve crop planning and reduce the undertaken risks. With evolving EU policies, and as subsidies for agriculture phase out, other subsidies compatible or even supported with European policies can phase in. These can be designed to support the farming sector to produce high added-value fresh products for an increasingly sophisticated services and tourism sectors, and to enhance the role of farmers and rural population in protecting and enhancing natural and environmental resources.

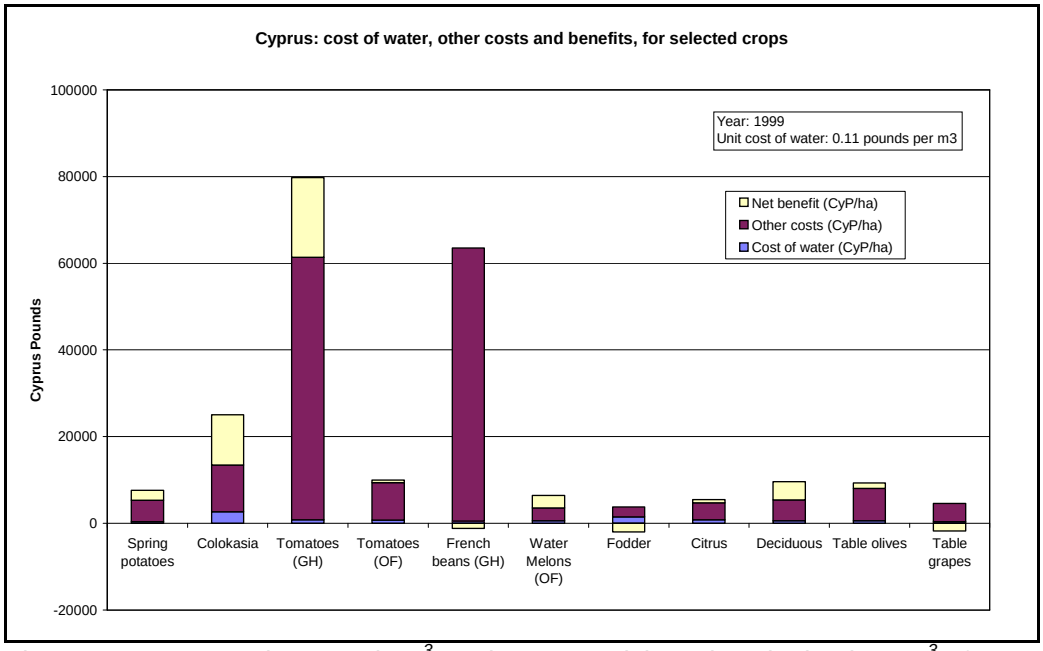


Figure 26: Water requirements in m^3 per hectare and the value obtained per m^3 of water

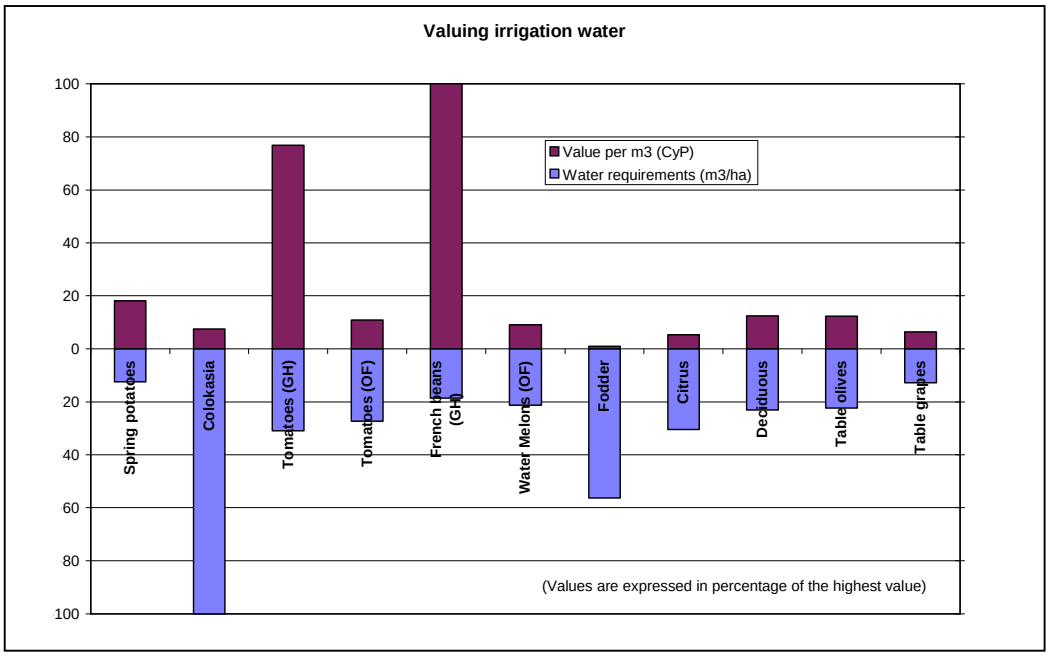


Figure 27: Cost of water, other costs (labour, financial, etc.) and benefits per hectare for selected crops

3.2.3 Governing water

Fragmentation of responsibility

The Institutional setup as now existing is a rather complex and bureaucratic system made up of at least four involved Ministries on the policy level, 15 Government Departments on the executive level, and a great number of Organisations on the Water Users level either for domestic water supplies or irrigation (see section 2.2). Water laws are many and complex, including dublications. These have been enacted from time to time in the past as needs demanded, so as to cover the requirements of various water-related interests and authorities, without ever making an effort to group them together in an organized form or code (section 2.4).

Society-driven conflicts

The conflicting and competing uses as a result of the current development pattern, pose great pressures on water management responses. A good example demonstrating the complexity of the issues to be resolved related to conflicting and competing water uses, is the Limassol region which is one of the main tourist destinations in Cyprus, while agricultural production in the area accounts for more than 25 % of the fruit trees, 6% of the vegetable and 20% of the table grapes production of the country.

The subsidized water price for irrigation water compared to the full cost recovery for domestic supply does not promote healthy competition and water conservation measures. As a result, Moreover, there are demonstrations against inter-basin transfers of water with the local farmers demanding full coverage of their demand before any transfer is made.

4 Stakeholder mapping

Public participation in planning and water management is insufficiently implemented at the local level. Four Farmers Unions, based on political affiliation, are active members of the Government Advisory Committee which advises the Minister of Agriculture on agricultural policy issues. They are also represented on all Agricultural Marketing Boards and are financed partly by the Government and partly by member fees. Public involvement is limited and takes only place in water allocation decisions made by WDD. However, WDD does seek irrigators' views when there is need for water rationing, particularly during droughts. There is no formal procedure for consultations with farmers regarding water use. Consultations regarding water use are made on the occasion of planning a new water scheme for irrigation, based on surface water development or groundwater. This consultation is made through meetings with farmer-union's representatives and village chairmen of the particular area involved. These meetings may continue during the design stage of such a scheme. On a number of past projects, local farmers were given the opportunity of an in situ description of the local water conditions and the scheme being planned. Staff of the Water Development and Agricultural Department usually carry out these demonstrations. A somewhat similar procedure is followed on the occasion of plans for local consolidation. Occasionally, the project is also discussed at meetings with the Parliamentary Committee on Agriculture where local Parliamentary Representatives may take particular interest. Meetings with farmers' representatives and local Water Boards are also made on the occasion of drought measures and rationing of water resources.

The WDD, the Institution of Agricultural Research and the Agricultural Department from the Ministry of Agriculture, Natural Resources and the Environment, the Sewerage Board of Limassol, the Limassol Water Board occasionally organise seminars, workshops and International Conferences in water related subjects which are open to the public.

4.1 Description of main stakeholders

The initial stakeholder mapping was done following guidelines and the experience gained from past research projects. Table 13 and Table 14 present the potential stakeholders that were initially contacted.

Table 13: Representative Citizen Groups, NGOs, Associations, Volunteers

	Number of Groups Associations /Volunteers
Citizen groups	4
Consumers groups	1
Women unions	?
Small scale Farmers	10
Large scale Farmers	4
Hotel owners	50
Private company/Small Industry	
Private company /Industry/exporters	
NGOs (environmental organisations)	10
Associations of Farmers	4
Associations of Hotel-owners	1
Associations of Industries	2

Table 14: Policy Makers

Policy Makers	Name	Role/Main Activities in relation to water management
Governmental Institutions		
Ministries	Ministry of Agriculture, Natural Resources and the Environment	It has technical responsibility for water resources policy, assessment and monitoring, but also for development of water resources and for the bulk sale of water to end-users. It is responsible for the enforcement of water-related laws including the issuance of groundwater permits
	Ministry of the Interior	
Regional Authorities	District Administrations	It plays a key role in the implementation and enforcement of water-related laws including the issue of groundwater permits. All municipal water supplies and non-government irrigation schemes are in principle under the jurisdiction of the Ministry of Interior
Municipalities	Local Municipalities and Communities, Union of Municipalities, Union of Communities	Responsible for water administration at local level
Other	The Department of Agriculture	It is a section of the Ministry of Agriculture, Natural Resources and Environment. The Department of Agriculture runs extension services that advise farmers on irrigation methods, fertilizers and other issues.
	Environmental Service	It is a section of the Ministry of Agriculture, Natural Resources and Environment.
Public Utilities		
Water/wastewater utilities	Water Boards Sewerage Boards	Provide waterworks and sewage services
Related Services		
Water Department	Water Development Department	It is responsible for implementing the water policy of the Ministry with objective, the rational development and management of the water resources
NGOs	Association of the Environmental Organisations in Cyprus	Active in developing environmental awareness to the public through the sensitisation on the health and safety issues
Research	University of Cyprus	The University has managed scientific and research studies in the scope of water management and waste water reuse
	Agricultural Institute of Research	

4.2 Summary of stakeholder interests

Table 15 presents the interests, as outlined by the representatives of the identified authorities. Contact details for each institution/association are presented in the Deliverable's Appendix.

Table 15: Stakeholder interests

Category/Group	**Interests in relation to water management, provision and pricing of water services**	**Potential impact to the application of institutional and economic instruments (+, - , N/A)**	**Priorities of interest in relation to water management (1-lowest to 5 highest)**
Representatives of Groups, NGOs, Associations, Volunteers			
Cyprus Counsil of Business Women			
Cyprus Consumer Association	Water availability Water quality Water tariffs	+	2
Cyprus Parents Association (elementary schools)	Education	+	2
Cyprus Parents Association (high schools)	Education	+	2
Representatives of Stakeholder Associations			
Union of Cyprus Farmers (EKA)	Availability Quality Tariffs Waste water use Aquifer recharge Best agricultural practices	+/-	1
"Panagrotikos" Farmers Union			
PEK Farmers Union			
"Agrotiki" Farmers Union			
Cyprus Hotel Association	Water availability Water quality Water tariffs	+/-	2
Union of Cyprus Municipalities	Waste water Water Tariffs Water Quality	+/-	2

Category/Group	Interests in relation to water management, provision and pricing of water services	Potential impact to the application of institutional and economic instruments (+, - , N/A)	Priorities of interest in relation to water management (1-lowest to 5 highest)
Union of Cyprus Communities	Waste water Aquifer recharge Water Tariffs Water Quality	+/-	2
Representatives of Governmental Institutions			
Water Development Department	Planning and water resources management infrastructure	+	1
Nicosia District Administration	Water resources management	+	1
Limassol District Administration			
Larnaca District Administration			
Pafos District Administration			
Famagousta District Administration			
Kerynia District Administration			
Environmental Service	Monitoring, environment	+	2
Agricultural Department	Monitoring, environment	+	2
Representatives of Water Utilities			
Water Board of Nicosia	Water supply services	+	1
Sewerage Board of Nicosia	Sewerage system Treated effluent	+	1
Water Board of Limassol	Water supply services	+	1
Sewerage Board of Limassol	Sewerage system Treated effluent	+	1
Sewerage Board of Pafos	Sewerage system Treated effluent	+	1
Water Board of Larnaca	Water supply services	+	1

Category/Group	Interests in relation to water management, provision and pricing of water services	Potential impact to the application of institutional and economic instruments (+, - , N/A)	Priorities of interest in relation to water management (1-lowest to 5 highest)
Sewerage Board of Larnaca	Sewerage system Treated effluent	+	1
Sewerage Board of Ayia Napa	Sewerage system Treated effluent	+	1
Representatives of related services			
Cyprus Green Party	Monitoring, environment	+	2
Representatives of Environmental NGOS			
Environmental NGO	Monitoring, environment	+	2

INSTITUTIONAL ANALYSIS AND FOCAL WATER MANAGEMENT PROBLEMS IN TUNISIA

Prepared by Tunis International Centre for Environmental Technologies (CITET)

1. Country overview

Water in Tunisia is not only considered as a natural resource, but also as an economic good and political factor that plays a central role in fighting poverty and fostering economic development, political stability and development of collaboration between regions.

Natural water resources in Tunisia are relatively limited and equal to at 4.670 million m^3, of which 4.100 million m^3 are considered exploitable. The ratio of available water resources per capita had been estimated at 450 m^3 in 1996 and will decrease further to 315 m^3 in 2030. Thus, the country is considered one of the poorest countries in terms of natural water resources.

1.1 Physical characteristics

Climate

Tunisia occupies an area of 163,900 km^2. The average altitude is 700 m, escalating at 1544 m in the Chaambi mountain at the central part of the country. In the northern part, along the coastline, the climate is typical Mediterranean, whereas at the southern part of the country the climate is typically arid, causing a high temporal and spatial variation in water availability. The average rainfall ranges from less than 100 mm/yr in the south to more than 1500 mm/yr in the northern part of the country. The average temperature varies between 11.4°C (December) to 29.3°C (July). The prevailing winds in the northern part are westerly to north-westerly. Wind speed is much lower in the southern part, where the prevailing winds are north-easterly, with Sirocco accompanied by Saharian dust being frequent during the summer months. The annual evapotranspiration is equal to 1200 mm in the northern part of the country, 1400 along the coastline, 1600 mm in the central and raises up to 1800 mm in the southern tip of the country.

Geomorphology and geology

Tunisia presents diversified geomorphological characteristics, due to both the influence of climatic conditions, vegetation and the influence of man over land use. There is clear differentiation in the type of soils between the northern and southern parts of the country. In the northern part, characterised by humid or subhumid climate, most soils are clayey, whereas in the south soils are characterised by different types of saline accumulations (calcareous, gyps, slat, etc.).

River Basins

Tunisia is divided in 7 River Basin Districts, which include several river basins which are characterised by similar features:

- **Basin 1**, which covers the north-most part of Tunisia.
- **Basin 2**, which comprises Cap Bon watershed and the Miliene River
- **Basin 3** which corresponds to Medjerda River watershed, and is the most important river basin in Tunisia.
- **Basin 4**, which corresponds to the central part of the country (Zeroud, Merguellil and Nebhana rivers)
- **Basin 5**, which comprises the Sahel of Sousse and Sfax.
- **Basin 6**, which expands from the limit south of the central part and the Sahel up to the north of Chot el Jerid.
- **Basin 7**, which covers the south-most part of the country, up to Algerian and Libyan borders.

1.2 Demographic characteristics

In 2006 the population of Tunisia was estimated at 10 million, exhibiting an annual growth rate of 1.12%. The average expected lifetime is equal to 73.4 years. The scholarization rate at 6 years of age is 99%.

The rate of exploitation of available resources is at present equal to 90% and over 20% of irrigation equipment contributes to water saving in the agricultural sectorThe reuse rate of treated wastewater is equal to 32%. 95% of the population is connected to the electricity grid; in rural areas, this percentage is equal to 88%. At the national level, potable water supply is provided to 92.3% of population, and to 80% of rural population. In average values, potable water supply is provided to 92.3% of the country and to 80% in rural areas. 75.5% of households are connected to public water supply networks; this percentage drops to only 30% in rural areas. 85.7% of households in urban areas are connected to sewerage systems.

1.3 Brief description of main economic sectors

General Information

The 2005 structure of the Gross Domestic Product ("PIB") was the following:

- Services: 18.182 million TD
- Non-manufacture industry: 4.141 million TD
- Agriculture and fisheries: 4.334 million TD
- Manufacture industry: 6.523 million TD

In factor costs, the GDP was equal to 33.180 million TD in 2005 and in market prices it was equal to 37.202 million TD. At the same period, The value of indirect income taxes and subsidies was equal to 4.022 million TD. In 2005 the value of total exports equalled 17.854 million TD, whereas total imports accounted for 18.838 million TD. The 2005 per capita Gross National Product was equal to 3.530 TD.

The agricultural sector

The main agricultural products are:

- Cereal production : average of 2 million tons/year
- Olive oil: 250000 tons
- Oranges: 250000 tons
- Dates: 100000 tons
- Vineyards: 500000 tons

The industrial sector

The industrial sector comprises:

- Non manufacture industry, including Mines, Energy, Electricity, and Water, construction and public works.
- Manufacture Industry: Food Industry, Construction material and glass, Ware, Mechanic and electric products, chemistry and rubbery, textile and leather.

Tourism sector

The geographic position of Tunisia, its natural beauty and ancient civilisation monuments boosted the development of tourism activities. This development was reinforced by the 40-year efforts of the state and the public. In 2005, Tunisia was the first African and Arab tourist destination for the Europeans. The total number of visitors was estimated at 6 million, whereas the number of overnight stays

equalled 40 million. The revenue from tourism escalated at 2575 million TD[14].

1.4 Hydrological balance

In 1996 total water demand was estimated at 2,528 million m^3 and is expected to follow a tremendous and continuous growth, following the socio-economic development of the country. On the other hand, the total volume of available resources, comprising both natural and non-conventional water resources, presents low variability and ranges between 4,000 and 4.600 million m^3. It is estimated that in 2010 exploitable resources will be equal to 4,600 million m^3, whereas water demand is projected at 2,689 million m^3.

Demand management constitutes an important axis of future water policies, with the overall aim of controlling the consumption of the different sectors, and in particularly that of agriculture which is the largest consumer. Employed measures and tools are mainly based on water conservation, water pricing and rationalization of water use in agriculture.

At the end of 2002, the main water sources comprised 27 large dams, 182 small dams, 650 artificial lakes, 3,176 boreholes, 130,000 wells and 93 natural water springs.

In addition, and in order to assess and monitor water resources and quality, a monitoring network has been established all over the country. This network consists of:

- 95 pluviometric stations
- 218 flow measurement stations in rivers
- 3.750 points of piezometric measurements and observations
- 1.200 measurement points of groundwater quality

1.5 Inter-basin transfer

Inter-basin transfer is performed between northern regions, towards the coast and from the western to the eastern part of the country. Water is primarily used for domestic and irrigation purposes. The conveyance network for inter-basin transfer is approximately equal to 30,000 km.

Although at present the country does not experience extreme water shortage, there is an increasing pressure on available resources due to accentuated droughts, pollution problems and over-exploitation of resources which render difficult the current decision-making processes with regard to water management.

Therefore, there should be a better understanding of these phenomena and promote (a) the use of non-conventional water resources in order to meet potable water demand in deficient regions and (b) the exploitation of additional resources for the development of economic sectors, and especially agriculture.

[14] 1TD = 0.8 US$

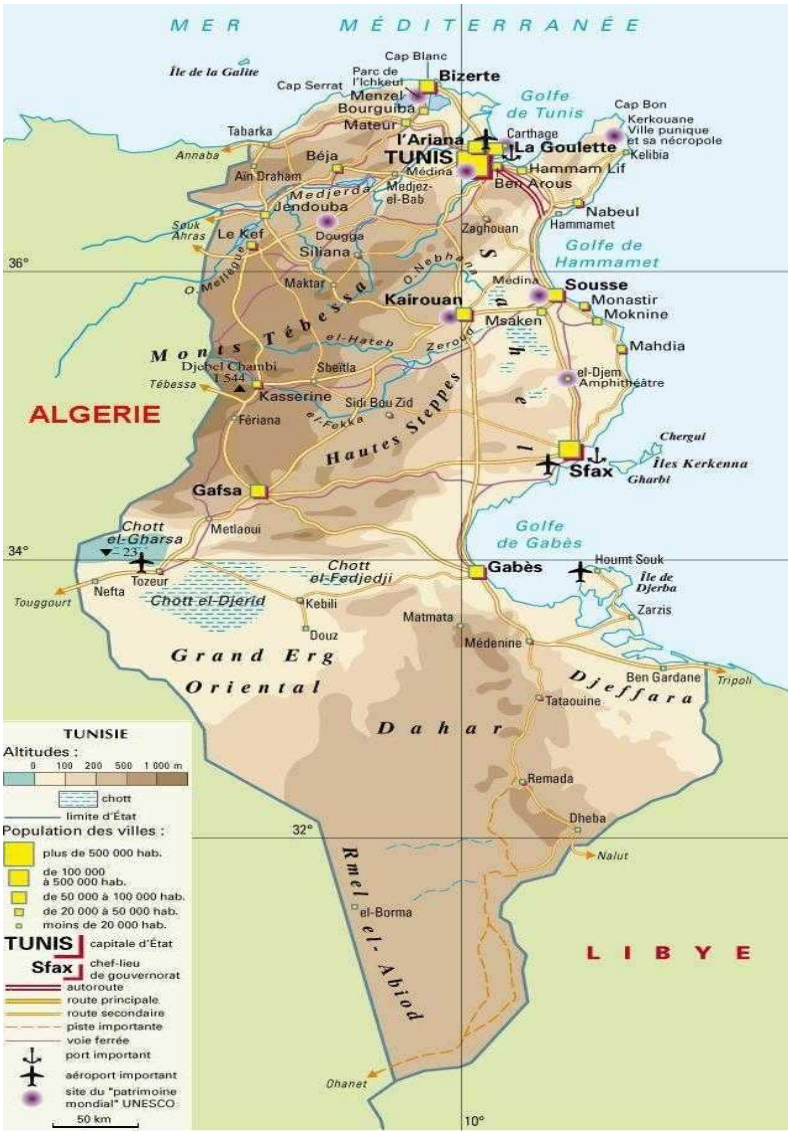


Figure 28: General map of Tunisia

2. Institutional and financial context

2.1 Institutions and responsibilities

Table 16 presents the institutions with a role in water management and analyses their responsibilities. It should be noted that:

- Institutions 1 to 11 are placed under the authority of the Ministry of Agriculture and Water Resources
- Institutions 12 to 15 (ONAS, ANPE and CITET) operate under the authority of the Ministry of Environment and Sustainable Development.
- Institutions 17 (CRTE) and 18 (IRA) are placed under the authority of the Ministry of Scientific Research.

Finally, Table 17 presents the water resources planning matrix, summarising the information already presented in Table 16.

Table 16: Institutions and responsibilities

No	Authority	Responsibilities
1	General Direction of Water Resources (DGRE)	- Implements and manages monitoring networks for different aspects of the country's water resources - Monitors surface and ground water exploitation - Elaborate on legislation regarding water resource exploitation and use - Compiles and updates the inventory of available water resources and compiles the national report on water resource use and exploitation - Collects data and maintains the national Geographical Information System Databases on water resources - Processes and validates all relevant hydro-geologic information pertaining to the different river basins of the country. - Monitors the operation of hydrometric, piezometric and water quality monitoring stations. - Coordinates, compiles and disseminates all reports on water resources - Updates and maintains the hydrological database. - Coordinates and monitors hydrologic, hydrogeologic and other relevant assessments for surface water bodies in the country. - Provides expertise and assistance to regional/local authorities for the management of all data related to water resources use and exploitation - Proposes appropriate principles and methods for water resources exploitation and management, according to the current supply and demand patterns. - Promotes research on the exploitation of natural water resources.
2	General Direction of Rural engineering and water exploitation (DG/GREE)	- Prepares strategic plans, formulates policies and elaborates on projects related to rural engineering and water provision for the agriculture sector. - Monitors and assesses projects related to the irrigated perimeters and agricultural sanitation. It also maintains infrastructure and hydraulic equipment, and proposes appropriate technical and economic solutions for those areas. - Rationalizes water use, promotes non-conventional water use in agriculture, monitors institutional aspects for the formation of

No	Authority	Responsibilities
		interest groups, and assesses and implements instruments for managing water demand in the agriculture sector. - Coordinates rural infrastructure programs and assesses technical and economic aspects in agriculture industrialisation in order to encourage the modernisation of the agriculture sector. - Coordinates, monitors and assesses the performance of potable water provision projects in rural zones.
3	General Direction of Dams and great hydraulic works (DG/BGTH)	- Prepares water resource assessments. - Elaborates management plans on the exploitation of surface waters. - Elaborates assessments on water resources exploitation. - Prepares feasibility studies on infrastructure for surface water exploitation (i.e. large dams, conveyance networks, small dams), and is responsible for their construction. - Maintains large dams. - Is responsible for the construction of infrastructure for the protection of rural and agricultural zones from erosion.
4	National Company for Water Exploitation and Distribution (SONEDE)	- Provides potable water all over the national territory. - Exploits, maintains and renews water abstraction, conveyance, treatment and water distribution facilities and networks. At present, SONEDE is responsible for: - The production, treatment and distribution of 317 million m3/yr of drinking water, through a conveyance network of 30000 km. - Water distribution, operation and maintenance of networks and the provision of drinking water to 1.4 million of customers. - The preparation of feasibility studies with regard to water works. The company employs 7.500 people and is regionally represented in all 24 governorates.
5	General Direction of Agricultural land Management and Conservation (DG/ACTA)	- Develops plans and guidelines for the conservation of natural resources (land, forestry, vegetation and water) - Proposes and promotes measures towards the rational use of natural resources - Assesses land use. - Performs soil and water analyses. - Performs research in soil science. - Controls land management. - Ensures coordination between all institutions for issues related to land and water conservation. - Elaborates plans on watershed management and erosion prevention. - Controls and monitors land and water conservation programmes. - Assesses land and water conservation management projects. - Develops and promotes approaches for the conservation of natural resources and involves all operators in similar efforts to ensure their effective implementation. - Manages, through its regional services, the construction of small reservoirs (capacity of 50.000 to 200.000 m^3) and water table recharge infrastructure. - Manages the protection of large dams from sedimentation and water conservation projects at the watershed level.
6	Rural Engineering, Water and Forestry National Research Institute (INRGREF)	- Promotes/performs research in natural and non conventional water resources with emphasis on: - Chemical, physical and microbiological analysis of water samples.

No	Authority	Responsibilities
		- Irrigation water and irrigation methods - Wastewater treatment and reuse technologies - Water conservation - Regulation and quality standards for wastewater reuse in agriculture.
7	Regional Department for Agriculture Development (CRDA)15	- Assesses water resources at the governorate level. - Monitors water resource use and realises irrigation and potable water supply projects at the governorate level. - Maintains and updates the respective regional databases on water resource exploitation, use, water quality, availability and allocation, in line with the requirements of the National Information System.
8	National Committee of Water (CNE)	Acts as a consulting body on issues related to water management
9	Commission of the Public Hydraulic Estate (CDPH)	Acts as a consulting body on issues related to water resources.
10	Exploitation of Conveyance Networks of the North (SECADENORD).	- Manages all conveyance infrastructure (canals and pumping stations) along the Mejerda- cap bon and Jounine canals - Supplies water to major institutions such as SONEDE and CRDAs.
11	Surveillance Office of Hydraulic Resources (BIRH)	- Draws up the inventory related to the monitoring of water resources. - Intervenes in the collection of fees from sand and water extraction from rivers performed in the framework of public water resources exploitation and the sale of positive boreholes.
12	National Sanitation Utility (ONAS)[16]	ONAS is the major agency dealing with the protection of the water environment and pollution abatement, with the following aims: - Eliminate water pollution sources in the areas falling under the ONAS jurisdiction. - Manage, operate, maintain, rehabilitate and construct all facilities intended for the provision of sewerage and wastewater treatment services in the towns assigned to ONAS. - Promoting the distribution and re-sale of the by-products of wastewater treatment, such as treated wastewater and sludge; - Planning and implementation of sanitation sector programmes. - Planning and implementation of integrated projects related to the treatment of wastewater and the disposal of storm water.
13	National Agency for Environment Protection (ANPE)	- Participates in the elaboration of national strategies on pollution abatement and environmental protection. - Acts for the prevention and mitigation of all forms of pollution and threats to the environment. - Acts in favour of rational exploitation of natural resources for sustainable development. - Approves investment projects aiming at pollution prevention/mitigation and environmental protection. - Establishes regional offices in order to facilitate contact with citizens and industries and ensure control and monitoring of the state of the environment.

[15] CRDA is a Regional Direction. There is one CRDA in each of the 24 governorates. Each of the General Directions indicated above is represented in the CRDA.

[16] The ONAS manages a sewerage network of 12.771 km and 83 wastewater treatment plants. In urban areas the overall sewerage connection rate is estimated at 85,7%, whereas the volume of treated wastewater is equal to 201 million m^3/yr.

No	Authority	Responsibilities
		- Undertakes actions for raising awareness and promoting research in the field of pollution abatement and environmental protection
14	Tunis International Centre for Environmental Technologies (CITET)	- Performs chemical, physical, microbiological analysis of water samples. - Promotes wastewater reuse and improved wastewater treatment technologies. - Provides training and promotes capacity building in the field of water, water pollution and environmental protection. - Promotes know-how on desalination technologies.
15	Groups of Hydraulic Interest (GIH)[17]	- Formulates proposals on the common use of water resources in its area of action (governorate). - Expresses an opinion on management and water allocation projects in the governorate. - Controls owners and end-users associations
16	Agricultural Development Groups (GDAs)[18]	- Jointly manages water resources. - Collects fees from water users - Maintains water infrastructure and networks
17	Research centre for science of Water Technologies (CRTE)	- Elaborates and applies strategic plans and guidance documents related to the water sector in general. - Maintains and operates laboratories dealing with geochemistry and physical chemistry.
18	Arid Region Institute of Mednine (IRA)	- Promotes water harvesting and water saving technologies in arid regions. - Conducts experiments on water reuse for the irrigation of therapeutic and aromatic plants.

[17] GIH are consulting agencies established in each governorate and operate under the authority of the Governor.
[18] GDAs are mainly formed by farmers

Table 17: Water resources planning matrix

ACTIVITY	DG/RE	DG/GREE	BGTH	SONEDE	DG/ACTA	ONAS	PRIVATE
Surface waters							
Use		x		x			x
Storage				x			x
Groundwater recharge	x				x		x
Diversion			x		x		
Quality monitoring	x			x			
Assessment	x			x			
Groundwater							
Use		x		x			x
Storage				x			
Recharge							
Quality monitoring	x			x			
Assessment	x						
Well permits	x						
Irrigation network							
Rehabilitation		x					
Modernisation		x					
Reuse							
Drainage water		x					
Wastewater		x				x	
Desalination							
Introduction of technology				x			
Efficient water utilisation				x			
Domestic				x			
Industrial				x			
Agricultural							
Legislation							
Regulation and codes	x					x	
Standards	x					x	
Policy setting							
Water allocation	x	x		x		x	
Project financing		x	x	x	x	x	x
Project design		x	x	x	x	x	x
Project implementation		x		x	x	x	x
Operation and Maintenance		x		x		x	x
Pricing (tariffs)		x		x		x	
Enforcement							
Water data records	x			x			

2.2 Legislation

Since the independence of Tunisia in 1956, **the rapid water demand growth** in the domestic, industrial, tourism and specially the agricultural sector, has forced the national authorities to implement policies for the sustainable management and exploitation of water resources. This effort for water resources mobilisation prevailed in the development of National Master Plans, along with the need to mitigate the socio-economic impacts of droughts which occurred during the last 15 years.

In this regard, Tunisia has engaged since 1990 an ambitious program for the exploitation and management of natural and non-conventional water resources, through the construction of 21 large dams, 203 off-stream dams, 1000 small reservoirs, 200 water spreading units, desalination units, borehole and well drilling, wastewater reuse and artificial recharge of the water table. This strategy aims primarily at safeguarding available resources, providing potable water to supply population needs and maintaining agricultural production, thus preserving the stability of the country's economy.

All tasks related to water resources management fall under the responsibility of the Ministry of Agriculture and the institutions placed under its authority, such as DG/RE, DR/GREE, DG/BGTH, DG/ATCT, SONEDE, CRDA's , as well as local development groups of public interest.

At present, transboundary water management is realized by DG/RE for surface water. Few river basins are shared with neighbouring countries, and no problems have been encountered with regard to their management. However, with regard to groundwater resources, Tunisia, Algeria and Libya solicited the creation of "Sahel and Sahara Observatory (OSS)", with the aim to provide assistance in the implementation of a concertation mechanism of the Aquifer System of the Sahara This mechanism, which will start operating in 2007 will have the main goal of providing an information exchange and cooperation framework between the 3 countries through the:

- Establishment of indicators on available water resources and water demand
- Elaboration of water resources management scenarios for the development of the basin.
- Strengthening cooperation and development of common databases for information exchange.
- Development and management of common monitoring networks for the Aquifer system.

Chapter 7 of Code des Eaux (Waters Regulation) comprises 46 articles addressing the issues of pollution and flood control. Water pollution prevention is effected through the prohibition of liquid and solid waste discharges in water bodies, the establishment of protected areas in the vicinity of water supply sources and the obligation for wastewater treatment in urban areas. In terms of flood protection, the "Waters Regulation" requires the construction of infrastructure by the government, development groups of public interest or by individuals.

Article 106 of Chapter 7 regulates wastewater reuse in agriculture, setting the appropriate quality standards and the crops that can be irrigated with treated effluent.

The largest water user in Tunisia is irrigation, which absorbs 80% of the country's available resources. The irrigated area is estimated at 400.000 hectares, whereas irrigation demand is actually estimated at 2.120 million m^3. Irrigation water supply originates from large dams, boreholes and wells, and wastewater treatment plants and is managed by the CRDA's and development groups.

Domestic water demand concerns urban, rural zones, as well as water sources in the Sahara and at present is estimated at 350 million m^3/yr. Water supply is provided by SONEDE and the regional public services (CRDAs and Development groups in the rural zones). Industrial demand corresponds

to 120 millions m^3/yr approximately and tourism demand is estimated at 30 million m^3/yr; both are supplied by SONEDE.

Wastewater collection and treatment is managed by a public company (ONAS). The ONAS is the main utility responsible for the protection of water environment and for pollution abatement. One of the responsibilities of ONAS is the collection and treatment of wastewater. An estimated volume of 201 million m^3 of wastewater is treated the 83 ONAS plants.

Drought is a periodic and usual phenomenon in Tunisia, always taken into account in development plans and water projects. Thus, the country has managed to overcome drought impacts over the last decade, mostly as a result of appropriate management of hydraulic works and socio-economic measures, such as appropriate agricultural practices, irrigation management etc. A practical drought guidance document was elaborated in 1999, with the aim to inform the different user-groups and institutions on appropriate measures for impact alleviation and mitigation. This policy has helped the country overcome problems in meeting water needs during wet and dry periods.

The regional services of DG/ACTA grant pumping authorisation for water abstraction from small reservoirs. These authorisations are often granted to individuals but also to user-associations, such us the Agricultural Development Groups and other management committees. The volume of water allocated should not exceed 2/3 of the lake reserve capacity. In case of collective use, the water price is determined by the management committee or the development group.

Tariff regulation and water pricing is an important issue in the country. Water for irrigation is still subsidised at a rate of 30%, allowing for the recovery of operation and maintenance costs. Costs related to the renewal of equipment and important repairs in infrastructure are undertaken by the government.

For potable water, an Increasing Block Tariff system is applied, according to quarterly consumption. The water bill also includes a charge for wastewater collection treatment. The first (social) block (which corresponds to a minimum water consumption) is limited to 20 m^3. The second block corresponds to quarterly consumption between 20 and 75 m^3 whereas the third block is between 5 and 150 m^3. For a quarterly consumption over 150 m^3 the price per cubic meter is 6 times higher than the one of the first block, in regions where SONEDE is not subsidised by the state. The current regulation system provides incentives for water conservation, and recovers the management, operation and maintenance costs of the networks operated by SONEDE.

Table 18: List of Water Laws and regulations

Reference	Focus	Content	Implementation Status
Legislative Decree of 24 September 1885	Water Resource Management	Emphasizes on the public hydraulic estate, including only surface and not groundwater resources	Implemented during the colonialism period
Legislative Decree of 24 May 1920	Water service provision	Provides for the creation of a special water service, the establishment of an agricultural and industrial hydraulic fund and for the establishment of a Water Committee	Implemented during the colonialism period
Legislative Decrees of 5 August 1933, 26 November 1936 and 24 March 1938	Water utilization, conservation and pricing	Regulates the utilization and conservation of public estate water and fixes the price for water use	Idem

Reference	Focus	Content	Implementation Status
Legislative Decrees of 30 July 1963, 11 January 1945 and 17 March 1949	Creation of groups of hydraulic interest	Emphasizes on the regulation and organization of groups of associations of hydraulic interest	Idem
Laws of 11 January 1958, 26 June 1960, 27 May 1963 and 16 February 1971	Water for irrigation	Provides for the creation of public irrigated perimeters and emphasizes on the role of the government to develop agriculture	Implemented through the CRDAs
Legislative decrees of 12 March 1964 and Decisions of 19 July 1958 and of 12 March 1964	Water for irrigation	Emphasizes on the role of the farmers in the creation, management and irrigation through privately built water infrastructure and in soil and water conservation	Implemented
Law no 75-16 of 31 March 1975	Law for water resource mobilization, exploitation and protection	Confirmes all regulations cited above and introduced new elements for water resources protection and utilization The law consists of 9 chapters and 160 articles. These are further described below.	Implemented
Chapter 1 (comprises 7 articles)	Water resource management	Defined all components of the public hydraulic estate, which is administered by the Ministry of Agriculture and Water Resources.	
Chapter 2 (comprises 13 articles)	Water mobilization and conservation	Defined the perimeters for the management and water utilization, operations needed for the granting of authorization from the administration, regulated the instauration of protection zones for groundwater tables, and identified the agents in charge of water conservation and protection of the public water estate	
Chapter 3 (comprises 18 articles)	Water exploitation	Emphasizes on the replacement of private water ownership rights by rights of use and describes on all actions required to obtain such rights. The chapter focuses mainly on water springs and streams,	
Chapter 4 (comprises 12 articles)	Water exploitation	Emphasizes on the identification of special zones in the water public estate and regulated their exploitation, which is subject to a pre-authorization from the administration.	
Chapter 5 (comprises 34 articles)	Water exploitation	Defined all regulations and responsibilities for hydraulic works and concessions required for the exploitation of the public water estate.	
Chapter 6 (comprises 21 articles)	Water use and water quality	Emphasizes on water conservation, special measures for consumptive and potable water use and measures for agricultural use. Water use should be justified through economic assessment in order to ensure the preservation of water resources both in terms of quantity and quality.	

Reference	Focus	Content	Implementation Status
Chapter 7 (comprises 46 articles)	Water quality	Includes regulations for addressing water pollution and flood mitigation, and regulates treated wastewater use. Conditions of treated water reuse in agriculture are fixed by the Decree 89-1047, which describes the parameters to be analyzed and the list of crops that can be irrigated. A relevant decision of the Ministry of Agriculture describes in more detail the list.	
Chapter 8 (comprises 3 articles)	Water exploitation	Emphasizes on the creation and organization of user-associations and defined the tasks attributed to Groups of Hydraulic Interest (GIH). Article 154 was modified by the Law of July 6, 1987, which redefined the activities of associations of collective interest, called initially user-associations. Article 155 which was also modified by the same law, determined the regulations for these associations, which were approved by the Decrees of 12 January 1988 and of 21 December 1992. The framework provides associations with financial autonomy, as financial management was previously controlled by the government.	
Chapter 9 (comprises 5 articles)	Water law application	Determines jurisdictions and penalties for breach of the statutory provisions of the water law (code) and the decrees for its execution.	

2.3 Financial Framework

Governmental authorities involved in the financing of the investments in the water sector consist of the:

- Ministry of Finance,
- Ministry of Agriculture and Water Resources,
- Ministry of Environment and Sustainable Development,
- Ministry of Public Health,
- Ministry of Scientific Research, and
- Ministry of Economic Development and International Cooperation.

The implementation of the national water management strategy, formulated in 1990 and aiming at the integrated development of water resources required a total investment of 2 billion US$. The funds were made available through bilateral and multilateral cooperation programmes. Loans and donations were offered for different projects related to water resources exploitation, land and water conservation, sanitation, potable water production and agricultural water management by many international actors and agencies, such as the World Bank, the European Commission, the Japanese Bank for International

Cooperation, the African Development Bank, the Islamic Development Bank, the European Investment Bank, French Development Agency, German Bank (KFW), German Cooperation Agency (GTZ), Food and Agriculture Organisation of the United Nations etc.

The contribution of the private sector in the financing and operation of water infrastructure is limited to the maintenance of installations by local Development Groups of collective interest and to soil and water conservation structures consolidations by land-owners. Farmers finance on their own the excavation of wells and boreholes and are sometimes subsidised by the government, when a permit has been granted and the project has been approved by the authorities concerned.

3. Focal Problems in Water Management

3.1 Constraints facing the water sector

Natural

Similarly to the rest of Southern Mediterranean countries, the main concern of Tunisia with regard to water management is linked to droughts, their causes and impact mitigation.

The probability of 2 successive dry[19] years is relatively high (2-4 times/90 years in the northern and central part of the country and 6 times/90 years in the southern part). The succession of 3 years is less (1 time/90 years in the northern part and 2-3 times in the central and southern parts of the country). A succession of 4 dry years has not been registered yet. Rainfall occurs throughout the year but at times exhibits temporal instability.

The country is also affected by periodic floods, which are often catastrophic and supply additional water, which is difficult to manage.

The geologic formations of the central part of the country present high erosion risk. The majority of surface run-off is lost to the sea. Additionally, there are phenomena of land degradation and desertification after torrential rainfall events.

Technical

One of the major problems in the country is the reduction of surface water storage due to sedimentation, which decreases the dams' useful lifetime and limits their capacity. The situation is aggravated by the arid climate and torrential rainfalls, as well as the low vegetation density.

Water supply is at times intermittent, due to the reduction of available volume at the distribution level, resulting from damages in pumping equipment or conveyance networks.

Excessive application of chemicals, fertilizers and pesticides in agriculture results in water quality deterioration and pollution of groundwater resources by phosphates and nitrates.

The uncontrolled discharge from developing industrial sectors may lead to the pollution of rivers, water tables, lakes and the sea by liquid and solid wastes.

However, water pollution is still considered an accidental phenomenon and of less importance when compared to water shortage.

Irrigation methods applied in certain regions still result in overconsumption.

Earthquake risk is minor in Tunisia; however it should be taken into account in the design and construction of large dams.

Financial

Water is an economic good and its exploitation should be justified by the economic output of water use. However, it is widely acknowledged that priorities imposed by socio-economic considerations, such as supply of potable water and irrigation of crops of strategic importance should be respected.

[19] One dry year is defined as showing a deficit of at least 40% compared to the average. It should be noted that for a very dry year this deficit can exceed 60%.

The collection of fees from consumers is at times inadequate, resulting to the lack of financial resources for the development groups associations.

Administrative and Institutional

As a result of the current situation regarding socio-economic development and intensive exploitation of resources, many improvements should be made in the current water-related legislation, which focuses on the exploitation of resources, rather than demand regulation.

Lack of legislative measures promoting water conservation.

Lack of legislation for regulating the construction of infrastructure and improving the management of phreatic water tables, with the overall aim to protect groundwater resources from over-exploitation.

The open economy from one side and the scarcity of the resources on the other are bound to create competition in water use. This will eventually lead to the establishment of water markets, allowing for the exploitation of water by uses of high value and cause a shift towards a more economically efficient water allocation.

Transboundary groundwater resources are controlled at the national level, but not by neighbouring countries yet.

There is need to orient the water sector towards:

- Decentralisation in water management and participation of water users in decision-making.
- Integrated resource management.
- Resource conservation and environmental protection.

The inability to predict yearly rainfall variability complicates planning and management of droughts or water abundance.

3.2 Identification of focal problems

Sharing water

Water supply is subject to interruptions, due to the reduction of available supply at the distribution level. These more or less important incurred water shortages can have negative impacts on public health, the economy and the environment. The risk of water shortage is due to either the inadequacy of infrastructure or to natural phenomena, such as sedimentation in reservoirs or successive droughts, which were not taken into account in planning.

Rationalization of water use did not have notable effects on urban and rural population consumption. Only small variations in water quality were observed; however required standards for potable water quality were not exceeded. Deficits in surface water are usually met through the exploitation of groundwater resources.

Groundwater resources in the coastal areas of southern Tunisia often exhibit high salt concentration and can be used only after their desalination or for municipal uses such as irrigation of parks and green spaces and street cleaning. Such reserves are often encountered in deep aquifers. Exploitation costs are significant, when the piezometric level is deep and the specific yield is low.

Agriculture is the main water consumer; the situation will not be reversed up to 2030, and even if the growth of irrigated perimeters remains low during the period 2005-2030. In some regions, where at present irrigation remains an important water use, irrigated agriculture may disappear due to the low availability of water resources and the highly valued alternative land uses, which are the main factors affecting the viability of irrigated perimeters. However, irrigated agriculture can still be developed in other regions with high water availability if a more economically efficient allocation of other production inputs is attained.

Tunisia is bound to face a deficit between exploitable water resources and water demand. Such a deficit cannot be met through water conservation or non-conventional water resources, such as sea-water desalination and wastewater reuse.

Available resources in the country are more and more vulnerable to risks resulting from successive droughts and climate change.

Valuing water

With regard to irrigation water pricing, up to 1970 water was granted to farmers free of charge, with the aim to encourage agricultural activities and increase the value of agricultural land. Since 1970, public irrigation perimeters are managed by the National Agricultural Development Utilities, established at the governorate level or at the river basin level. At present, the real cost of water comprises operation and maintenance costs and the costs for the rehabilitation/renewal of infrastructure. The current governmental policy with regard to irrigation water pricing aims primarily at the recovery of operation and maintenance costs. The aim is to ensure the financial sustainability of water utilities, while at the same time provide better services to farmers. In 1996, the recovery of operation and maintenance costs reached a global equilibrium at the national level, due to the regular increase of 15% in irrigation water tariffs since 1991. However, the recovery of operation, maintenance and renewal costs did not exceed 60%.

Table 19: Comparison between regional water cost and tariffs (year 1996, values in TD)

Region	Cost	Tariff	Recovery (%)
North	0.079	0.073	92
Sahel	0.161	0.090	56
Centre	0.088	0.054	61
South	0.036	0.024	67
Tunisia	0.079	0.069	87

It is expected that future pricing policies for irrigation water will lead to the intensification of agricultural activities in the irrigated perimeters and orient farmers towards the application of water conservation measures.

Before 1968, water pricing was uniform for all users. After the establishment of SONEDE, a distinction was made between households, tourist facilities and the sugar, textile and steel industry. This approach prevailed up to 1974, when an IBT pricing system, distinguishing between consumption blocks and user

types was established.

Future pricing systems should maintain the concepts of social equity and access to basic water services, such as sanitation and health. At the same time they should not hinder economic development but also ensure financial sustainability of water service providers. The application of appropriate pricing policies may be beneficial in the exploitation of water in the agricultural, industrial and tourism sectors agriculture, industry and tourism.

There is need for the reorganisation of SONEDE and ONAS in order to ensure their financial autonomy, allowing also for the privatisation of (some) of their responsibilities. Such a reorganisation may be realised through the creation of large hydraulic regions.

Governing Water

The government should concentrate on the resolution of conflicts in water allocation at the regional and sectoral level and disengage from its role in intra-sectoral water allocation.

There is some overlap in responsibility between water authorities and water institutions; however responsibilities are generally complementary and coherently allocated.

Water sector investments are of national priority, ever since 1990, through the elaboration of 5-year round economic development plans. At the time being there is no problem with regard to the financing of water sector infrastructure.

4. Stakeholder Mapping

4.1 Description of main stakeholders

4.1.1 Constitutional level

The governmental authorities involved in water resources management are:

- **Ministry of Agriculture and Water Resources,** which undertakes all tasks related to water resource management and exploitation. The Ministry controls several institutes responsible for the assessment, monitoring and evaluation of water resources and for the construction, operation and maintenance of water works.
- **Ministry of Public Health,** whose central and regional services of the Ministry of the Public Health are responsible for monitoring the quality of potable water and treated wastewater used for irrigation, in order to prevent and eliminate water-related diseases and epidemics.
- **Ministry of Environment and Sustainable Development,** which undertakes through its three institutions (ANPE, ONAS and CITET) all tasks related to water pollution and quality.
- **Ministry of Technology and Communication**, which controls the National Institute and Meteorology, responsible for the monitoring of meteorological, oceanographic and seismic data.
- **Ministry of Scientific Research**, which controls the Research Centre on Water Technologies and the Arid Regions Institute.

The **governmental institutions** with a role in water management are extensively presented in Table 2. In brief they are:

- DGRE: General Direction of Water Resources
- DG/GREE: general Direction of Rural engineering and water exploitation
- DG/BGTH: General Direction of Dams and great hydraulic works
- SONEDE: National Company for Water Exploitation and Distribution
- DG/ACTA: General Direction of Agricultural land Management and Conservation
- INRGREF: Rural Engineering, Water and Forest National Research Institute
- CRTE: Research Centre for Sciences of Water technologies.
- IRA: Arid Regions Institute
- CNE: National Committee of Water
- CDPH: Commission of Public Hydraulic Estate
- SECADENORD: Exploitation of Conveyance Networks of the North.
- BIRH: Surveilling Office of Hydraulic Resource.
- ONAS: National Sanitation Utility
- ANPE: National Agency for Environment Protection
- CITET: Tunis International Centre for Environmental Technologies

4.1.2 Organisational and operational levels

Stakeholders acting at the organizational and operational level are described in detail in Table 2. In brief they are:

- CRDAs: Regional Department for Agriculture Development

- GIH: Group of hydraulic Interest.
- The Regional Directions of SONEDE
- The Regional Directions of ONAS
- GDA: Agricultural Development Groups

Table 20: Representatives of Citizen Groups, NGOs, Associations, Volunteers

Category/Group Name	**Number of Groups /Associations /Volunteers**	**Population/interested parties represented (in absolute and relative numbers - %)**
Citizen groups	N/A	N/A
Consumers Associations	1400	10%
Women unions	N/A	N/A
Small scale Farmers	N/A	N/A
Large scale Farmers	N/A	N/A
Hotel owners	N/A	N/A
Private company/Small Industry	N/A	N/A
Private company /Industry/exporters	N/A	N/A
NGOs (environmental organisations)	N/A	N/A
Associations of Farmers	570	15%
Associations of Hotel-owners	N/A	N/A
Associations of Industries	N/A	N/A
Hotel owners, NGOs, environmental organizations, small scale farmers etc.	70 (mixed)	N/A

Table 21: Policy Makers

Governmental Institutions	**Role/Main Activities in relation to water management**
Ministries	
Ministry of Agriculture and Hydraulic Resources	All tasks related to water mobilisation management and regulation
Regional Authorities	
CRDA's	Assess and monitor water resources in the region, realize irrigation and domestic water, disposes of water resources projects data base in the region

4.2 Summary of stakeholder interests

Table 22 outlines stakeholder interests. Contact information is presented in the Deliverable's Appendix.

Table 22: Stakeholder interests

Category/ Group	Interests in relation to water management, provision and pricing of water services	Potential impact to the application of institutional and economic instruments (+, - ,N/A)	Priorities of interest in relation to water management (1-lowest to 5 highest)	Relationship with other stakeholders (e.g. through partnership or conflict)
DG/RE	Water management	+	5	Partnership with SONEDE for raising awareness with regard to water management issues
DG/GREE	Water supply provision and pricing of water services	+	5	Partnership with SONEDE and consumer associations in rural areas for water management and distribution
DG/BGTH	Water management	+	5	Partnership with DG/GREE and SONEDE for water provision for domestic and irrigation purposes
SONEDE	Water supply provision and pricing of water services	+	5	Partnership with DG/GREE, DG/REE, SECADENORDS for water supply and pricing in the industrial, domestic and tourism sectors.
DG/ACTA	Water conservation	+	4	Partnership with CRDAs and small-scale farmer associations to construct small dams (reservoirs) to supply water for the irrigation of small perimeters.
ONAS	Water provision and pricing of water services	+	3	Partnership with DG/GREE, INERGREF, CRDAs and Ministry of Health to supply treated wastewater for irrigation.
INERGREF	Water research	+	5	Patrnership with DG/RE, DG/GREE and ONAS to control water quality
OTDE/ANPE	Natural resources and environmental protection	-	2	Partnership with CITET, ONAS, DG/RE and DG/BGTH to control water pollution

INSTITUTIONAL ANALYSIS AND FOCAL WATER MANAGEMENT PROBLEMS IN EGYPT AND IN THE BAHR-BASANDEILA REGION

Prepared by International Consultants-Egypt,
in collaboration with the Water Management Research Institute and
the Ministry of Agriculture and Land Reclamation

1 General Overview

1.1 Country overview

The Arab Republic of Egypt is located at the North-Eastern corner of Africa and, with an area of almost 1,000,000 km², occupies nearly 3% of the total area of the continent. Egypt measures 1262 km from west to east and 1073 km, between latitudes 22 and 32° N (Figure 29). This latitudinal location means that most of the country falls within Africa's dry desert region, except for a narrow strip along the northern coast, which experiences a Mediterranean type of climate.

These, relatively favourable climatic conditions, when compared to the desert areas of the south, have led to a concentration of rainfed agriculture in the north-west coastal region. Egypt is predominantly desert and only 5% of Egypt's total land is cultivated and permanently inhabited.

Figure 29: The Location of Egypt

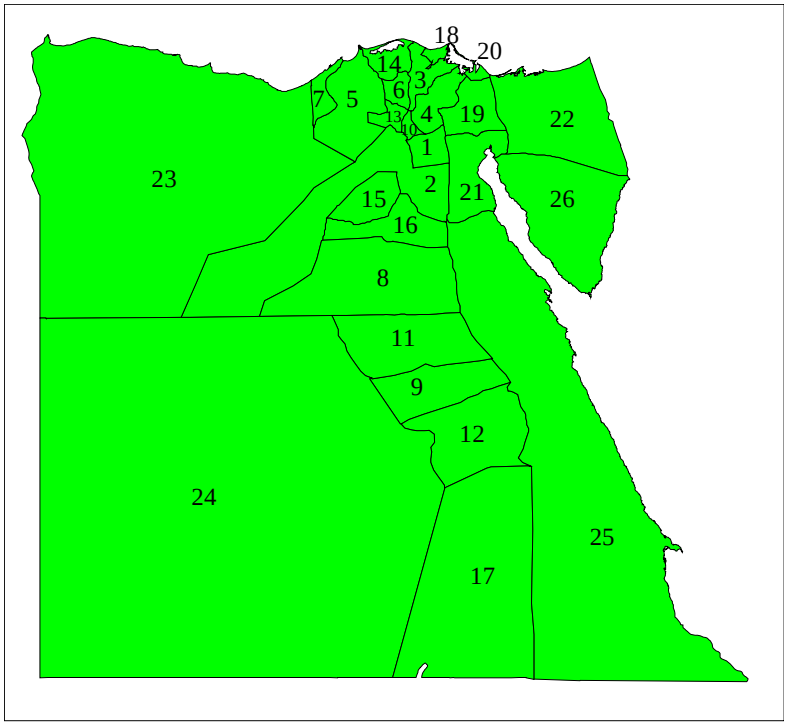
1.1.1 Physical Characteristics

Geography and Administration

Geographically, Egypt is divided into four regions:

- The **Nile Valley and Delta**, including Cairo, El Fayum depression, and Lake Nasser (3.6%);
- The **Western Desert**, including the Mediterranean coastal zone and the New Valley (68%);
- The **Eastern Desert**, including the Red Sea coastal zone and the high mountains (22%);
- The **Sinai Peninsula**, including the coastal zones of Mediterranean, the Gulf of Suez and the Gulf of Aqaba (6.4%).

The country is divided into 27 administrative Governorates. These governorates and their total area are illustrated in Figure 30.



Governorate ID	Governorate	Area (km^2)
GOV01	Cairo	457
GOV02	El-Giza	4840
GOV03	El-Dakahlia	3459
GOV04	El-Sharkia	4190
GOV05	El-Beheira	9504
GOV06	El-Gharbia	1943
GOV07	Alexandria	2879
GOV08	El-Minya	2263
GOV09	Sohag	1574
GOV10	El-Kaliobia	1001
GOV11	Assiut	1558
GOV12	Kena	12743
GOV13	El-Menoufia	2158
GOV14	Kafr El-Sheikh	3748
GOV15	El-Fayoum	4949
GOV16	Bany Swif	9576
GOV17	Aswan	34608
GOV18	Demiat	1029
GOV19	El-Ismailia	4483
GOV20	Port Said	1351
GOV21	El-Suez	25000
GOV22	North Sinai	31000
GOV23	Matroh	212000
GOV24	New Valley	376505
GOV25	Red Sea	130000
GOV26	South Sinai	28438
GOV27	Luxor City	55.4
Total Area (km^2)		**911311.4**

Figure 30: Administrative Governorates in Egypt and the Total Area of Each Governorate

Geomorphology and Geology

The landscape in Egypt can be broadly divided into the elevated structural plateaus and the low plains, which include the fluviatile and coastal plains (Figure 31). These geomorphologic units play a significant role in determining the hydrogeological context of the country and natural constraints facing population distribution. The structural plateaus constitute the active and semi-active watershed areas, whereas the low plains can contain productive aquifers and are also, in places, areas of groundwater discharge.

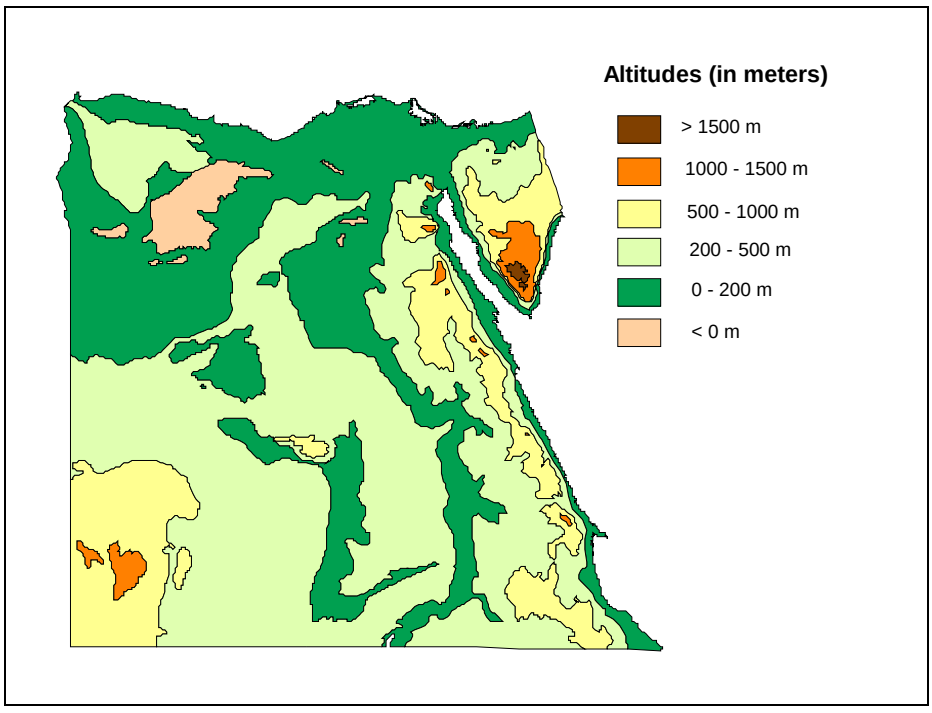


Figure 31: Topography of Egypt

Climate

Egypt lays in the dry equatorial region, except for its northern areas which lay in the moderate warm region, and have climate similar to the one of the Mediterranean region. The climate is characterized by hot dry summers, while winters are moderate with limited rain fall that increases in the coastal area. Overall, the country can be divided into six climatic districts (Figure 32):

(j) (1) Mediterranean District: It extends along the Mediterranean Sea with several kilometres to the interior. In summer, the mean temperature is about 23°C while during winter it is about 14°C. This district is the rainiest (100-190 mm/yr).

(k) (2) Nile Delta District: It lies to the south of the Mediterranean District. The mean temperatures are 13°C (January) and 27°C (July). In this district the annual average amount of rainfall decreases sharply to the range of 20-50 mm/yr.

(l) (3) Sinai Highlands District: It includes the highlands of Sinai. The weather of this district differs from other parts of Sinai in temperature and rainfall amount. It is colder with a minimum of 10°C difference in temperature. Rainfall reaches the amounts of the Mediterranean district.

(m) (4) Middle Egypt District: It lies between Cairo and Assiut and extends up to the borders of the country in the west and to the highlands of the Red Sea in the east. During the winter, it is the coldest district, whereas the average temperature in the summer is equal to 30°C on average. Annual average rainfall is very limited (< 10 mm).

(n) (5) Upper Egypt District: It extends from the south of Assiut to the southern borders. Rainfall is rare and the difference between the day and night temperature can exceed 18°C (desert area).

(o) (6) Red Sea District: The region of Red Sea highlands differs climatically from other neighbouring low lands, being colder and rainier.

Overall, summer temperatures are extremely high, reaching 38°C to 43°C with extremes of 49°C in the southern and western deserts. The northern areas on the Mediterranean coast are much cooler, having a maximum temperature of 32°C. Around April, a hot windstorm, the “Khamsin”, sweeps accross the country. Its driving winds blow large amounts of sand and dust at high speeds. The khamsin may cause temperatures to rise to as much as 38°C, and hot winds can damage crops.

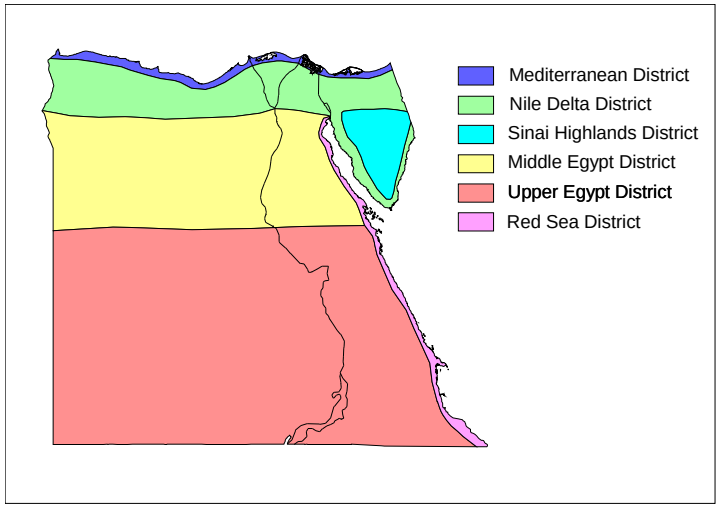


Figure 32: The climatic districts of Egypt

Hydrology

The hydrogeological framework of the country comprises six aquifer systems as shown in Figure 33:

a) 1. The Nile Aquifer System, assigned to the Quaternary and Late Tertiary, which occupies the Nile flood plain region (including Cairo) and the desert fringes.
b) 2. The Nubian Sandstone Aquifer System, assigned to the Palaeozoic-Mesozoic, which mainly occupies the Western Desert.
c) 3. The Moghra Aquifer System, assigned to the Lower Miocene, mainly occupying the western edge of the Delta.
d) 4. The Coastal Aquifer Systems, assigned to the Quaternary and Late Tertiary, and occupying the northern and western coasts.
e) 5. The Karstified Carbonate Aquifer System: assigned to the Eocene and to the Upper Cretaceous, which outcrops in the northern part of the Western Desert and along the Nile system.
f) 6. The Fissured and Weathered Hard Rock Aquifer System: assigned to the Pre-Cambrian, which outcrops in the Eastern Desert and Sinai.

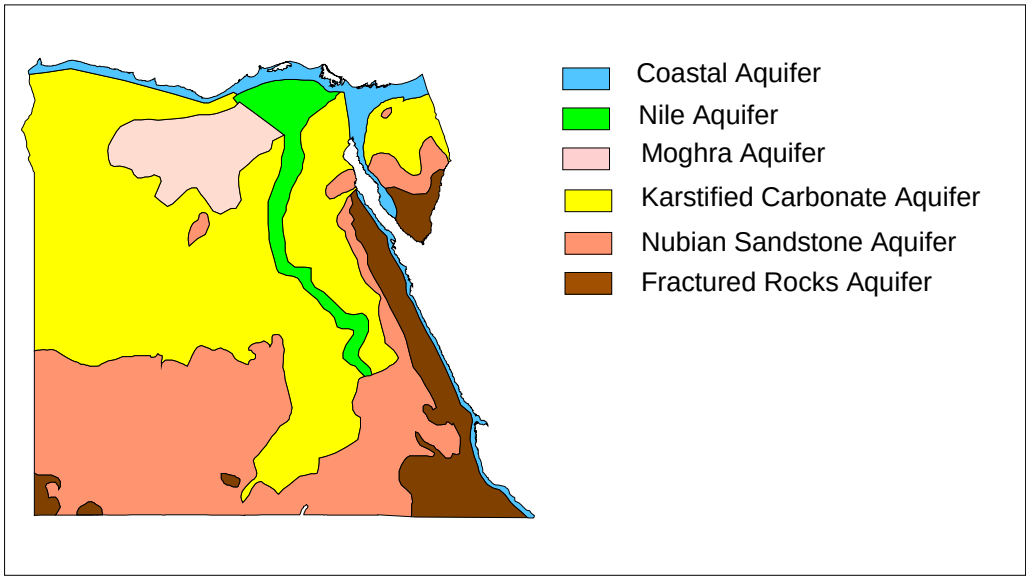


Figure 33: Surface Distribution of Main Aquifer Systems

1.1.2 Demographic characteristics

The total population of Egypt is estimated at about 74 million people, with an average annual growth rate of 1.91% (2005). The rural population corresponds to 58% of the total. The average population density is 74 inhab/km². However, approximately 97% of the total population resides along the Nile Valley and Delta. In those areas, population density exceeds 1,165 inhab/km², while in the desert regions it drops to only 1.2 inhab/km².

The following charts and tables present indicators relevant to the demographic characteristics of the country, including education, life expectancy and mortality and education.

Table 23: Population Indicators

Indicator	**1991**	**2004**
Population (million)	54.08	70*
Annual population growth rate (%)	2.28	1.94
Annual Number of household (million)	10.7**	15.1*

** Jan. 2005 ** 1992*
Source: The Central Agency for Public Mobilization and Statistics (CAPMAS)

Table 24: Life Expectancy and Infant Mortality Rate

Indicator	1994	2004
Life Expectancy (years): Male	64.2	68.4
Life Expectancy (years): Female	68	72.8
Infant Mortality Rate; less than one year (per thousand)	30.8*	21.9**

**1993/1994 ** 2003*

Source: The Central Agency for Public Mobilization and Statistics (CAPMAS)

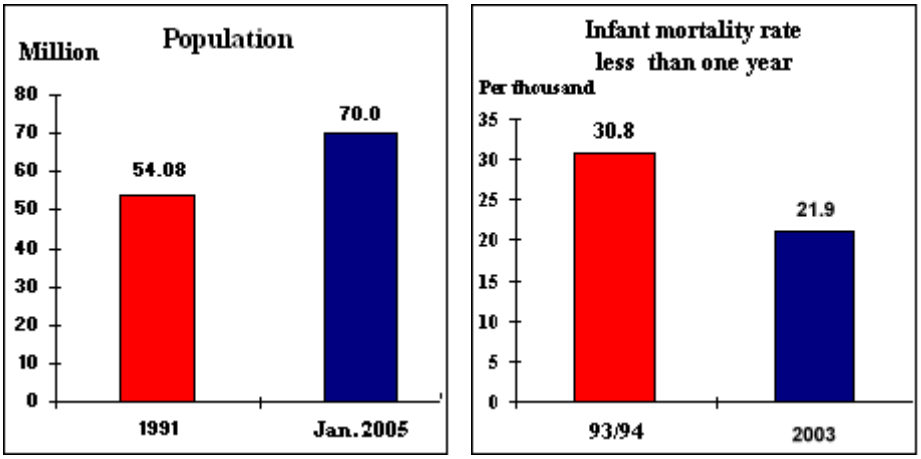


Figure 34: Population and Infant Mortality Rate Indicators (Source: The Central Agency for Public Mobilization and Statistics-CAPMAS)

Table 25: Education Services' Indicators

Indicator	1991/1992	2004/2005
Total number of students (million)	13.6	19.6*
Students enrolled in pre-universities education (million)	12.8	16.9**
Students enrolled in university and higher education (million)	0.8	2.5*
Number of classrooms in pre-university education (thousand)	309	436
Education expenditure as a percentage of GDP (%)	3.4	6.1**

** targeted ** 2003/2004*

Source: Ministry of Higher Education, Ministry of Education & Ministry of Planning

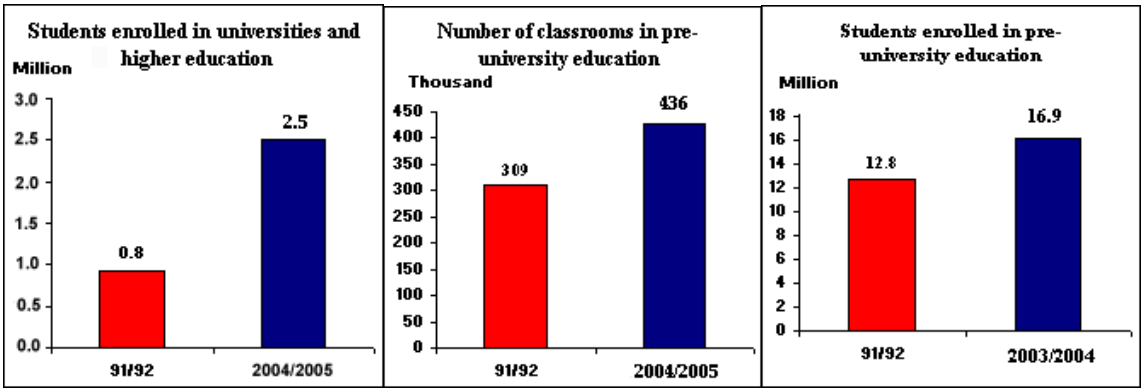


Figure 35: Education Services' Indicators
(Source: Ministry of Higher Education, Ministry of Education & Ministry of Planning)

1.1.3 Major Economic Characteristics

Between 2000 and 2003, the national economy has had an average 3% annual GDP growth rate, experiencing a drop, as a result of September 11th, recent regional political instability and economic reforms. This growth was insufficient to let the economy take off and unemployment, which is officially 10.7% and unofficially exceeds 20%, has maintained its increase. However, a moderate recovery has started in 2004, when GDP grew at a rate of 3.7%. In 2005, economic growth reached 4.8%. The appreciation of the Egyptian Pound has contributed to the drop of inflation rate (8.8% in 2005 vs. 11.3% in 2004).

Table 26: GDP Indicators

Indicator	1991/1992	2004/2005
Inflation rate - Annual average (%)	21.1	4.7*
Annual real GDP growth rate (%)	2	4.9**
Private sector's contribution to the GDP (%)	61.2	72***
Budget deficit / GDP (%)	6.4	5.9****
GDP at Market Prices (Current Prices) (L.E. billion)	139.1	558**

** July 2005 - the base year is 1999/2000 ** expected *** targeted **** estimated*
Source: Ministry of Planning, Central Bank of Egypt (CBE), Ministry of Finance and CAPMAS

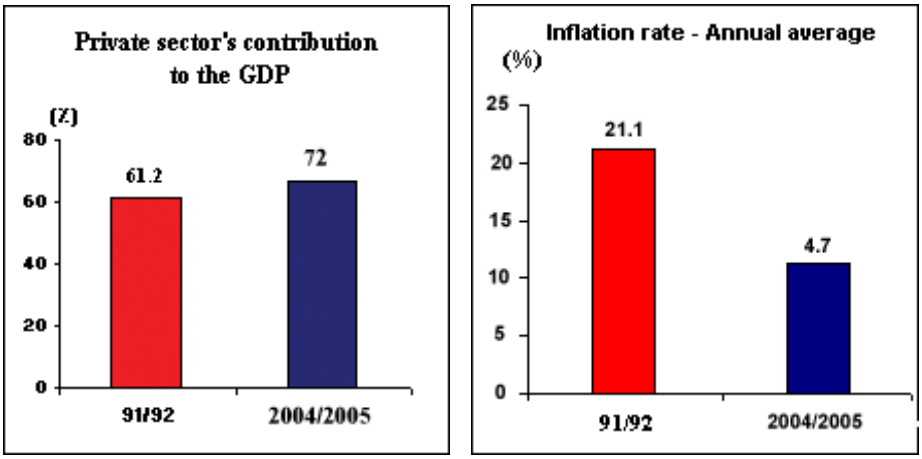


Figure 36: GDP Indicators (Sources: Ministry of Planning, Central Bank of Egypt - CBE, Ministry of Finance and CAPMAS)

Agriculture employs 35% of the active population and contributes to 17% of the GDP. The main crops are cereals, cotton and sugar cane. Egyptian hydrocarbon reserves are significant, and in the long run, gas could replace oil, which is declining. In the manufacturing sector, the food processing industry has developed considerably and now provides 17% of the GDP. Maritime freight ensures 80% of the country's exchanges. Tourism and rights of passage on the Suez Canal are the country's main foreign currencies resources.

Table 27: Other Economic Indicators

Indicator	1991/1992	2003/2004
Foreign currency reserves in the Central Bank (US$ billion)	10.6	14.8
Total outstanding debt (US$ billion)	32.6	28.9
Total external debt service / exports of goods & services (%)	21	10.8*
Current account balance (US$ billion)	2.7	3.4*

** Preliminary Figures*
Source: Ministry of Planning, Central Bank of Egypt (CBE), Ministry of Finance and CAPMAS

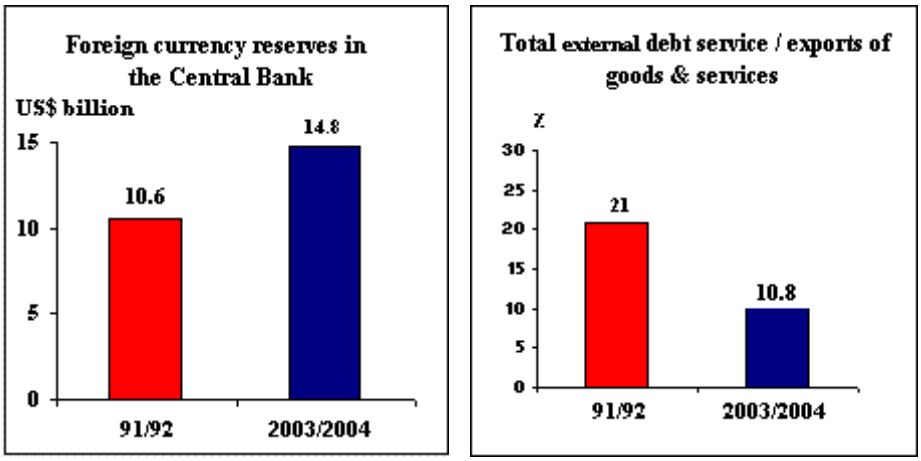


Figure 37: Other Economic Indicators (Source: Ministry of Planning, Central Bank of Egypt (CBE), Ministry of Finance and CAPMAS)

The Egyptian market has gradually been opening up, especially after the signature of the EU-Egypt Association Agreement in June 2001, which became effective in June 2004. The country's top export partners are India, the United States and the United Kingdom. Its top import partners are the United States, Italy and Germany. Egypt mainly imports consumer and capital goods, cereals and chemicals. Overall, the national economy is based on agriculture, industry, income from the Suez-canal and tourism, as well as petroleum.

In 2003, the **agricultural sector** accounted for 16.81% of Egypt's GDP and employed about 31% of the total labour force, of which 49% were female. In 1997, 99.8% of the total agricultural land was irrigated, as even the more humid area along the Mediterranean coast requires supplementary irrigation to produce reasonable yields. The agricultural sector is characterized by smallholdings: about 50% of holdings have an area of less than 0.4 ha (1 feddan). The areas under cultivation include arable lands and those with permanent crops, and represent a total area of 3,300,000 ha.

The agricultural sector faces a serious threat from farmland urbanization. It is prohibited by law to construct any buildings on farmland without a license from the Ministry of Agriculture and Land Reclamation, and violators are prosecuted and face serious penalties.

With regard to fisheries, the production of shellfish, mollusks and cephalopods is estimated at 12,176 tons, whereas the production of saltwater fish is estimated at 129,896 tons. Production from aquaculture is equal to at 309,576 tons.

Table 28: Agricultural sector indicators

Indicator	1991/1992	2004/2005
Cultivated area (million feddan)	7.1	8.3
Cropped area (million feddan)	12.5	14.6
Wheat productivity/feddan (ardab)	14.72	18.2
Agricultural sector share of GDP (%)	16.5	13.9
Value of agricultural production (L.E. billion)	30.1	96.5
Value of agricultural export (L.E. billion)	1.4	5.8

Source: Ministry of Agriculture and Land Reclamation & Ministry of Planning

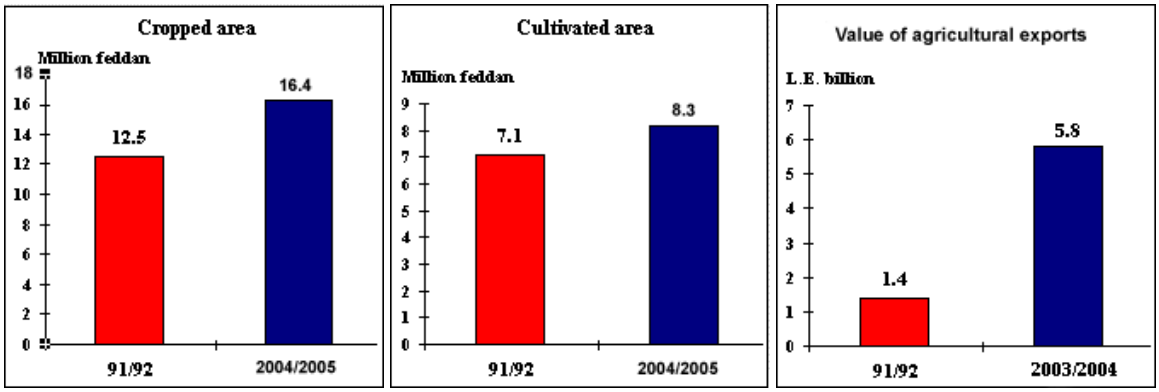


Figure 38: Agricultural sector indicators (Source: Ministry of Agriculture and Land Reclamation & Ministry of Planning)

Throughout the years, farming has drawn significant attention from authorities, which has led the implementation of policies encouraging investments for improving food sufficiency. With regard to irrigation, investments are constantly increasing. In 1997, President Moubarak inaugurated the project for the development of the Nile Valley. This zone, with a total area of 100,000 ha, was formerly desert and unexploited. Foreign investments are exempted from taxes for the next 20 years, starting from the early beginning of the exploitation.

Egypt is self-sufficient in almost all agricultural commodities with the exception of cereals, oil and sugar. However, these exceptions make the country one of the world's largest food importers. Agricultural imports in 2001 included 4.4 million tons of wheat and wheat flour, 4.7 million tons of yellow maize, 0.6 million tons of vegetable oils and 0.4 million tons of sugar. On the other hand, the main export crops were 53,000 tons of cotton, 444,000 tons of rice, 176,000 tons of potatoes and 37,000 tons of citrus.

Table 29: Crop-Yield Indicators

Crop	Yield (Metric Tons)	Surface (hectares)	Yield (hectograms/hectares)
Wheat	6,564,050	1,050,000	62,515
Rice Paddy	5,996,830	660	90,861
Corn	6,394,830	730	87,6
Potatoes	1,783,640	83	214,896
Watermelons	1,506,960	56	269,1

Source: Ministry of Agriculture and Land Reclamation

Table 30: Livestock Indicators

Livestock type	Headcount
Ovine races	4,450,000
Goats	3,300,000
Buffaloes	3,200,000
Cattle	3,180,000
Pigs	29,5

Source: Ministry of Agriculture and Land Reclamation

The geographic position of Egypt, its natural assets and old civilization have been the basis for the development of **tourism**, where the combined effort of the State and the public was concentrated. In

2005 the total number of visitors was estimated at 8.7 millions. The main tourist sites are Cairo, Alexandria, Luxor, Aswan and Sinai.

Table 31: Tourism Sector Indicators

Item	1991/1992	2004/2005
Number of hotels, tourist villages and floating hotels (hotel & village)	663 *	1207**
Number of rooms in hotels, tourist villages and floating hotels (thousand)	54.7	136.5***
Number of tourists (million)	3	8.7
Number of overnight stays (million)	20.2	85.7

** 1992 ** until Dec.2004 *** until Dec.2003*
Source: Ministry of Tourism

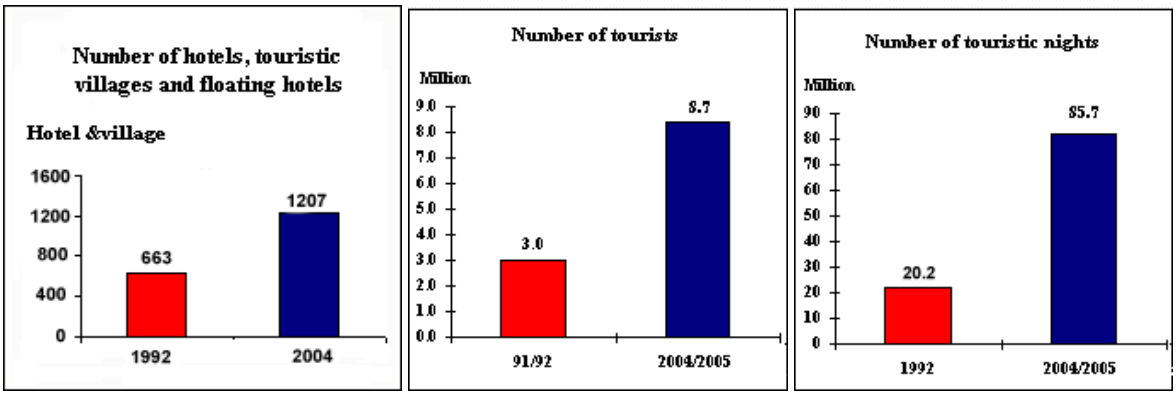


Figure 39: Tourism Sector Indicators (Source: Ministry of Tourism)

Egypt is endowed with significant quantities of important metals such as phosphates, raw iron and oil. The manufacture **industry** consists of textiles, food processing, construction material and glass, ware, mechanic and electric products and chemicals. The non-manufacture industry consists of mine, energy, electricity, waters, constructions and public works.

Table 32: Industry Sector's Indicators

Indicator	1991/92	2004/2005*
Actual cement production (million tons)	14.9	32.5*
Actual reinforced steel production (million tons)	0.94	4.7*
Industrial sector share of GDP (%)	16.6	19.3**
Exports of manufactured commodities (L.E. billion)	5	21.7*
Number of industrial zones	26	90*

** estimated ** targeted*
Source: Ministry of Foreign Trade and Industry and Ministry of Planning, CAPMAS

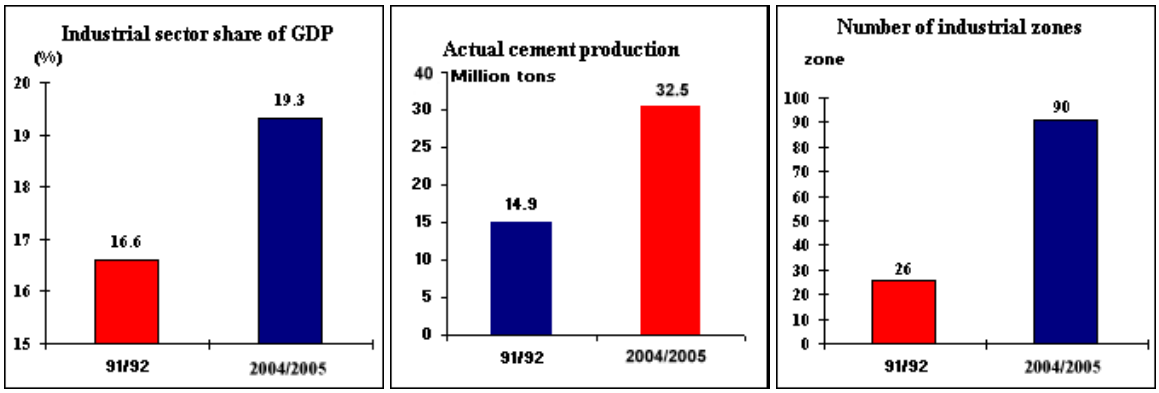


Figure 40: . Industry Sector's Indicators (Source: Ministry of Foreign Trade & Industry and Ministry of Planning, CAPMAS)

1.1.4 Hydrological balance

Overall, water resources are becoming increasingly scarce. Surface-water resources originating from the Nile are now fully exploited, while groundwater resources are limited. Furthermore, the country is facing increasing water needs, demanded by a rapidly growing population, increased urbanisation, higher standards of living and an agricultural policy which emphasises production growth in order to ensure food security and sufficiency.

Water supply

Surface water resources are limited to the country's share of the flow of the River Nile. In accordance with the terms of the 1959 Nile water agreement between Egypt and Sudan, Egypt's present annual share downstream of the Aswan Dam is 55.5 billion m³. The High Aswan Dam, commissioned in 1968, provides inter-annual storage to guarantee regulated water supplies, and this Nile Water discharge constitutes more than 95 % of the total national water supplies.

The Nile River enters Egypt at its southern boundary with Sudan and runs through a 1000 km long narrow valley, which varies between 2 and 20 km in width. Then, it is divided at a distance of 25 km north of Cairo into two branches (Damietta and Rosetta) forming a delta resting with its base on the Mediterranean shores (Figure 41). The lengths of the Damietta and Rosetta Branches are 250 km and 239 km, respectively. The Delta expands from south to north for about 200 km and its base is about 300 km long, from Alexandria to Port Said.

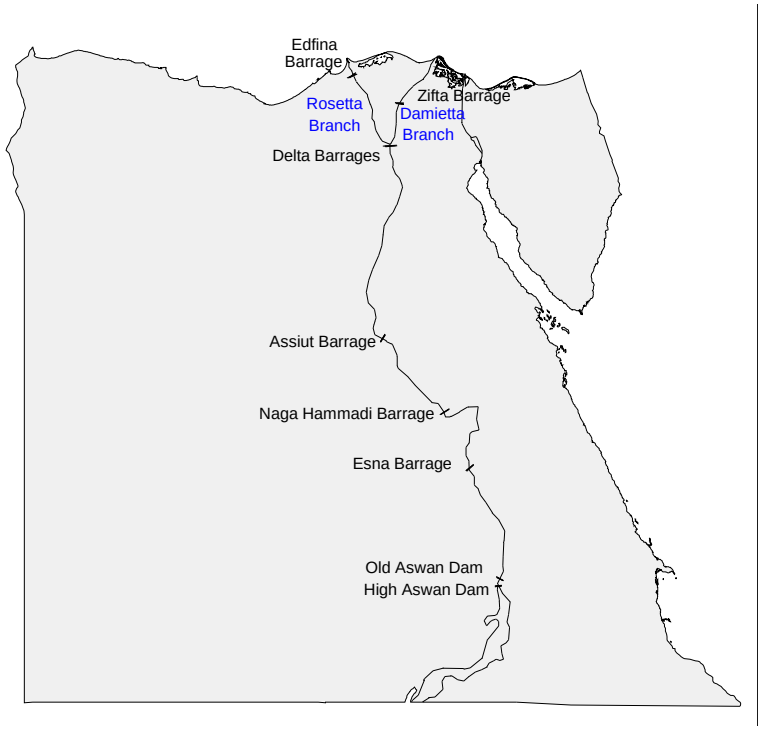


Figure 41: The Nile, its branches and main hydraulic infrastructure

The rainfall is typical of arid regions, limited, irregular and unpredictable. This means that in the North a few days of rainfall are distributed from November to March. The mean annual rainfall of 18 mm ranges from 0 mm/yr in the desert to 200 mm/yr in the northern coastal region (Figure 42). Rainfall on the Mediterranean coastal strip decreases eastward from 200 mm/year at Alexandria to 75 mm/yr at Port Said. It also declines inland to about 25 mm/yr near Cairo and 1 mm/yr at Aswan. Significant rainfall intensity is recorded on parts of Red Sea coast, and the most southern part of the country, on the boarder with Sudan, is marked with those phenomena. Rainfall intensity of 500 mm/yr in the neighbouring area has also been observed. The total amount of rainfall is equal to 1.8 billion m^3/yr in the aforementioned regions.

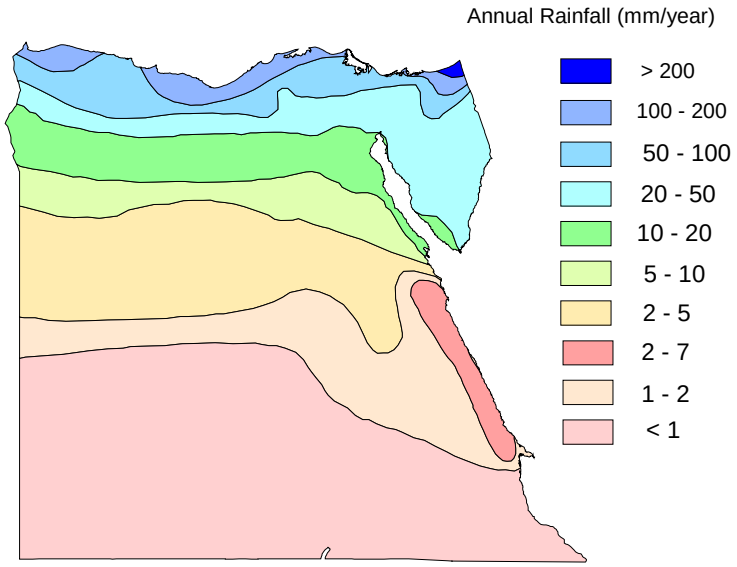


Figure 42: Annual rainfall (mm/Year)

The groundwater aquifer underlying the Nile Valley and the Delta is entirely recharged and dependent on deep percolation of irrigation water and seepage for the irrigation system. Some limited renewable and non-renewable groundwater reserves within the Western Desert and Sinai are currently used and the potential for future water supply depends on its financial feasibility.

The Nile system below Aswan can be considered a closed system with inflows only from the High Aswan Dam. Outflows are crop evapotranspiration, non-recoverable municipal and industrial water consumption, evaporation, drainage of agricultural water to the sea, and non recoverable inland navigation water released to the sea. In this perspective, groundwater extraction and reuse of drainage water can be considered as options for increasing the overall efficiency of the system and not as additional resources. The exact nature and details of these inter-relations are not clear yet. A new factor that adds to the complexity of the issue is the change in water quality, which are the focus of research studies presently carried out by the National Water Research Center (NWRC).

Table 33: Water Resources

Source	**Available water resources (km³)**
Nile Water (including Jonglei –1)	57.50
Ground water (Nile aquifers)	07.50
Ground water (in desert and Sinai)	03.77
Drainage reuse in delta	08.40
Savings due to changes in cropping patterns	03.00
Irrigation improvement	04.00
Waste water use	02.20
Flash flood harvesting	01.50
Total	87.67

Source: Ministry of Water Resources and Irrigation (MWRI)

Water Demand

Most of the cultivated lands are located near the Nile banks, its main branches and canals. Currently, the inhabited area is about 12.5 million feddans, and the irrigated agricultural land is about 7.85 million feddans (1 feddan = 1.04 acres). In 2000, the average annual water for **agricultural use** was estimated at 59.9 km³. Future agricultural water requirements will address two types of needs: those for the irrigation of existing lands and those for their expected expansion.

In 1997, two main land reclamation projects were launched: (a) the one of El-Salam Canal (west of Suez Canal) and El-Sheikh Jaber (east of Suez Canal), aimed at reclaiming about 620,000 feddans and (b) the El-Sheikh Canal for reclaiming about 500,000 feddans in the south of the New Valley. For 2025 agricultural water requirements are estimated at 69.43 km³ in total.

The total **municipal water requirements** was estimated to be 4.5 km³ in 2000. A portion of the water is actually consumed; the remainder returns back to the system (either to the sewerage system or by seepage to the ground water). For 2025, domestic water needs are estimated at 6.6 km³. **Industrial water requirements** in 2000 were equal to 7.8 km³ and will increase to 10.56 km³ in 2025.

The River Nile and part of the irrigation network are also used for **navigation**, when the discharge for meeting other agricultural demands is too low but provides the minimum draft required by ships and boats. At present, there are no particular releases for **hydroelectricity** production; release for irrigation , municipal, industrial and navigation purposes are regulated by the High Aswan Dam, where the

hydroelectric power plant is located. The water requirements for the different water uses are presented in Table 34, which also presents the corresponding projections for 2025.

Table 34: Water Requirement for Different Sectors

Sector	Demand in 2000 (km³)	Demand in 2025 (km³)
Agriculture	60.7	69.43
Domestic water	4.5	6.6
Industry	7.8	10.56
Navigation	0.3	0.3
Total	73.3≈73	86.89≈87

Source: Ministry of Water Resources and Irrigation (MWRI)

1.1.5 Main Water Infrastructure

Dams

The High Aswan Dam (HAD) has been implemented as a long-term storage reservoir to ensure a constant and regular inflow for both Egypt and Sudan. However, the drought period that prevailed in the region from 1979 and lasted for nine uninterrupted years has seriously affected the storage in the High Dam Lake Reservoir. This motivated the State to develop different scenarios for facing the probability of a recurrence of such a catastrophe.

Figure 43: The High Aswan Dam (HAD)

Some of the alternatives were to consider reducing, as much as possible, rice and sugarcane cultivation, to minimize water requirements for different uses, and to generate electricity during the winter closure period.

Furthermore, the Government is studying alternatives for storing fresh water, which is discharged to the sea during the winter months, and reusing it for irrigation purposes. Along these proposals and plans, new laws and regulations for water use and for the coordination between Ministries, authorities and end-users are being considered. In order to discuss future water policies, a Ministerial Committee was formed, headed by the Minister of MWRI, and including representatives from all agencies concerned.

The Irrigation Systems

The farmland of the Nile Basin is dissected by a complex network of irrigation canals and drains. The major irrigation canals originate from the Nile or its Damietta and Rosetta branches, and are repeatedly divided to bring fresh water to every field. Smaller drains collect excess irrigation water from farm plots and discharge it to larger drains which release their water into depressions, such as the Wadi Rayan in the Western Desert, or into the brackish lakes of the northern Delta.

There are efficient drainage institutions supporting this programme's implementation, research and training aspects. The Drainage Research Institute of the National Water Research Center supports research in the field of drainage, whereas the Drainage Training Center deals with drainage technology and applications. The Egyptian Public Authority for Drainage is the main organization dealing with implementation of drainage projects.

Irrigable land is estimated at 4,420,000 ha. The total area equipped for irrigation was 3,422,178 ha in 2002; 85% of this area is located in the Nile Valley and Delta. Rainwater harvesting is practiced in about 133,500 ha in Matruh and North Sinai. All irrigation is of full or partial control. In 2000, surface irrigation was practiced on 3,028,853 ha, while 171,910 ha were under sprinkler irrigation and 221,415 ha under drip irrigation.

Surface water was the supply used for 83% of the irrigated area in 2000, while 11% (361,176 ha) of the area was irrigated with groundwater in the provinces of Matruh, Sinai and New Valley. The remaining 6% (217,527 ha) was irrigated with different sources.

With regard to drainage, the system of open drains has been under construction since the start of the 20th century, but the network did not solve the problem of waterlogging and salinity. To overcome these problems, subsurface drainage was found necessary to control the groundwater, and a corresponding National Drainage Programme has been carried out over the last 4 decades. At present, the drainage system consists of open drains, sub-surface drains and pumping stations. In 2003, slightly over 3 million ha of the total irrigated area were drained, of which about 2.2 million ha with sub-surface drainage. The sub-surface drained area represents more than 65% of the total cultivated area. There are 99 pump stations devoted to the pumping of drainage effluent. The gravity-drained area was estimated at about 1.65 million ha in 2000. Drainage water from agricultural areas on both sides of the Nile Valley is returned to the River Nile or main irrigation canals in Upper Egypt and in the southern Delta. Drainage water in the Delta is pumped back into irrigation canals for reuse, pumped into the northern lakes or discharged the Mediterranean Sea.

Table 35: Irrigation infrastructure data

Indicator	1991/92	2004/2005
Length of uncovered canals (thousand km.)	29.1	23.2
Area served with covered drainage (million feddan)	3.8	5.5
Length of drainage (thousand km.)	16.7	21.5

Source: Ministry of Water Resources and Irrigation (MWRI)

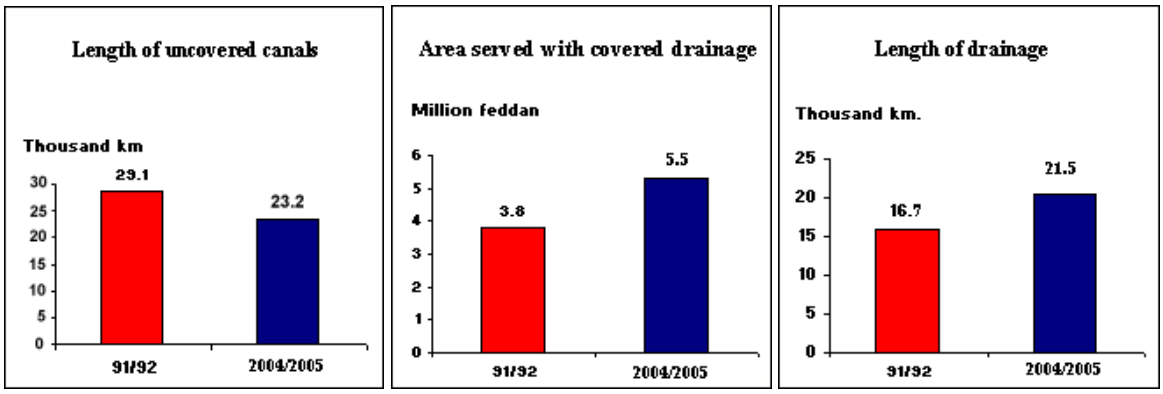


Figure 44: Length of Uncovered Canals and Area Served with Covered Drainage (Source: Ministry of Water Resources and Irrigation)

1.1.6 Transboundary water management

Under the 1959 Nile Waters Agreement between Egypt and Sudan, Egypt's share of the Nile flow is 55.5 km³/yr. The agreement was based on the average flow of the Nile during the period 1900-1959, which was equal to 84 km³/yr in Aswan. Average annual evaporation and other losses from the Aswan High Dam and reservoir (Lake Nasser) were estimated at 10 km³/yr, leaving a net usable flow of 74 km³/yr, of which 18.5 km³/yr was allocated to Sudan and 55.5 km³/yr to Egypt. If conditions permit the completion of the development projects on the Upper Nile, Egypt's share in the Nile water will increase by 9 km³. This amount includes 1.9 km³ and 1.6 km³ respectively from the first and second phases of the Jonglei canal project in southern Sudan. Two other projects in the upstream swamps are expected to provide 5.5 km³.

In 1998, and recognizing that cooperative development was the best way to bring mutual benefits to the region, all riparian countries (except for Eritrea which had only an observer status) joined in a dialogue to create a regional partnership to facilitate the common pursuit of sustainable development and management of the Nile waters. The transitional mechanism, the Nile Basin Initiative (NBI), was officially launched in February 1999 in Dar es Salaam of Tanzania, by the Council of Ministers of Water Affairs of all the Nile Basin States. The shared vision of the NBI is *"to o achieve sustainable socio-economic development through the equitable utilization of and benefit from the common Nile Basin water resources"*.

The first meeting of the International Consortium for Cooperation on the Nile (ICCON) took place in 2001 in Geneva, Switzerland to celebrate cooperation between the ten countries of the Nile Basin and to establish partnerships leading to sustainable development and management of the Nile River for the benefit of all. This ICCON's first meeting was a major milestone for the NBI as it brought together, for the first time, ministers and senior officials from Nile Basin countries with a broad range of bilateral and multilateral donors and other interested parties from civil society, professional organizations, the media and NGOs.

Finally, the vast Nubian Sandstone aquifer is shared with the Libyan Arab Jamahiriya, Sudan and Chad.

1.2 Overview of the Bahr-Basandeila Region

The Basandeila Region, the area selected for the implementation of INECO in Egypt, is located in the Dakahlia Governorate, and includes three large villages: El Hawadaia, Damlash and El Gawadia, in addition to 16 smaller ones (Figure 45). The total area of the region is estimated at 5739 feddans, whereas the cultivated area is estimated at 5524 feddans, representing 96.3% of the total area. The total population of the region is estimated at 45000 inhabitants.

The total length of water canal network that covers the region, originating from the Bahr Basandeila Canal is estimated at 12 km, whereas the length of the drainage network is estimated at 8 km.

Figure 45: The location of the Basandeila Region

The main water resource for the region is Bahr Basandeila Canal, which receives water from Bahr Shibin, from El Rayah El Abbassy Canal, from Damietta Branch of the River Nile.

Bahr Basandeila Canal is located at the end of Bahr Shibin Canal (Figure 46). This canal irrigates a cultivated area estimated at 3000 acres in Basandeila Village (the main village irrigated by Basandeila Canal), reporting a population estimated at 25,000.

The region experiences significant water quality problems, similar to those encountered in the entire River Nile distribution network. Waste disposal, heavy use of pesticides, inadequate domestic wastewater treatment, and uncontrolled discharge of industrial effluents have transformed open waterways to repositories and conveyors of liquid waste, and have created major pollution issues. In the region of the Bahr Basandeila Canal, water pollution is mostly due to the discharge of industrial and municipal effluents without prior treatment.

Furthermore, current agricultural practices, including the excessive application of fertilizers and pesticides, result in high nutrient concentrations in the canal surface water, and exacerbate eutrophication and water quality deterioration. Large amounts of wastewater (domestic, industrial, and agricultural) are discharged onto land, and from the Bahr Basandeila canal end up in the Damietta

Branch of the River Nile, posing a serious threat on human health, agricultural production, and the river and coastal ecosystems.

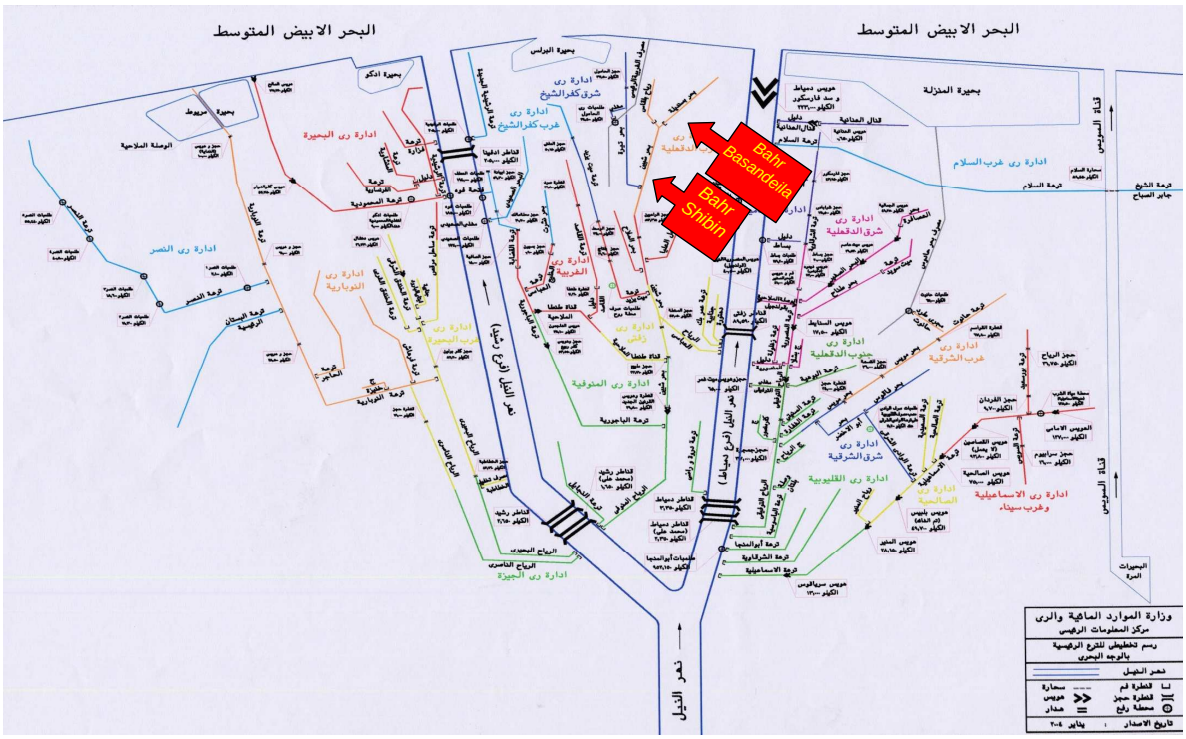


Figure 46: The location of the Bahr Shibin and Bahr Basandeila Canals

2. Institutional and financial context

2.1 Overview

Water management falls under the responsibility of several Ministries, the most important ones being the Ministry of Water Resources and Irrigation (MWRI), the Ministry of Agriculture and Land Reclamation (MALR), and the Ministry of Housing, Utilities & Urban Development; (MHUUD). Other ministries with a role in water policy formulation and secondary water management operations are the Ministry of Health and Population (MoHP), the Ministry of State for Environmental Affairs, and the Ministry of Local Development (MoLD)

The Government has indicated its intention to shift emphasis from its role as the central (or sole) actor in developing and managing water supply systems, and promote participatory approaches in which water users will play an active role in the management of irrigation systems and cost sharing. In this perspective, important institutional and legislative measures were recently implemented, in order to promote the establishment of sustainable participatory irrigation management (PIM) associations. However, despite those efforts, the development of water users' associations (WUAs) as effective partners in irrigation management remains at an early stage.

In the newly reclaimed lands, the concept of PIM is not yet fully operational for a variety of economic, financial and institutional reasons. While most parties involved recognize the importance of WUAs in the equitable distribution of available water, the uneven water availability, either due to deficiencies in infrastructure design or to the slack enforcement of rules against excess abstraction by front-end water users, has in many cases been a disincentive to the successful operation of WUAs.

There are numerous laws and rules prohibiting certain water use and abuse activities. Yet enforcement remains weak. This is a principal institutional constraint to improved water management. MWRI derives its legal mandate as the lead governmental body for the water sector from Law 12/1984 on Water Management (primarily dealing with water for agriculture) and Law 48/1982 on Protection of the River Nile and its Waterways from Pollution. The Ministry of State for Environmental Affairs and its subsidiary body the EEAA also exert considerable influence over water quality management through authorities vested through Law 4/1994 on Environmental Protection. The principal laws governing water management include:

- **Water Quantity Issues:** Law 12/1984 and its supplementary Law 213/1994 provide the basic legal structure for water quantity issues. The basic law defines the use and management of the public and private sector irrigation and drainage network structures, including main canals, feeders, drains and tile drains. It also provides legal direction for the use and maintenance of public and private canals and specifies arrangements for cost recovery in irrigation and drainage works. In addition to Nile surface water delivery, the law also regulates groundwater and drainage water; protection against flooding; navigation; and coastal protection.
- **Nature Protection:** Law 102/1983 delineates nature protection areas, forbids actions that lead to destruction of the natural environment, including marine and freshwater, and proscribes fines and penalties for violators. Under this Law, the Government can pursue damage assessments for harms to the environment.
- **Wastewater Discharges into the Sewerage System:** Law 93/1962 establishes standards for wastewater discharged into the sewerage system.

- **Regulation of Water Resources and Treatment of Wastewater:** Law 27/1978 regulates public sources of drinking water. It instructs and empowers the MHP to set standards for potable water.
- **Protection of the River Nile and Its Waterways:** Law 48/1982 regulates the discharge of waste and wastewater into the Nile and its waterways and sets standards for the quality of effluents. The law establishes the responsibilities of the MWRI and M0HP in monitoring the quality of effluents discharged into the River Nile (and its associated drainage system, lakes and groundwater) to ensure that water quality standards are met. Industrial establishments are required to obtain pollution discharge licenses. A bond is required with the license application and a fee of L.E. 0.1 (one piaster) per cubic meter of effluent is levied according to Article 82 of the implementing regulations. Under this Law, the MOHP has the obligation to carry out periodic sampling and analysis of wastewater and waste discharge from establishments that are licensed to discharge to waterways.
- **Environmental Protection Law:** Law 4/1994 delineates the roles and responsibilities of EEAA, including its financing through the Environmental Protection Fund. The Law authorizes use of incentives for managing the environment and supports Law 48 regarding the management of water resources.

The Government invests considerable resources in the land-reclamation programme. Investment is primarily directed for irrigation and drainage infrastructure, construction of agglomerations, and provision of potable water, electricity and roads. Very little is invested in social services (education and health), and no investment is made in the provision of agricultural services (technology, water management and rural finance). Consequently, the poor face difficulties in settling and farming, and a considerable percentage returns to the old lands, abandoning their new farmland. Both MWRI and MALR activities are considered public services and their water and land development projects are budgeted in the national economic and social development plan.

2.2 Institutions and Responsibilities

This section presents in detail the institutions involved in water management in Egypt and their responsibilities. A summary is provided in Table 36, and Table 37. Furthermore, Figure 47 illustrates the framework for water quality management in the country.

Table 36: Responsibilities in Water Management

AUTHORITY	RESPONSIBILITY
Actors under MWRI	
Water Sector (WS)	Distribute the surface water among different users
Groundwater Sector (GWS)	Monitoring the depletion in different aquifers.
Dams and Grand Barrage Sector (DAGBS)	Safety and operation of dams and grand barrage.
Water Quality Units (WQU)	Monitoring the water resource quality.
Central Laboratory for Environmental Quality Monitoring (CLEQM)	Water sample and analysis, data processing and interpretation.
Drainage Authority (DA)	Assess the quantity of water to be reuse and implement and maintain the drainage net works.
National Water Research Center (NWRC)	Research concerning water resources development and management.
Planning Sector (PS)	To follow up with ministry of planning to ensure the availability of budget for different activities.
Other Actors	
National Organization of Potable Water and Sewage Disposal (NOPWASD)	Provide drinking water and Trent the municipal waste water.

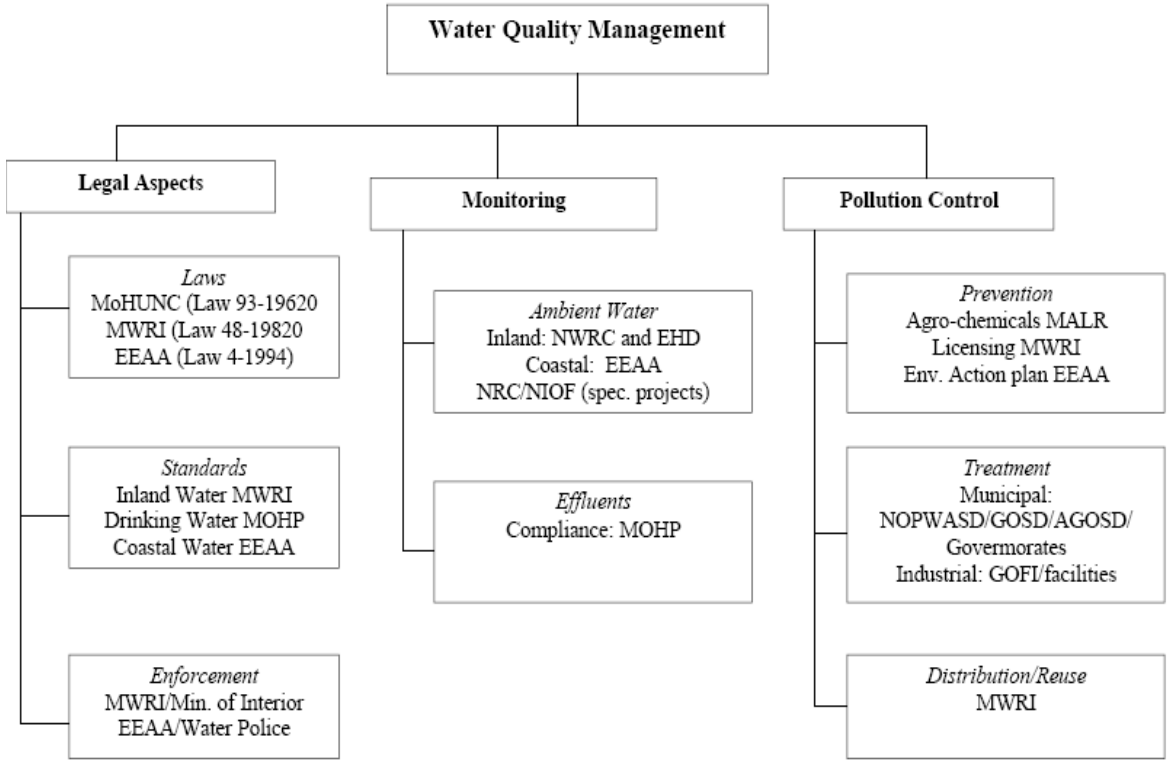


Figure 47: The Institutional framework for Water Quality Management in Egypt

Table 37: Water Resources Planning Matrix

ACTIVITY			
Surface waters			
Use	WS		
Storage	WS	DAGBS	
Groundwater recharge	GWS		
Diversion	WS		
Quality monitoring	WS	WQU	CLEQM
Assessment	WS		
Groundwater			
Use	GWS		
Storage	GWS		
Recharge	GWS		
Quality monitoring	GWS	WQU	CLEQM
Assessment	GWS		
Well permits	GWS		
Irrigation network			
Rehabilitation	WS		
Modernisation	WS		
Reuse			
Drainage water	DA	WS	
Wastewater	DA	WS	NOPWASD
Desalination			
Introduction of technology	NWRC	HH	
Efficient water utilisation			
Domestic	WS		
Industrial	WS		
Agricultural	WS		
Legislation			
Regulation and codes	MWRI	EEAA	MOHP
Standards	MWRI	EEAA	MOHP
Policy setting	MWRI		
Water allocation	WS		
Project financing	MOP	PS	
Project design	MWRI		
Project implementation	MWRI		
Operation and Maintenance	WS		
Pricing (tariffs)			
Enforcement	MOI		
Water data records	WS	GWS	

2.2.1 The Ministry of Water Resources and Irrigation (MWRI):

The Ministry of Water Resources and Irrigation (MWRI) plays a key-role in the development and management of the water system throughout the country. The ministry is in charge of water resources

research, development and distribution, and undertakes the construction, operation and maintenance (O&M) of irrigation and drainage networks.

Specifications and permits for groundwater well drilling are also among the responsibilities of MWRI. The Ministry is also responsible for collection and disposal of agricultural drainage water, monitoring and assessment of water quality of the various water sources, and for the protection of the coastal zone and lakes. The Ministry's organizational chart of MWRI is presented in Figure 48.

There are two major departments and four main authorities responsible for the day-to-day operation of the water resources system, irrigation water delivery, and drainage water disposal. Each of these entities has a wide coverage along the Nile irrigation network and there are several entities within each administrative governorate to carry out all activities related to water distribution and drainage.

The two major departments of the MWRI are the Irrigation Department (ID) and the Mechanical and Electrical Department (MED), which have the widest spatial coverage through their representing bodies as the irrigation directorates, inspectorates, and districts. Within the MWRI, the following sectors and departments are of importance:

- The **Planning Sector** is responsible at the central level for data collection, processing and analysis for planning and monitoring investment projects.
- The **Sector of Public Works and Water Resources** coordinates water resources development.
- The **Nile Water Sector** deals with cooperation with Sudan and other countries sharing the Nile River Basin.
- The **Irrigation Department** provides technical guidance and monitoring of irrigation development, including dams.
- The **Mechanical and Electrical Department** is in charge of the construction and maintenance of pumping stations for irrigation and drainage.

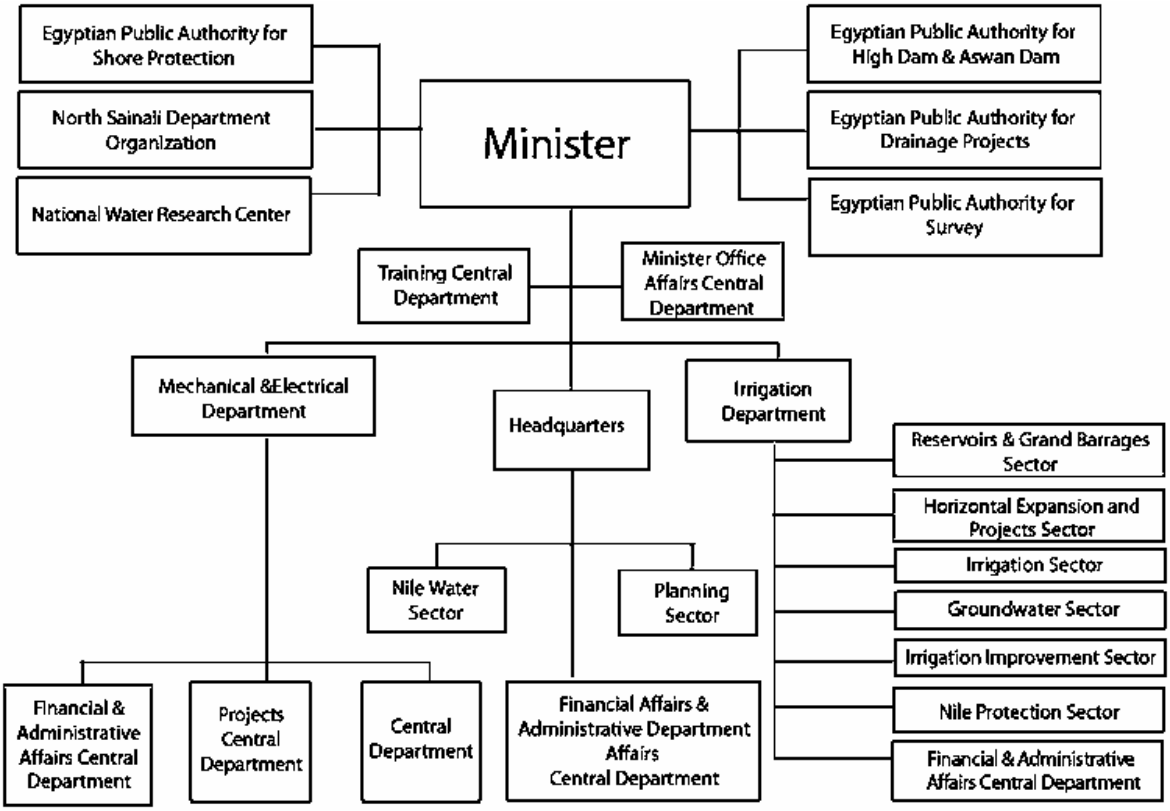


Figure 48: The Organization Chart of Ministry of Water Resources and Irrigation; (MWRI)

Further to the above, other public authorities are directly related to MWRI are:

- The **National Water Research Center (NWRC)** is the research institute of the MWRI and acts as scientific body for all aspects related to water resources management. It consists of 12 research institutes, a Central Laboratory for Environment Quality Monitoring (CLEQM) and the Strategic Research Unit (SRU).
- The **Egyptian Public Authority for Drainage Projects** (EPADP) is in charge of all drainage activities within MWRI, and has representing directorates within the entire Nile network. EPADP is responsible for the construction and maintenance of closed and open drains.
- The **High Dam Authority** is responsible for the Aswan dam operation.

Their responsibilities are outlined in the following paragraphs.

MWRI also represents Egypt in the meetings of the Nile basin countries on Nile water issues. There are several joint projects between those countries for the development of Nile water, which, if completed, would increase significantly the water shares of member countries.

The National Water Research Center (NWRC)

The National Water Research Center is a national institution with an international outlook making a vital contribution to Egypt's development, with the following objectives:

- Study, outline and propose long-term policies for managing water resources in Egypt.
- Solve problems associated with the technical application of the national policy for irrigation, drainage and water resources.
- Carry out investigations and research work for the reclamation of agricultural lands.
- Elaborate on options for exploiting the water resources of the country in the most efficient and cost-effective way.

- Propose measures for the environmentally sound development of the irrigation and drainage systems.

The NWRC plays not only a national role, but also an international one. On the local scale, the Center has worked to strengthen the research programmes of its research institutes, which are further presented below. This has been possible through the establishment of linkages with relevant Egyptian Universities and other research centers, such as the Agricultural Research Center, the National Research Center and the Egyptian Academy of Scientific Research and Technology. Further assistance has been offered to the NWRC institutes for raising funds from internal and external sources to implement their programs.

On the regional scale, NWRC acts as the Coordinating Unit for the African Water Resources Network and is a member of other water resources networks in Europe and other countries. Moreover, in view of the scarcity of water resources, NWRC has taken the lead in setting a general framework for future cooperation between Arab countries. The aim is to maximize water benefits, meanwhile conserving Arab water rights and developing appropriate techniques for implementing a common water plan. A proposal for establishing an "Arab Network for Water Research (ANWAR)" has been initiated by the NWRC, with the aim of creating Arab-driven solutions and technologies with the sole purpose of sustaining Arab water resources for economic growth. On the international scale, NWRC has established wide-scale communication with several international organizations and bodies.

The **Water Management Research Institute (WMRI)** deals with research in the fields of crop water requirements, water distribution, water losses, on-farm irrigation systems and water quality. Its main activities cover the following topics:

- Definition of crop water requirements.
- Development of the existing irrigation networks.
- Improvement of irrigation rotations to achieve optimum water distribution.
- Development of better irrigation methods, improvement of irrigation outlets.
- Study of evaporation and seepage losses from waterways, lakes and reservoirs.

The institute owns twelve experimental research stations scattered all over the country. Their location was selected to represent the variation in climate, soil texture, crops and agricultural and irrigation practices.

In addition to the above experimental stations, the institute carries out research programmes on fields owned and managed by individual farmers. The institute has six sites laboratories which are equipped in such a way as to carry out sample analyses of water, soil and crop samples. The institute also has the capability of arranging training programmes in various themes and for different target groups.

The main objectives of the **Water Resources Research Institute (WRRI)** include the:

- Assessment of the amount of water available in the Nile basin and in Egypt, including the Sinai Peninsula.
- Definition of policies and development of projects required to maximize water availability.

The **Nile Research Institute (NIR)** undertakes activities relevant to the:

- Monitoring the quality of the River Nile water.
- Protection of existing small-scale dams.
- Navigation development.
- Protection of bank erosion.

- Utilization of sediments deposited in the Aswan High Dam reservoir.

The main goals of the **Hydraulic Research Institute (HRI)** are to:

- Undertake research for determining the river bed and banks of the Nile, and irrigation canals.
- Perform hydraulic model studies for infrastructure.
- Perform coastal hydraulic studies.
- Develop and execute specialized training programmes on river hydraulics.

The main responsibilities of the **Construction Research Institute (CRI)** institute are to:

- Carry out basic and applied research on hydraulic infrastructure, soil mechanics and foundation engineering.
- Provide MPWWR with comprehensive laboratory and field testing services and facilities.
- Train the personnel of MPWWR on the operation and handling of available advanced equipment in monitoring and controlling construction.
- Provide advice to MPWWR in the matters of construction design and execution.

The **Channel Maintenance Research Institute (CMRI)** has been established with the aim to address problems associated with the maintenance of irrigation and drainage networks and to investigate alternative solutions from both technical and economic points of view. The institute's activities cover the following main topics:

- Determine the magnitude of aquatic weed problems.
- Design canals and drains to meet hydraulic and irrigation requirements.
- Conduct experiments and make recommendations on artificial grass carp in different canals.

The **Coastal Research Institute (CoRI)** was established in 1972 in the Academy of Scientific Research and Technology. Since 1982, the institute has been operating under the control of the NWRC. The main goal of the institute is to monitor the evolution of Egyptian Northern coast, to study coastal dynamics and to investigate efficient and cost-effective control works to protect the coastal zone from erosion. It also provides expert advice to the Egyptian Government on problems associated with coastal instability and coastal zone management for the Mediterranean and Red Sea. Principal activities include:

- Monitoring the evolution of the Mediterranean shoreline.
- Collecting and analyzing meteorological, coastal and marine data.
- Conducting physical & numerical models to predict future changes in the coastal zone.
- Providing expert advice on problems associated with coastal instability.
- Coastal zone management for Mediterranean and Red Seas.

The main goals of the **Groundwater Research Institute (GRI)** are to:

- Study the quality and quantity of groundwater in the Egyptian desert areas.
- Study the conjunctive use of the surface and groundwater water in the Nile valley.

The main research fields of the **Mechanical and Electrical Research Institute (MERI)** include:

- Energy management in pumping stations.
- Improvement of the performance of motors and pumps.
- Testing and calibration of hydraulic and electrical machinery.
- Utilization of renewable energy for water pumping.
- Automation, control and instrumentation in water schemes and plants.

- Telecommunication and telemetry for water management.
- Development of new mechanical weed control equipment.

The **Drainage Research Institute** is also affiliated to the National Water Research Center (NWRC), and carries out applied research to support national plans for developing land drainage in Egypt, and implementing technically affective and economically sound drainage system. It also develops tools for planning and managing the reuse of drainage water for irrigation. The main responsibilities of the institute are to:

- Develop and test appropriate methods and technologies for planning, design and implementation of drainage system.
- Identify the most convenient and economic methods of operation and maintenance of subsurface drainage systems.
- Develop specifications for drainage material.
- Determine & evaluate the technical and economic effectiveness of drainage projects.
- Determine drainage water quantity and quality.
- Develop criteria and guidelines for reusing drainage water in irrigation.

The **Central Laboratory for Environment Quality Monitoring (CLEQM)** undertakes tasks for:

- Studying the long-term impact of climatic fluctuations on the optimal management of surface water and groundwater in terms of both quantity and quality.
- Carrying out environmental impact assessments for water resources projects.
- Developing effective methodologies for the optimal management of water resources.
- Identifying environmental problem area and their implications.
- Preparing national, regional and issue-specific assessments of climatic conditions affecting water resources.

Finally, the main goals of the **Survey Research Unit (SRU)** are to:

- Adapt, develop and incorporate modern methods of computer-aided field surveying.
- Act as the central organization for the development and application of all modern aspects of geodesy, photogrammetry, remote sensing and geographical information systems.

Egyptian Public Authority for Drainage Projects (EPADP)

The Egyptian Public Authority for Drainage Projects (EPADP) is affiliated to the Ministry of Water Resources and Irrigation (MWRI). The authority was established in 1973, with the aim of controlling and preventing waterlogging and salinity, which pose threats on crop production. The main focus of EPADP's activities are new surface and subsurface drainage projects, as well as maintenance and rehabilitation of existing ones. In more detail, the tasks of EPADP are to:

- Study drainage conditions in order to set priorities for the installation of drainage systems.
- Design drainage systems and prepare tenders for contracting.
- Undertake operational research on the installation of such systems.
- Supervise installation, operate and maintain drainage systems.
- Train personnel on all the above tasks.

Egyptian National Committee on Irrigation and Drainage (ENCID)

The ENCID is a semi-governmental entity, also affiliated to the MWRI. The 30 members of the National Committee are Senior Governmental Engineers, Professors from Engineering Universities and Research Centers.

2.2.2 The Ministry of Agriculture and Land Reclamation (MALR)

The Ministry of Agriculture and Land Reclamation (MALR) is involved in improving agricultural activities and land reclamation, including water management at the on-farm level.

Furthermore, MALR is in charge of agricultural research and extension, land reclamation and agricultural, fisheries and animal stock development.

The Agricultural Research Centre, controlled by MALR, comprises 16 institutes and 11 central laboratories and is the scientific body of MALR for all aspects related to agricultural development. Furthermore, the Land Development Authority is in charge of contracting and monitoring land development projects and manages land allocation to investors and individuals.

Finally, the Agricultural Development and Credit Bank provide credit to farmers to finance various production requirements.

The Central Administration for Soils, Water and Environment (CASWE)

CASWE is mandated to accomplish:

- Planning programs for farmers for optimum irrigation methods, irrigation scheduling and irrigation water quality.
- Methods to rehabilitate and maintain, irrigation and drainage canals in order to reduce water losses.
- Water harvesting techniques in rainfed areas and methods of supplementary irrigation.
- Transfer technologies generated in research organizations to be applied in the field.
- Training programmes to increase the capacity of agricultural engineers working in the area of soil, water and environment.
- Identification of farming problems and posing them to research organizations.
- Assessing and monitoring the environmental impact of various agricultural practices.

Soils, Water & Environment Research Institute (SWERI)

The Soils, Water & Environment Research Institute (SWERI) undertakes studies and research on soil-water-crops interrelations, soil survey and classification, improvement and conservation of cultivated soils, soil fertility and plant nutrition, organic farming, crop water requirements, water suitability for irrigation, designing and evaluation of field drainage networks, reuse of marginal water in irrigation and environment. SWERI also gives technical recommendations on water-related issues.

The General Authority for the Development of Lake Nasser

The Authority is responsible for the development of natural resources in the region of Lake Nasser. Its tasks include the monitoring/implementation of programmes for:

- Exploiting the Lake for the production of cheap protein products, and the increase of fish production.

- Exploiting the significant amount of mineral resources (e.g. marble, granite, caoline), by promoting the establishment of related industries according to the availability of resources and electric power.
- Exploiting the tourist potential of the region, considered a major tourist site.
- Reclaiming and cultivating the area around the Lake, and creating new urban communities.

2.2.3 The Ministry of Housing, Utilities & Urban Development (MHUUD)

The **Ministry of Housing, Utilities & Urban Development (MHUUD)** is responsible for the provision of water supply and sanitation services to the municipal and industrial subsectors. Under MHUUD, the National Organization for Potable Water and Sanitary Drainage (NOPWASD) and its affiliated agencies, are responsible for planning, designing and supervising the construction of municipal drinking water treatment plants, distribution systems, sewage collection systems, and municipal wastewater treatment plants.

The **NOPWASD** assumes these responsibilities throughout the country, with the exception of the cities of Cairo, Alexandria, and of the Suez-canal cities. For Cairo, Alexandria, and the Suez Canal area, such services are provided by the General Organization for Sanitary Drainage in Cairo (GOSDC), the General Organization for Greater Cairo Water Supply (GOGCWS), the Alexandria General Organization for Sanitary Drainage (AGOSD), the Alexandria Water General Authority (AWGA), and the Suez Canal Authority. Operational and maintenance responsibilities are delegated to the local governments, which oversee local agencies. The latter are classified into economic/general authorities and public/private enterprises or utilities, established in 9 Governorates (private companies assume wastewater treatment in Damietta, Kafr El Sheikh, Beheira).

The **General Authority for Potable Water and Sanitary Drainage (GAPWSD**) is the central body subsuming these governorate entities. The Presidential Decree 135 (2004), authorizes the creation of a Holding Company for Drinking Water and Sanitation and its affiliated companies that include the General Economic Authorities for Drinking Water and Sanitation operating in the Governorates. In order to meet the required operation and maintenance expenses and relieve the burden on the government, the company will seek new financial resources.

Moreover, the Presidential Decree 136 (2004) provides for the creation of the **Central Authority for the Drinking Water and Sanitation Sector and Protection of the Consumer**. This decree aims at regulation and monitoring on quality and consumer-price control. The authority would report to the Minister of Housing, Utilities and Urban Communities, and will be the liaison body between the government, the society and the holding company to ensure that national policies and regulations are abided. The Minister of Housing heads the Governing Board, which includes members from outside the subsector, namely two technical experts and a representative of the consumers, seconded by the Minister of Housing. The Ministries of Finance, Health and Population and of the Environment are represented on the governing board. NOPWASD acts as technical advisor.

The National Organization for Potable Water & Sanitary Drainage (NOPWASD)

As mentioned above, NOPWASD is responsible for the planning, designing and supervising the construction of municipal drinking water treatment plants, distribution systems, sewage collection systems, and municipal wastewater treatment plants. The organization is structured in two main sectors, the Potable Water Sector and the Sanitary Drainage Sector.

The current goals of the **Potable Water Sector** are:

- Full coverage during the next two years through ongoing plans and programs.
- The implementation of the national project for drinking water provision in 240 unserved villages. The project's estimated cost is about 2 billion EP, and is partially by the Arab Fund for Economic & Social Development, with KD 47M. This project is due for completion at the end of the 2002-2007 plans.
- Implement 55 integrated projects (plants and networks) for insufficiently provided villages. The total capacity is 3.5 million m^3/d and the project's cost is about 5 billion EP.
- Implement 40 extension projects for existing plants, with total capacity of 1.2 million m^3/d and 2.2 billion EP investment cost. The implementation of these projects was awarded to specialized companies, giving priority to severely deficient areas and villages.

The current goals of the **Sanitary Drainage Sector** are to:

- Achieve, by 2022, full coverage in rural areas, using advanced techniques depending upon:
  - New, unconventional economic systems and surface networks, complying with the rural conditions for the safe disposal of treated water.
  - Use, whenever possible, local material for reducing investment costs.
  - Prioritize villages located near water streams.
- Install self-treatment drainage, in areas where the completion of sanitary drainage projects is pending, in full co-ordination with competent ministries and research entities for raising the self treatment capacity of open drains.

2.3 Legislation

Several laws and decrees have been approved by the Egyptian Parliament, the Cabinet of Ministers and the President to organize the work of the MWRI and to organize the distribution of water among different users and recently to protect the environment and water system from pollution. The main laws of relevance to the water sector legislative framework are: Law 12 for the year 1984 for the Irrigation and Drainage, Law 213 for the year 1994 for farmer participation and cost sharing, Law 93 for the year 1962 for the discharge to open streams and its modifications for the years 1962, 1982, and 1989. Additional legislation includes Law 27 for the year 1978 for the Regulation of water resources and Treatment of Wastewater, Law 48 for the year 1982 Regarding the Protection of the River Nile and Waterways from Pollution, Decree 380 for the year 1982 for the Industrial Water Pollution Control, Law of Local Administration 43 of 1979, and Law 4 for the year 1994 for Environmental Protection. A detailed description of all water-related legislation and its current status is included in the National Water Resources Plan (NWRP).

The main water and irrigation strategy focuses on the development and conservation of water resources. This is effected through water rotation for irrigation canals, decrease of the rice growing area, lining irrigation canals in sandy regions and prohibiting surface irrigation in the newly developed agricultural areas outside of the Nile Basin.

Recent water resources policies include different structural and several non-structural measures. Structural measures include the rehabilitation of irrigation infrastructure, irrigation systems improvement, installation of water level monitoring devices linked to the telemetry system and expansion of the tile drainage system. Non-structural measures address the expansion of water user associations (WUAs) for irrigation canals, the establishment of water boards on branch canals, the promotion of public awareness programmes, and the involvement of stakeholders.

The legal basis for irrigation and drainage is set in Law No. 12/1984 and its supplementary Law No. 213/1994 which define the use and management of public and private sector irrigation and drainage systems including main canals, feeders and drains. The laws also provide legal directions for the operation and maintenance of public and private waterways, and specify arrangements for cost recovery in irrigation and drainage networks.

The most recent water policy was drafted in 1993. It included several strategies to ensure satisfying the demands of all water users and expanding the existing agricultural area (7.8 million feddans, about 3.12 million ha at that time), by an additional 1.4 million feddan (about 560,000 ha).

The issues of cost recovery and pricing have started receiving increased attention. Water pricing is considered as an approach to generate additional revenue which could be used to operate and maintain irrigation systems, and even repay some or all of the investment costs. It could also help to promote water conservation, especially in irrigated agriculture. However, the effectiveness of a cost recovery policy in achieving its expected objectives depends on many factors. These include the system through which water consumption is measured and the relation between existing taxation and water subsidy and the proposed water charge. Farmers' reactions to such changes are not easy to predict. Furthermore, the identification of beneficiaries and the possibilities of charging external costs, e.g. those associated with environmental damage, should be further explored.

Consideration has to be given to what type of system could be instituted that would be equitable, generate revenue and simultaneously promote more efficient water usage. In July 94 the Egyptian people's assembly passed a law to charge the MPWWR to implement a cost recovery law at the Mesqa level. The same law sets the procedures to establish farmers' water users association and the irrigation advisory service.

2.3.1 Water-Use Legislation and Standards

In Egypt, water "use-standards" are sets of laws and regulations under the responsibility of the Ministry of Housing and the Ministry of Health. The legal framework for water resources management is established in a number of laws and decrees of which the most important are:

- **Law 48/1982**, described below, provides the "effluent-standards" as well as "ambient standards" for inland waters with the Ministry of Water Resources and Irrigation (MWRI) as the primarily responsible office. It regards the protection of the River Nile and waterways from pollution.
- **Law 12/1984** on irrigation and drainage regulates the use of water, including groundwater. It controls water rights, setting priorities between users, beneficial and harmful use of water, financial aspects and penalties.
- **Law 4/1992** sets "effluent-standards" for solid and hazardous wastes and for discharges to the marine environment. The law designates the Ministry for the Environment as the competent authority on those issues.
- **Law 213/1994** amends the irrigation and drainage law 12/1984, legalizes private Water Users Associations at the mesqa level and provides for recovery of capital costs for improved irrigation facilities at the mesqa level over a period up to twenty years.

Other laws and decrees are more specific, e.g. Law 27/1982 regulating public water resources used for drinking and domestic use and Ministerial Decree 2703/1966 of the Ministry of Health, establishing the Supreme Committee for Water. This committee has to set standards for drinking water, swimming, etc. and to approve water treatment projects. The Ministerial Decree No. 380/1982 of the Ministry of

Industry requires new industries to include equipment to prevent pollution in the technical specification of the project.

It should be noted that the "effluent-standards" for inland waters distinguish between industrial and domestic wastewater and between the Nile and irrigation system on the one hand and the drainage system and lakes on the other.

Since 1982, Egypt has changed and developed. Awareness and environmental education has grown in society. The environmental bureaucracy is maturing with the establishment of the Ministry of the Environment and the former Ministry of Irrigation becoming truly a Ministry of Water Resources and Irrigation (MWRI), emphasizing its role in integrated management.

2.3.2 Legislation on water pollution control

A legal basis for controlling water pollution exists through a number of laws and decrees. Law 48/1992 regarding the protection of the river Nile and other waterways from pollution, and Law 4/1994 on Environmental protection are the most important ones and are discussed below.

- **Law 48/1982 and Decree 8/1983**: Law 48 of 1982 specifically deals with discharges to water bodies. This law prohibits discharge to the Nile River, irrigation canals, drains, lakes and groundwater without a license issued by the MWRI. Licenses can be issued as long as the effluents meet the standards of the laws. The license includes both the quantity and quality that is permitted to be discharged. Discharging without a license can result in a fine. Licenses may be withdrawn in case of failure to immediately reduce discharge, in case of pollution danger, or failure to install appropriate treatment within a period of three months. Under the law, the Ministry of the Interior has police power while the Ministry of Health and Population is the organization responsible to give binding advice on water quality standards and to monitor effluents/discharges. Law 48 does not cover ambient quality monitoring of receiving water bodies although some standards are given, and recognises three categories of water body functions:
  - Fresh water bodies for the Nile River and irrigation canals;
  - Non-fresh or brackish water bodies for drains, lakes and ponds;
  - Groundwater aquifers.

  Ambient quality standards are given for water resources, which are intended as raw water supplies for drinking water. The implementing Decree 8 of 1983 specifies water quality standards for the following categories:
  - The Nile river and canals into which discharges are licensed (article 60);
  - Treated industrial discharges to the Nile river, canals and groundwater;
  - Upstream the Delta barrages discharging more than 100 m^3/day (article 61);
  - Downstream the Delta barrages discharging more than 100 m^3/day (article 61);
  - Upstream the Delta barrages discharging less than 100 m^3/day (article 62);
  - Downstream the Delta barrages discharging less than 100 m^3/day (article 62);
  - Drain waters to be mixed with the Nile river or canal waters (article 65);
  - Treated industrial and sanitary waste discharges to drains, lakes and ponds (article 66);
  - The drains, lakes and ponds into which discharges are licensed (article 68).

  Discharge of treated sanitary effluents to the Nile River and canals is not allowed at all (article 63) and any discharge of sanitary waste into other water bodies should be chlorinated (article

67). The water quality standards are generally based on the drinking water standards and are not linked to all other functions a water body may have. The use of agrochemicals for weed control is also regulated in the law.

- **Law 4/1994:** Through Law 4 of 1994 the EEAA is defined as the authority responsible for preparing legislation and decrees on environmental protection. The agency also has the responsibility for setting standards and for carrying out compliance monitoring. It should participate in the preparation and implementation of the National Programme for environmental monitoring and utilisation of data (including water quality). The agency is also charged with establishing an "Environmental Protection Fund" which would include water quality monitoring. With respect to the pollution of the water environment, the law states that all provisions of Law 48/1982 are not affected. Additional provisions of Law 4 covers coastal and seawater aspects.

  Nevertheless a number of issues remain unclear:

  - The MWRI remains the responsible authority for water quality and water pollution issues, although the definition of "discharge" in Law 4 specifically includes discharges to the River Nile and waterways. However, the EEAA is responsible for coordinating the pollution monitoring networks.
  - In Law 4 it is stated that all facilities discharging to surface water are required to obtain a license and maintain a register indicating the impact of the establishment's activity on the environment. The register should include data on emissions, efficiency and outflow from treatment units and periodic measurements. EEAA will inspect the facilities yearly and follow-up any non-compliance. This provision is confusing or creating duplication, because Law 48/1982 also includes certain standards for effluents, and designates the MOHP as the compliance monitoring organization and only MOHP laboratory results are considered to be official.

  Both laws establish funds where fines are collected and which are used to fund monitoring and other activities.

2.4 Financial Framework

Currently, the ministries entrusted with the financing of the public expenditures are the Ministry of Finance, the Ministry of Water Resources and Irrigation, (MWRI), the Ministry of Housing, Utilities & Urban Development (MHUUD) and to a limited extent, the Ministry of Agriculture and Land Reclamation (MALR), mandated to improve on-farm water management and fisheries.

Almost 90% of the development, operation and maintenance (O&M) costs of water services in the country are funded by public sources. The public financing of O&M in the irrigation sector amounts to about 4% of the total public recurrent expenditures. On the investment side, since 2000 some 12 Billion LE of public finance were spent on national irrigation infrastructure and water-resources related programs, which on average-annual would translate to 15% of the average-annual public investments since 2000. Currently, cost sharing for irrigation services is mainly attributed to the land property taxes levied at 30 LE/feddan/year on average, which accrue to the local governments. The land property taxes amount to a total of only 20% of the recurrent budget appropriations allocated through MoF to MWRI.

An on-going Public Expenditure Review study, conducted by the World Bank (2005), depicts that the country's total public spending on new investments is much less than the total recurrent spending

(ratio is 20% on average since the fiscal year of 2001). However, this pattern is reversed for the water sector, where the ratio of investment-to-recurrent spending has been ranging from 200% to 300% since 2001. There is s generally a declining trend in recurrent expenditures and debt repayment, while investment expenditures are relatively steadier. This suggests that new investments are prioritized instead of maintaining existing assets and repaying debts. Figure 49 illustrates water sector public expenditures in Egypt.

The entire budget of MWRI is mainly allocated for the administration of irrigation and drainage networks in Egypt that meet the needs of all water-use sectors. The irrigated agriculture sub-sector consumes about 85% of the budget of the MWRI. A mere 10% is allocated to services for the water supply and sanitation sector subsector, and 5% is attributed to the industrial sector. The latter distribution is based on sub-sectoral water usage ratio. The Ministry of Agriculture and Land Reclamation (MALR) contributes to the water sector by about 20% of the annual budget of its administrative agency and service authorities in addition to 50% of the annual budget of the General Authority for Reconstruction Projects and Agriculture Development (GARPAD).

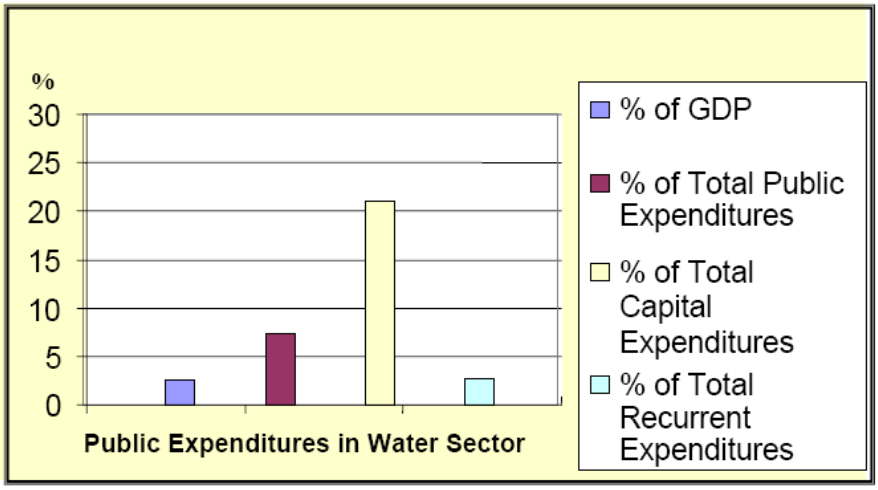


Figure 49: Water Sector Public Expenditures in Egypt

An overall view of the financing of the water sector is illustrated in Table 38, which provides estimates for investment costs for water projects and O&M costs for each institution and subsector (irrigated agriculture, water supply and sanitation, industrial, in addition to environmental degradation cost estimates). The distribution of total expenditures among the major agencies within the water sector is shown in Figure 50.

Table 38: Investment and O&M costs in the Water Sector

All values are in Billion L.E. per Year	Stakeholder (Budget Provision)		Investments in Water Projects		Operation and Maintenance		Total Costs
			97/98	03/04	97/98	03/04	03/04
Irrigated Agriculture Sector	**MWRI**		1.555	2.771	0.442	0.662	3.433
	MARL		0.275	0.489	0.111	0.165	0.652
	Sub-total		1.830	3.260	0.553	0.827	**4.087**
Water Supply and Sanitation Sector	**MHUNC**	**Water Supply**	0.991	1.65	0.580	1.027	2.677
		Sanitation	1.490	2.480	0.870	1.54	4.020
	Sub-total		2.481	4.130	1.450	2.567	**6.697**
Industrial Sector	**Private Sector**		1.140		1.180		**2.320**
Environmental Degradation	**State Budget**		Damage cost ~ 1.62 – 3.24% of GDP				

The estimated investment costs for water services from the three ministries have increased from 4.31 billion L.E. in year 1997/98 to 7.4 billion L.E. in year 2003/04. While the estimated O&M costs was increased from 2.0 billion L.E. to 3.38 billion L.E. in the same period.

The NWRP has predicted a total of 145 billion Egyptian Pounds worth of investments within the water sector during the period 2003-2017. The Ministry of Housing, Utilities and Urban Development is foreseen to contribute to 63% of the latter investments and the Ministry of Water Resources and Irrigation will provide 32%. The private sector, based on current scenarios, will assume about 5% of these investments.

For the same period (2003-2017), the total recurrent costs are estimated at 44 billion Egyptian Pounds. These costs include the operation and maintenance costs of the system but exclude the personnel costs of the government agencies. The municipalities (Ministry of Local development) assume by far the biggest share of the O&M costs (70%) for the operation and maintenance of the drinking water and wastewater treatment plants. In this case, it is estimated that the Ministry of Water Resources and Irrigation will cover 12% while the private sector will contribute about 15% of the cost.

The municipal water supply and sanitary services are carried out by a set of economic authorities controlled by the MHUUD and to a less extent by the Ministry of Local Development (MoLD). The analysis of the budgets of these economic authorities of MHUNC showed that the total annual budget allocated for these authorities increased from L.E. 4.73 billion in year 1997/98 to L.E. 8.45 billion in 2003/04. During the period 1982-2004, a total of 25.0 billion L.E. worth of investments have been channelled by the state budget to potable water supply services. Moreover, a total of 40 billion L.E. were invested in sanitation services. Correspondingly, potable water production increased from 5.8 million m³/d in 1982 to 18.2 million m³/d in 2000. Similarly, the per-capita rate of potable water use increased from 130 l/d in 1981 to 275 l/d in 2000. The capacity of sanitary stations increased from 1.0 million m³/d in 1982, to 8.3 million m³/d in 2000, and planned to reach 20.0 million m³/d by 2017. Even today, rural sanitation still is a major challenge and an impeding factor for achieving environmental sustainability.

With regard to the industrial sector, the private sector is mainly responsible for providing the investments and O&M costs required for water services. The Government provides a set of incentives for industries to comply with environmental regulations.

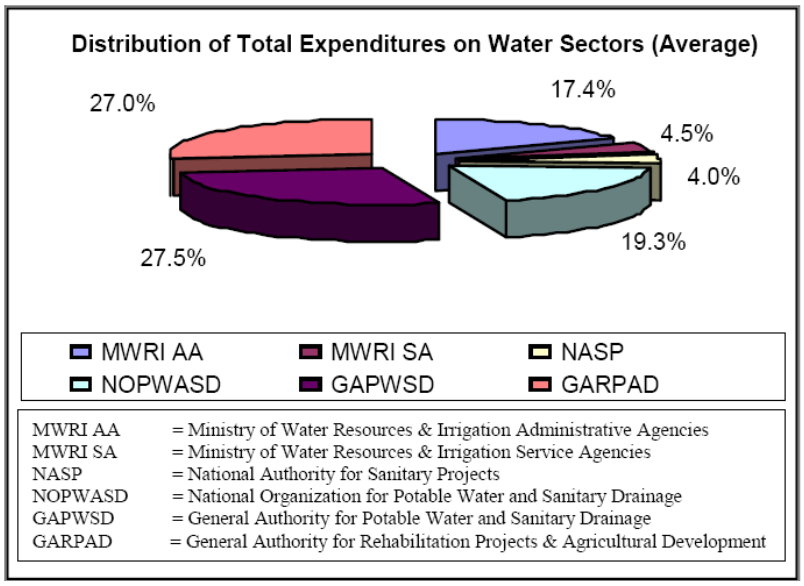


Figure 50: Distribution of Total Expenditures among the Major Agencies within the Water Sector

2.4.1 Governmental authorities & foreign sources of financing

The authorities involved in the allocation and channeling of the State budget towards the water sector include the Ministry of Finance, the Ministry of Health and Population, the Ministry of Trade and Industry, the Ministry of Transportation, the Ministry of Local Development (MoLD), the Ministry of Electricity and Energy, the Ministry of the Interior, the Ministry of Tourism, the Ministry of Water Resources and Irrigation, the Ministry of Agriculture and Land Reclamation, the Ministry of Housing, Utilities & Urban Development and in particular the National Organization for Potable Water and Sanitary Drainage, the Ministry of State for the Environment Affairs, and the Egyptian Environmental Affairs Agency in particular, and the Ministry of State for Economic Development, previously known as Ministry of Planning.

International agencies involved include the Netherlands Ministry of Foreign Affairs, the Finnish Government, the Rural Development Department of the World Bank, ARCADIS EUROCONSULT, the German Cooperation Agency (GTZ), the Egyptian Dutch Advisory Panel Project on Water Management, etc.

2.4.2 Private Sector and NGOs

Water Users' Associations

During the last decades, and in the frame of the overall effort to improve the effectiveness of irrigation systems, major emphasis has been given to the potential role of Water Users' Associations (WUAs). The WUAs are voluntary organizations of farmers. In the past, associations comprised of a few farmers along a single tertiary distributor (mesqa). Usually, individual water users associations are expected to elect representatives to higher level associations reflecting the water delivery system.

It is expected that the establishment of WUAs will significantly contribute to the equity and sustainability of the system. The overall rationale is that organized farmers will contribute towards more equitable water distribution and to greater water use efficiency to resolve conflicts and thereby, increase agricultural productivity. Six specific objectives can be identified.

The primary objective is to provide a basis for collective action of farmers along a given tertiary canal to maintain and improve their share of the system, by reducing waste from seepage losses and

improving control over the water supply. Secondly, WUAs will provide means for communicating farmer needs and expectations to irrigation system authorities, both prior to contraction or improvement projects and during its operation. Thirdly, WUAs would assist the irrigation authority with revenue collection. The fourth task is ensuring that water allocation among farmers is equitable. A fifth function is to resolve conflicts among individual users, and finally, WUAs could coordinate cropping patterns and planning dates to best use available water.

The irrigation improvement pilot project has documented specific benefits from WUAs effective management of improved mesqas. Mesqas delivery efficiencies increased from 69% to 92% after improvements.

The role and functioning of WUAs may appear at first glance to be quite distant from the topic of financing irrigation systems. However, through the establishment of the WUAs, Governments hope to shift a part of the burden of running the system off-budget. To the farmers, the policy is an attempt to shift more of the costs to the farmers and to conserve scarce government budget.

The main objective of the Irrigation Improvement Projects (IIP) implemented in the country is to contribute to increasing irrigation water use efficiency and agricultural production and to help the users in carrying on the production process, and increase the corresponding benefits for both the users and for the country.

In order to meet these goals, new technology and institutional changes were introduced. The major physical improvements belong to delivery and tertiary systems are concerned:

- Introduction of continuous flow through improved distributary canal control structures (automatic downstream level control gates) and rehabilitation of delivery system.
- Introduction of single point lifting with raised-lined or pipe line mesqas.

The other intervention included demonstration program to introduce improved on farm irrigation techniques (including land levying, good farming system, use of soil amendments etc.). The establishment of the WUAs at the mesqa and branch canal level can be the most important instrument in implementing improved technologies and techniques in irrigated agriculture. WUAs, can be the instrument that ensures water distribution, and the operation of systems at the farm level in as efficient conditions as possible under the varying conditions and constraints faced by the irrigator. Efficient water use over time is what is important. Users' participation can also function as an implementation system for government policies designed to increase food production, advance rural, economical development, and or improve resource management. This is accomplished in one or two ways:

- First, by providing services and technological assistance which users are unable to secure as individuals.
- Secondly, by providing users the guidance and training to take advantage of appropriate technologies and advanced cultural practices.

The impact of resulting changes in the functioning of the irrigation system are expected to include improvements in crop yield and beneficial changes in cropping patterns, leading to an overall positive impact in terms of increased farm income.

The Fayoum Governorate Irrigation Department is currently testing this different model, by implementing, on a pilot scale, two different organizational models for Branch Canal Water Users Organizations (BCWUOS). The first involves only farmers, whereas the other includes also an executive board, which, besides farmers includes also government officials. The organizations have

prioritized the required structural improvements in the canals and have assumed responsibility for canals maintenance activities since 1996.

From the experiences in Fayoum Governorate, it is clear that the relations between Fayoum Irrigation Department and farmers were substantially improved. The first evidence shows that water distribution has become more equitable, after the works suggested by farmers were implemented. At the same time it is becoming evident that farmers are willing to assume increasing responsibilities for water management at the branch canal level if they are provided with the opportunity. Overall, it is expected that this will not only lead to improved water management, but it also appears to be attractive to the irrigation department from a budgetary point of view. If legal changes are implemented, this would also make it easier for Irrigation Departments to change its mode of operation towards water users.

Build Operate Transfer Projects (BOT) & Joint ventures

There are whole ranges of options as to the ways in which straight operational contracts can be negotiated, which place the responsibility directly with the concession company and at the same time leaving direct control with the public utility.

In major capital investments, however, the normal major water and sewage treatment projects are the build, operate, transfer arrangement or BOT. In BOT type projects the private sector organization has the responsibility of: design, construction, operation and maintenance and project funding.

Many public utilities in addition to controlling charges and establishing their own standards of service, want to retain a direct involvement in the design, construction and operation of their water infrastructure. It is possible to achieve this objective and at the same time, through a joint venture, introduce the latest "private sector" technology, operational and design know-how into the utility company, together with the shared funding of capital investment for new works and infrastructure. This type of arrangement links the public sector utility to a private company, or group of companies, in order to develop water services through both operational and capital investment projects.

3. Identifying Focal Problems in Water Management

3.1 Constraints facing the Water Sector

The market-based water conservation generally refers to using the incentive principle for encouraging farmers to practice less water consuming agriculture. Incentives can entail drawing on the economic value of water to induce farmers to adopt conservation measures. Few experiences of irrigation water pricing have been carried out worldwide with varying indicators of success. However, the Egyptian Government is against irrigation water pricing. However, there are some cases where incentive pricing and cost recovery are practiced, such as:

- Irrigation improvement cost recovery,
- Subsurface drainage cost recovery,
- Cost recovery in the new lands,
- Cost recovery for operation and maintenance,
- Cost recovery on new projects.

The Irrigation Improvement Project comprises improving control structures, using modern methods in land levelling, on farm development, rehabilitation of main and branch canals and most of mesqas, promoting equity of water distribution, and forming water users associations. The Mesqa improving costs comprise:

- Investment costs for the mesqa pumps, the repayment over a period not exceeding 5 years.
- Investment costs for civil works including mesqa remodeling, PVC pipes, lining etc.

Costs are paid to the Government over a period not more than 20 year without interest. Farmers pay O&M costs directly to WUAs

3.2 Identification of Focal Problems

3.2.1 Sharing Water

Water Shortage Problems

Egypt; when is examined as a single geographic entity does not appear to face water shortage problems. The governorates that are located near the Nile River do not experience water shortage problems. However, some areas are identified as having a crucial situation regarding water supply. These areas are in Sinai, the Red Sea coast and Northern Desert coast (Figure 51), where economic development is primarily based on water availability.

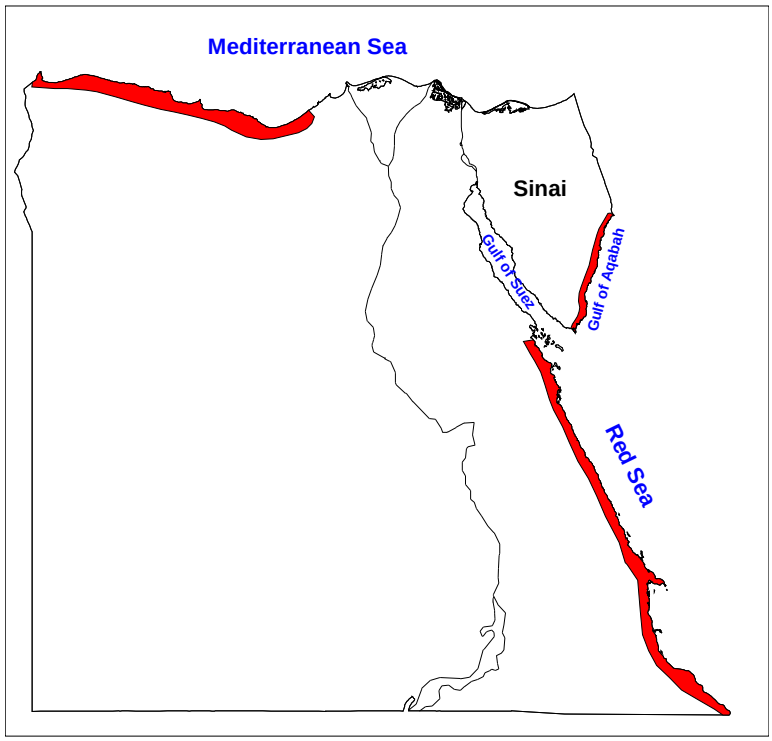


Figure 51: Areas Facing Water Shortage Problems

Water Quality and Pollution

As already stated, one of the main (focal) water management issues experienced in Egypt and in the Bahr-Basandeila area is linked to water quality deterioration in canal water. The problem is similar (in terms of causes and impact) to the overall water quality problems experienced in the River Nile and its distribution network. Towards this end, this section provides an overview of the water quality status in the River Nile and its economic impact, and of the recent efforts to pursue municipal water treatment and improved water services in rural and urban areas of the region.

Water quality problems in Egypt vary with location and depend on factors such as: water flow rates; water uses; population densities; sanitation systems; industrial discharges; demands for navigation; and agricultural runoff. Discharge of untreated, or partially treated, industrial and domestic wastewater, leaching of pesticides and residues of fertilizer and navigation are often factors that affect the quality of water. Egypt's major water quality problems are pathogenic bacteria/parasites, heavy metals and pesticides.

There is an increasing concern about the rising costs of environmental degradation to the country, including water misallocation and declining water quality. Table 39 represents some preliminary estimates associated with a range of environmental problems. The presentation of data does not aim to provide specific, accurate values, but rather to provide a good indication of the potential magnitude of social costs associated with environmental degradation and the importance of actions required for reducing these pressures on the economy.

Table 39: Costs of Environmental Degradation in Egypt

Sector	Economic Loss LE Billions	Percent of GDP
Air		
Morbidity and mortality	8.4	2.3
Aesthetics (including tourism)	2.9	0.8
Water		
Water pollution	4.6	1.3
Water allocation inefficiencies	18.0	4.9
Water system losses	2.6	0.7
Land		
Productivity losses	5.8	1.6
Urban encroachment	4.0	1.1
Waste		
Solid waste	2.2	0.6
Hazardous waste	0.1	0.0
Amenity and tourism impacts	1.3	0.3
Biodiversity losses	2.4	0.7

Each year a total of about 5 billion m³ of drainage water is reused in the Delta, and another 4.7 billion m³ of agricultural drainage water returns to the Nile upstream of Cairo. Official reuse in the Delta is expected to rise to about 7 billion m³ in the near term and 9 billion m³ by 2017. In addition to threatened agricultural water supplies, unauthorized use of polluted drainage water to irrigate fields also constitutes a growing health concern. Farmers illegally remove approximately 3-4 billion m³ of drainage water annually to apply to their fields. When contaminated with human waste and/or toxic and/or heavy metals, this can impose great health risks, and also adds to rising salinity and pollution levels in agricultural drainage water of the Delta, presenting one of the most important water management challenges facing the country.

Irrigation canals in the Nile Delta region are becoming increasingly polluted, particularly those passing through villages, towns and residential areas. Because of a lack of alternative disposal options, both solid and liquid wastes are routinely dumped into irrigation canals in violation of existing laws. Canals also receive increasing volumes of polluted drainage canal water under official drainage water "reuse" programs meant to supplement irrigation supplies.

Untreated and partially treated municipal wastewater and industrial wastewater from the Giza area is discharged directly into the Muheet and Rahway Drains. Toxic chemicals are discharged by industry at Kafr El-Zayat Drain that takes the effluent down the Rosetta Branch to be discharged to the Sea above Alexandria. Furthermore, many villages discharge raw or partly treated sewage into irrigation and drainage canals. The Damietta Branch receives nutrients (primarily in the form of ammonia) and organics from the Delta Company for Fertilizer and Chemical Industries (in Talkha) and saline agricultural drainage water in the vicinity of the Faraskour Dam. Raw sewage from Al-Kholei village also drains into the Damietta Branch. Water quality in the Damietta and Rosetta Branches deteriorates rapidly downstream of Cairo, and this is especially acute during low flow conditions. At about 120 km downstream from Delta Barrage, the Rosetta Branch receives polluted inflows from five drains (El Rahawy, Sabel, El-Tahreer, Zaweit El-Bahr and Tala).

The principal purpose of the agricultural drainage system is to maintain proper soil moisture levels in fields and to remove accumulated salts. In Upper Egypt, the drainage network discharges directly to main canals of the Nile Valley and to the Nile River. In the Nile Delta, the network collects irrigation drainage water and transfers salts (as well as sediments and other accumulated pollutants) from the soils of cultivated lands to the Northern Lakes in the coastal region and through Rosetta Branch Canal to the Mediterranean Sea.

Since the 1980s, efforts have been underway to extend available irrigation water supplies by mixing drainage water in the Delta with fresh water. When this policy was first conceived, the principal goal was to supplement irrigation canal waters with drainage water of low enough salinity levels to allow, through mixing, for better and additional irrigated lands. Salinity of drainage water upstream of the Delta is relatively low (below 1,000 ppm), but it increases in downstream drains to 2,000-5,000 ppm. Since the irrigation uses for water with salinity levels exceeding 2,000 ppm are quite limited, the Delta drainage water must be “mixed” with “fresh” canal water before use.

In practice, many drains in the Delta region are used to collect not only irrigation and stormwater run-off but also industrial and municipal wastes, and this has seriously complicated implementation of the drainage water reuse policy. For example, in Shoubra El-Kheima, a heavy concentration of industry (including metal fabrication, food processing, textiles finishing, paper production and detergent and soap manufacturing) discharges large volumes of wastewater into agricultural drains. The water contains chemical and biological pollution that can seriously limit its reuse potential for agriculture.

Groundwater in the Delta, largely a shallow underground aquifer fed by of the River Nile, receives pollution from a variety of sources. The excessive withdrawals, especially from coastal aquifers, increase groundwater salinity with negative long-term impacts on water use and soil pollution. Along the Mediterranean coast, high salinity levels occur from seawater intrusion when groundwater withdrawals exceed recharge capacity. In the newly reclaimed areas of the Delta’s fringes, shallow soils cannot effectively protect the aquifer from pollution leaching from agricultural drains and irrigation canals. Groundwater salinity in reclaimed lands (e.g. El Busstan, North of Tahreer and El Salhyiah) is more than 1,500 ppm. Salinity levels along the coast are even higher. Industrial waste sometimes is discharged into unlined lagoons (as in 10th of Ramadan City) where it easily leaks into shallow aquifers. Bacterial contamination of groundwater from raw sewage also is common in many parts of the densely populated Delta. Nitrate concentrations in reclaimed areas range between 70 and 100 ppm, a fact which poses additional health concerns. The Drainage Research Institute has established 140 stations for monitoring agricultural drains. Monthly samples taken at these stations are analyzed for 32 elements such as salinity, BOD, COD, organics, heavy metals and DO. Levels of COD and BOD exceed national ambient water quality standards at every monitoring station, and there also is a deficiency of DO relative to these standards. Certain locations have been deemed so polluted as to pose hazards to public health. The consequence has been the closure of some drainage canal mixing stations or of water treatment plants with intakes on main canals receiving polluted drainage water. An extensive network of 25 mixing stations has been established in the Delta to transfer drainage water back into irrigation canals for reuse, but five reuse stations have had to be closed due to these excessive pollution levels (Table 40). Several others are threatened with closure.

Table 40: Mixing Stations for Drainage Water Reuse in Nile Delta

Pumping Station	Drain	Mixing Location	Annual Discharge (million m³)	Current Status
East Delta				
Wadi	Qaliobia	East Wadi	200	Shut down
Bahr Elbaqar	Bahr Elbaqar	Elbateekh	20	Operating
Belad Elayed	Belad Elayed	East Wadi	150	Operating
Hanout	Hadous	Bahr Mouis	250	Operating
Geneina	Emoum Elbeheira	Elbahr Elsaghir	215	Operating
Saft	Saft Elbahry	Daffan	130	Operating
Elmahsama	Elmahsama	Ismailia	200	Shut down
Upper Elserw	Serw	Damietta Branch	275	Operating
Elsalam 1	Lower Serw	Elsalam	650	Operating
Elsalam 3	Hadous	Elsalam	1350	Operating
Middle Delta				
Upper (1)	Number 1	Damietta Branch	60	Shut down
East Menoufia	Elqarenein	Abbasi Rayah	50	Operating
Mahalet Rouh	Mahalet Roh	Mit Yazid	90	Operating
Elhamoul	Gharbia Main	Bahr Tira	400	Operating
Elgharbia Drain	Gharbia Main	Bahr Tira	800	Operating
Elmahalla Elkobra	Omer Bey	Damietta Branch	100	Operating
Boteita	Gharbia Main	Elzawia	100	Shut down
West Delta				
Elemoum	Elemoum	Nobaria	1000	Shut down
Itay Elbaroud	Itay Elbaroud	East Khandak	60	Operating
Idkou	Idkou	Mahmoudia	90	Operating
Dalangat	Dalangat	Elhager	235	Operating
West Khandak	West Khandak	Abou Deyab	60	Operating
Bostan	Bostan	Nobaria	55	Operating
Dalangat Extension	Dalangat Ext.	Nobaria	80	Operating
Mariout	Elemoum	Nobaria	60	Operating

Municipal Potable Water Systems

Despite the rapid population growth, the percentage of the population with access to municipal water supply has increased substantially over the past two decades. An estimated 95% of households in urban areas and almost 70 % of households in rural areas have currently access to piped water (Table 41). This remarkable extension of the municipal water and wastewater system, however, has not been accompanied by adequate attention to maintenance, resulting in very high seepage losses of 40 to 50%. These losses have, in turn, caused a rise in the groundwater table, creating considerable environmental problems.

Table 41: Municipal Potable Water Systems in Egypt, Rates and Customer Base

System	NOPWASD[20] (Municipalities)	GOGCWS[21] (Cairo)	AWGA[22] (Alexandria)
L.E. per m³			
Estimated Capital and O & M costs	1.0	1.1	NA
Subsidy	0.8	0.9	NA
Average User Fee[5](tariff)	0.2	0.2	0.3
Rate: piastre per m³ [23], [24]	15–25	15–25	25–35
% Of Customer Base			
Distribution of Customers Base			
% Served by House Connections5	Urban 92 Rural 70	95	96
% Multi–Unit Meters	Urban 55 Rural 30	50	48
% Single–Unit Meters	Urban 20 Rural 10	33	40
% Not connected legally or connected but meters are not working [5], [25]	Urban 18 Rural 30	12	8
% Served by Stand posts / donated	Urban 2 Rural 14	1	1
% Unserved[26]	Urban 6 Rural 16	4	3

A recent review of the municipal water supply sector identified three primary causes of piped water service deficiencies: inadequate water treatment capacity and deteriorating treatment plants, inadequate storage capacity, and deteriorating conveyance and distribution networks that cannot withstand the pressures needed to provide reliable water service. High system losses increase the strain on an already overburdened wastewater collection system and are a waste of costly treated water. Leaks also allow contamination of the water delivered, defeating much of the purpose of providing treated supplies. Municipal water and wastewater services are heavily subsidized by the Government. In the municipal areas outside of Greater Cairo and Alexandria, the subsidy level is almost 75%. Low recovery of costs from consumers reduces revenue that water and wastewater agencies can use to repair leaks and improve the services provided.

3.2.2 Valuing Water

As mentioned above, the Egyptian Government is against irrigation water pricing. This attitude is supported by several technical reasons, including:

- The generally small ownership of agricultural land in the Nile Valley and Delta, which renders the issue of metering water supplies to a large number of small farms rather impractical.

[20] National Organization for Potable Water and Sanitary Drainage
[21] General Organization for Greater Cairo Water Supply
[22] Alexandria Water General Authority
[23] Wastewater tariff is 20% of water tariff for Cairo and 35% for Alexandria
[24] These are applicable to the residential units, which have water meters. Those who do not have meters, or their meters are not working, pay a fixed monthly charge for water consumption (L.E. 5–20 monthly/unit). The charge changes with house area.
[25] No service charge for meters' maintenance if meters are not working, it is difficult to repair. In Alexandria there is monthly maintenance charge for meters (a lump sum of 50 piaster). The life span of a meter is 7 years and costs L.E. 300 for ½ inch pipe. In most cases when meter is not working, the client pays an estimated fixed charge.
[26] Unserved people extract either polluted groundwater or surface water from the Nile, canals or drains.

- It is not expected that the high overall efficiency of the Nile irrigation system will be significantly improved as a result of water pricing. This is due to the fact that most water that is lost via canal/drain seepage or from irrigation application onto agriculture fields replenishes the underlying closed aquifer, and can subsequently be retrieved by pumping. Moreover, water drained from agricultural lands in the Nile Valley is routed back into downstream reaches of the Nile.

Furthermore, water pricing will be of insignificant impact in parts of the Nile catchments where soil has a physical structure that allows the cultivation of specific crops only, thus decreasing the opportunity to consider alternative cropping decisions.

4. Identification of stakeholders

This section presents the main stakeholders involved in the outlined water management issues and in water management in the Bahr-Basandeila area. Further contact details are provided in the Appendix of this Deliverable.

4.1.1 Ministries

- Ministry of Water Resources and Irrigation; (MWRI)
- Ministry of Agriculture and Land Reclamation; (MALR)
- Ministry of State for Environmental Affairs; (MOSEA)
- Ministry of Health and Population; (MOHP)
- Ministry of Trade and Industry; (MOTI)
- Ministry of Housing, Utilities & Urban Development; (MHUUD)
- Ministry of Higher Education and the State for Scientific Research
- Ministry of Electricity and Energy; (MEE)
- Ministry of Transportation
- Ministry of Tourism
- Ministry of Interior; (MOI)

4.1.2 Secondary stakeholders, end-user and civil associations

- Farmers (tenants/owners) and farmer organizations, namely WUAs and Water Boards, participate in O&M of the irrigation system at the mesqa and secondary-canal levels.
- Private sector companies (contractors, suppliers and Egyptian and International consultancy firms) undertake services via contracts with the MWRI.
- Public sector companies, or holding companies, owned by the Government, but operating as private establishments (e.g., the two holding companies set up for the management of mega projects in Southern Valley & West Delta and in North Sinai, and the WS&S holding company, subsuming 14 subsidiary companies nationwide).
- Several other holding companies owned by the MWRI and MALR for the construction of irrigation systems, drilling of groundwater wells, land reclamation, etc., and currently being transferred to the ownership of investors and private-sector companies.
- Representatives from key industrial sectors disposing effluents (tanneries, textile, food, refineries, metal).
- NGOs which form an integral part of local communities' development programs in the rural areas (e.g., Shorouq programs overseen by MoLD). Their roles include hygiene promotion and protection of the public health and the environment, improved water supply intakes and sanitation conditions, manual channel maintenance, drinking water saving campaigns, and public awareness.
- Environmental NGOs, i.e. Wafaa El-Nil Assosiation.
- Farmer co-operatives.
- Investors association and the Chamber of Industry.
- Women unions, hospitals and schools

INSTITUTIONAL ANALYSIS AND FOCAL WATER MANAGEMENT PROBLEMS IN THE DAMOUR RIVER BASIN, LEBANON

Prepared by Conseil et Developpement s.a.l.

1. General overview

1.1 Country overview

1.1.1 General Features

The Republic of Lebanon is located along the eastern shore of the Mediterranean Sea between latitudes 33°03 and 34°45 North and 35°05' and 33°30 East. The total area of the country is approximately 10,200 km with a maximum length and width of 200 and 80 km, respectively. The principal topographic features of the country are the coastal plain, the Lebanon and Anti-Lebanon mountain ranges and the Bekaa valley.

In spite of the small area of the country, its physiographic structure includes a variety of contrasting features. In general, five geomorphological regions can be distinguished:

- The coastal zone, including the shoreline, the coastal plain and Mount Lebanon foothills.
- Mount Lebanon.
- The Bekaa plain.
- Anti Lebanon.
- South Lebanon.

The climate in Lebanon is typical Mediterranean with dry summers and wet winters. The seasonal precipitation variation is partly due to the mountainous topography and partly due to two large-scale weather systems: the maritime and Eurasian continental air masses. The maritime air mass, which basically accounts for all rainfall in the country, is caused by Mediterranean storms, which traverse the country from October to April. Dry cold north-west winds from the Eurasian land mass also enter the country during the winter and mix with moist maritime air to cause heavy snowfall in the mountains. During summer, hot dry air of Eurasian origin follows a curving path around Cyprus and across Lebanon. Meteorological data are collected from the 40 meteorological stations established in all watershed basins.

The mean annual rainfall along the coast ranges between 700 and 1,000 mm, increasing from south to north. Mount Lebanon forms a barrier to rain movement. Precipitation in this area can reach more than 1,400 mm/yr, mostly due to snowfall. Rainfall declines rapidly on the eastern slopes of the Mount Lebanon range, reaching only 600 mm on its foothills. Precipitation in the Bekaa plain ranges from 800 mm in the South Bekaa to values lower than 200 mm in the farthest northeast part of the plain. Precipitation on the Anti Lebanon range is around 600 mm, and exceeds 1,000 mm in the Jabal Al-Sheikh.

In 2005, the permanent population of Lebanon was estimated at approximately 4.5 million inhabitants, of which more than one third lives in the greater Beirut area. The largest part of the population (37.49%) resides in the area of Mount Lebanon; however more than 50% of this population lives within the suburbs of Beirut and is served by the water authorities of Greater Beirut area. Nabatiyé and south Lebanon have the lowest population shares, equal to 6.98 and 8.72%, respectively. Administratively, these two Mohafazats correspond to the southern part of Lebanon and their total population share is 15.7%. The lowest population share corresponds to the area of Bekaa (12.27%).

1.1.2 Water Resources & Demand

Water resources

- Annual run-off occurs mainly between February and July.
- All wadis (i.e. streams) are dry during the summer season.
- The flow of all major rivers is negligible between August and January.
- The total annual surface run-off is estimated at 4300 million m^3.
- The total annual ground water recharge is estimated at 1280 million m^3.
- The annual stable exploitable water resources are estimated at 143 million m^3.

Watershed basins

- Lebanon has 14 perennial rivers and 24 main seasonal wadis.
- Lebanon can be divided into 26 watershed basins, of which:
  - 14 are basins of perennial rivers, and
  - 12 are coastal basins of seasonal wadis.

Water demand

- Domestic water demand is estimated at 200 million m^3/yr.
- Industrial water demand is estimated at 30 million m^3/yr.
- Irrigation water demand is estimated at 825 million m^3/yr. At present, only 60,000 ha are irrigated from a total irrigable area of 125,000 ha.

1.2 Overview of the Damour River Basin

The region selected for the project implementation is the Damour River Basin. Damour is a coastal village located 20 km to the south of Beirut. The population of the area is around 75,000 inhabitants. It is an important and necessary crossroad, linking Beirut to the Shouf Caza in the Mount Lebanon, and to other southern cities and villages such as Saida, Tyr and Nabatiyeh. In brief, the main issues characterizing water management in the area are:

- The Damour village relies on both groundwater (public and private wells) and surface water (Damour River – Water Basin 10) sources.
- The Damour River is a shared water resource among several villages. This fact triggers conflicts among its users (upstream and down stream).
- The Damour River is a vital socioeconomic resource, since it is used, in addition to few artesian wells, for irrigation.
- The deterioration of the water quality of the Damour River, due to the discharge of waste (sewage and industrial wastes) is a key problem.
- The Saadiyat area, which belongs to Damour Village, does not have access to piped water networks. Instead, private wells are extensively utilized for domestic purposes to meet the basic water needs. This threatens the availability of the groundwater resources in terms of both quality and quantity.
- The water resources (public wells) in Damour are used by the Beirut Water Authority for external supply. This increases the pressure on the groundwater resources in the area (shared groundwater use).

Figure 52 shows the different water basins in Lebanon, including the one of Damour. Table 42 summarizes key indicators for the basins, whereas Figure 53 presents the main sources of environmental pressures in the area.

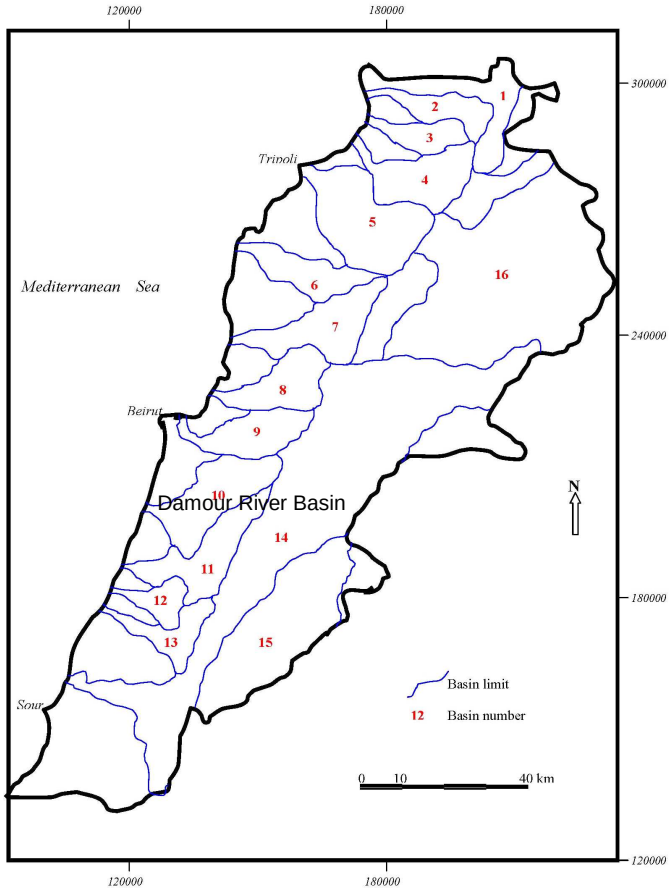


Figure 52: The location of the Damour River Basin

Table 42:River Basin Areas – Key statistics

No.	Major water course	Area (km^2)	Population (Million persons)
1	El-Kabir River	195*	0.08
2	Estwan River	146	0.057
3	Arka River	121	0.036
4	Al-Bared River	284	0.038
5	Abou-Ali River	482	0.126
6	El-Jauz River	196	0.038
7	Ibrahim River	326	0.095
8	El-Kalb River	237	0.069
9	Beirut River	216	0.276
10	**El-Damour River**	**333**	**0.076**
11	El-Awali River	291	0.062
12	Siniq River	102	0.024
13	El-Zahrani River	140	0.038
14	Litani River[27]	2170	0.68
15	Hasbani River	680*	0.058

[27] Area within Lebanon

No.	Major water course	Area (km^2)	Population (Million persons)
16	Al-Assi River	1720*	0.32
Total		**7640**	

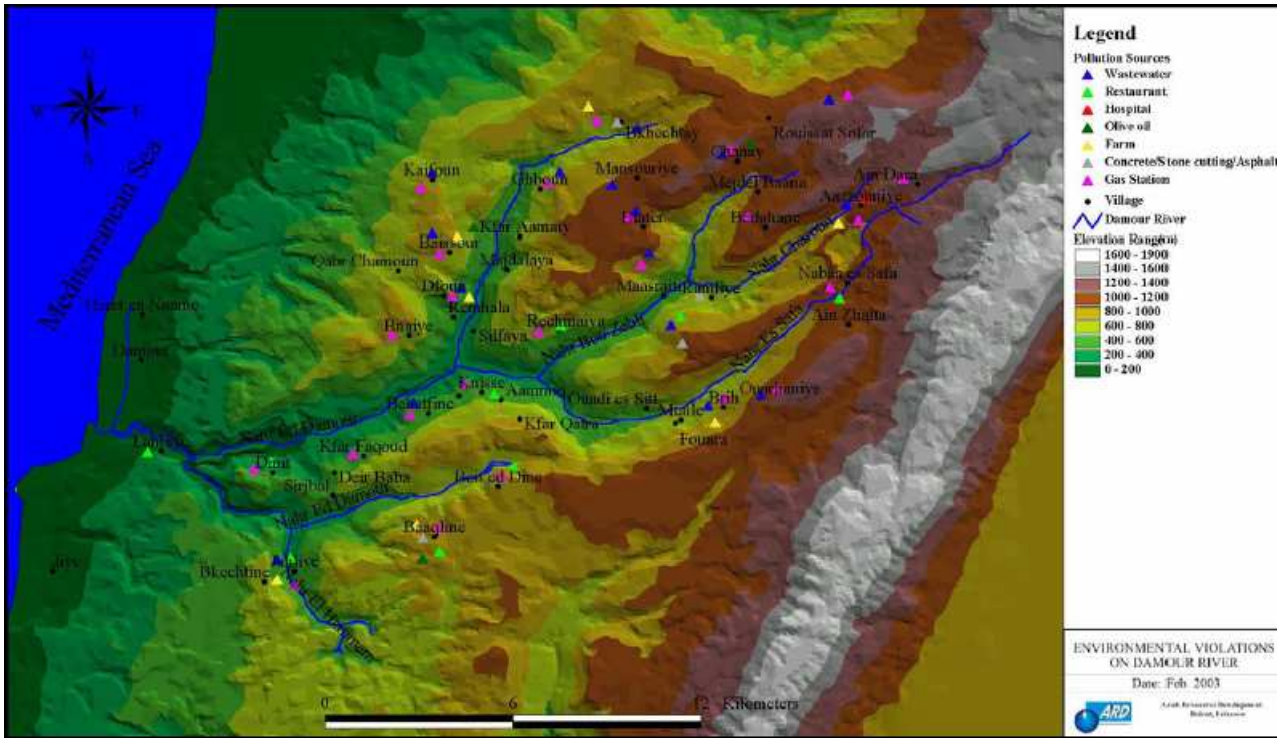


Figure 53: Sources of environmental pressure in Damour River Basin

1.2.1 Hydrological Characteristics

Meteorological conditions

The Damour coastal area has a yearly average humidity level of 67.5%. The highest humidity level occurs during the summer, ranging between 71% in June to 73% in August. Such high levels are mainly associated with its location along the coastline. The total and effective rainfall levels are estimated at 600 mm/year and 507.8 mm/year, respectively. Annual evapotranspiration is estimated at 1592.95 mm/year (Lebanese Meteorological Service).

Surface Water Resources

The Damour River is a perennial river with a length of 40 km. Its watershed extends over an area of 305 km^2 and has a maximum elevation of 1948 m, from which the river originates (Dar Al-Handasah, 1996). Its lithological characteristics comprise both karstic (27%) and non-karstic formations (73%). Two major springs, Es Safa and Barouk, contribute to river water discharge. Additionally, the river is formed by the convergence of three minor rivers: Es Safa, Zeble, and el Hamam. The average annual yield of water discharge, recorded for the years 1992-1993 and 1994-2001, was about 100 million m^3/yr, with an average annual flow rate of 8.2 m^3/s.

Groundwater Resources

Groundwater resources mainly exist in the Sannine Aquifer, which is protected from direct contact with the sea by the Chekka formation. This is in contrast to the situation in Saadiyat area. This aquifer is recharged through infiltration of precipitation run-off from the Damour River.

A total of 64 public and private wells operate in the village of Damour. Of those, 16 public wells, 14 belonging to Beirut Water Authority (BWA) and 2 municipal ones, are used for domestic supply. With regard to private wells, 44 are used for domestic purposes, whereas 6 are used for irrigation. Forty-two (42) private wells are utilized in Saadiyat Area for potable supply, since the area does not have a piped water network. The total annual volume of water exploited from all 64 wells ranges between 1.14 million m^3 to 8.9 million m^3, provided that the Beirut Water Authority wells operate from July until January (Table 43). Eighty percent (80%) of the water extracted from the 14 BWA public wells, during this period, is delivered to Beirut and Ain el Delbi. There area has also several springs in Damour.

Table 43: Results of Well Survey in Damour

Type	**Uses**	**Aquifer Tapped**	**No. of wells with known pump discharge**	**Total wells**	**Average Pump Discharge (m3/d)**	**Volume Exploited (million m^3/year)**	
						Min	**Max**
Beirut Water Agency	Domestic	Sannine	14	14	3115	-	7.2[28]
Barouk Water Agency	Domestic	Sannine	2	2	2376	0.29	0.58
Private	Domestic	Sannine	44	44	310	0.31	0.41
	Irrigation	Sannine	6	6	1958	0.54	0.71
Total No. of wells and the total yearly discharge			**64**			**1.14**	**8.9**

1.2.2 Socioeconomic framework

Damour has an agricultural economic profile, with bananas and vegetables being the main types of crops cultivated in the area. For this reason, the Damour River is of major socioeconomic significance, as it is used for the irrigation of the agricultural plains. Two dams, upstream and downstream, were constructed to divert water for irrigation. Currently, the water is diverted at a rate of 1,100 m^3/hr downstream, and 650 m^3/hr upstream. The overexploitation of river water by upstream users leads to downstream water shortages, especially during the summer season. This would affect agricultural activities in the deprived areas. Additionally, it causes conflicts between the Damour Municipality and upstream users, especially due to the lack of relevant legislation for water allocation. Moreover, environmental violations committed upstream affect the downstream river water quality, which in turn can adversely affect the crops in the plains.

It should be noted that the political instability in Lebanon led to the displacement of the majority of the Damour population. This caused the loss of the human and financial resources necessary for the development of the area. Given the current, relatively more stable, situation, displaced population could return to Damour causing a large increase in water demand. Finally, the recently developed Saadiyat area lacks proper access to water supply. It has been reported that the village inhabitants do not have sufficient resources to pay municipality fees for water supply, and thus prefer to use their own private wells.

[28] The Beirut Water Authority wells operate only from July to January, i.e. for a period of 6 months/yr

2. Institutional & Financial Context

2.1 Institutions & Responsibilities

The responsibilities of the main actors in water management at the constitutional, organisational and operational level are outlined in Table 44.

Table 44: Responsibilities in water management

AUTHORITY	RESPONSIBILITIES
Ministry of Energy and Water (MEW) *Decision 144/1925* *Decision 320/1926* *Law 221/2000 – art. 2 amended by Law 337/2001* *Decree 14438/1970*	– Collects, controls, meters, establishes statistics and studies water resources, evaluates water needs and fields of its usage all over the Lebanese territory. – Controls the surface and underground water quality and identifies standards to be applied. – Establishes the General Planning Project for water resources allocation, allocation between drinking and irrigation water at the national level, as well as prepares the National Water and Wastewater General Master-plan and updates it continuously, and submits it through the Minister to the Council of Ministers for approval. – Designs, studies, implements and operates large water installations and works such as dams, artificial lakes, tunnels, water courses rectification, water networks etc. – Implements, when needed, artificial recharge of aquifers and controls groundwater extraction. – Protects water resources from losses and pollution by elaborating legislation and taking necessary measures and dispositions to prevent water pollution, and undertakes measures to restore water bodies back to their former quality. – Issues licenses and permits for water abstraction, public water usage and temporary occupation of public properties and finalizes all necessary formalities according to the laws and by-laws in force. – Implements studies and hydraulic, geological and hydrological surveys to collect technical data relative to water resource assessments, establishes technical maps concerning these studies, surveys and data, and regularly updates them. – Carries out control and tutelage over Public Establishments and other bodies operating in the water field, according to the present law dispositions, texts and stipulations relative to each establishment and institution. – Ameliorates the performance of the Water Exploitation Public Establishments (WEPEs) and evaluates their performance on the basis of indicators mentioned in the action plans, approved according to the legal procedures. – Establishes standards to be adopted in the studies conducted by Water Exploitation Public Establishments, as well as during their implementation. – Establishes conditions and regulations for extraction and use of surface water, groundwater and management of wastewater their quality standards and control. – Prepares and carries out expropriation formalities relative to the MHER and WEPEs submitted to its tutelage according to the laws and regulations in force. – Expresses expert opinion on the licensing of quarries and mines according to their impacts on water resources. – Raises public awareness on rational water use and provides to the public all necessary information concerning water issues.

AUTHORITY	RESPONSIBILITIES
Ministry of Public Health (MPH) *Decree Law 227/1942 art. 2* *Decree No. 8377/1961, art. 38, 61, 84, 95* *Decree-Law 108/1983*	– Monitors the safety of drinking water (microbiological and physicochemical-properties). – Analyzes drinking water samples. – Authorizes the usage of water resources for drinking purposes – Issues permits for mineral water bottling.
Ministry of Environment (MOE)	**Law 690/2005- art. 2:** – Sets urban and industrial wastewater treatment strategy, policies, plans, and studies – Implements environmental protection measures for aquifers, coastal areas, wetlands and water streams. – Monitors surface water and groundwater quality. **Law 690/2005- art. 6:** – Monitors the implementation of environmental measures in the exploitation of water and for the protection of aquifers, seaside, wetlands and water streams. – Monitors the impacts of environmental pollution on climate change. **Law 444/2002- art. 36:** – Draws-up of a water quality inventory for groundwater and surface water. – Draws-up a water quality inventory for supplied potable and irrigation water. – Establishes bacteriological and physico-chemical standards for groundwater and surface water quality. – Establishes bacteriological and physico-chemical standards for supplied drinking and irrigation water. – Establishes bacteriological and physico-chemical standards for recreational water. – Proposes and establishes methods of analysis for all above mentioned waters. – Establishes procedures for wastewater collection and treatment and monitor their implementation. – Sets protection measures for any potential hazards that can affect water quality and monitors their implementation. **Decision 129/1/1998:** – Classify Damour river area as natural reserve. – Set a protection zone covering 500m from each side of the Damour river.
Ministry of Agriculture (MOA) *Legislative decree No. 31/1955, art. 1* *Decree 5246/1994, art. 96* *Decree No. 5246/1994, art. 103*	– Manages water supply for irrigation – Constructs small-scale irrigation water supply projects (artificial lakes, storage tanks, etc.) – Conserves and utilizes water resources – Enhances and monitors irrigation systems and manages small and medium irrigation projects
Ministry of Public Works and Transportation (MOPWT) *Decree 1610/1971, art. 35*	– Authorizes sea dumping (Law 444/2002- Art 31) – Provides meteorological data through its Meteorological Department of the General Directorate for Civil Aviation – Carries out infrastructure works related to water distribution network
Ministry of Interior and Municipalities (MIM) *Decree 4082/2000*	– Maintains and rehabilitates infrastructure (water, wastewater, and storm water drainage systems)

AUTHORITY	RESPONSIBILITIES
Beirut - Mount Lebanon Water and wastewater Establishment (B&ML WWA) *Law 221/2000 – art. 4 amended by Law 337/2001 Decrees 14596/2005-14597/2005-14637/2005*	– Carries out surveys and assessments, operates, maintains and renews projects for potable and irrigation water distribution, as well as wastewater collection and treatment, according to the General Water and Wastewater Master-plan or according to the Ministry's prior permit on base of the Ministry's choice for the establishment of wastewater (WW) treatment plants or new sites for WW effluent discharge. – Proposes drinking, irrigation water and WW services tariffication systems, taking into consideration the general socio-economic conditions of the country. – Monitors the quality of distributed drinking and irrigation water, as well as the quality of wastewater and effluent of wastewater treatment plants.
Beirut Water Agency (BIWA) *Decree 3971/1951 abolished by law 221/2000*	**Mandate transferred to B&MLWWA by law 221/2000:** – Supplies drinking water to Beirut and suburban regions. – Collects fees from water consumers in Beirut and suburban regions.
Barouk Water Agency (BWA) *Law of july 20th, 1956 abolished by law 221/2000*	**Mandate transferred to B&MLWWA by law 221/2000:** – Supplies drinking water to Chouf area – Collects fees from water consumers in Chouf area
Municipalities (Damour and other) (MUNICIP) *Law 316/2001*	– Monitor the safety of drinking water (microbiological and physicochemical properties)
Litani River Authority (LRA) *Law of August 16th, 1954*	– Monitors water quality and quantity in all rivers and water streams – Implements the Litani River project for irrigation and drinking water supply and hydroelectricity production
Council of Development and Reconstruction (CDR)	– Implements water projects, according to the National Master Plan.
Green Plan *Decree No. 13785/1963, art. 1*	– Is involved in land reclamation. This entails the installation of irrigation canals and distribution networks.
LIBNOR *Law of July, 23th, 1962*	– Establishes all kind of standards and guidelines – Renders standards mandatory (drinking water standard 161:1999)
Ministry of Displaced (MOD) *Decree No. 6504/1995, art. 16*	– Assesses the maintenance and rehabilitation needs for the infrastructure (water, electricity…) in the displaced areas.

Table 45 summarizes the role of main actors in different aspects of water resource management, thus outlining potential overlaps. In summary, the main areas of conflict are:

- **Establishment of standards**, where current legislation empowers the Ministries of Public Health, of Energy and Water and of Environment, as well as LIBNOR, with the responsibility of establishing quality standards on drinking water, effluent from wastewater treatment plants and discharge in the water environment.
- **Water quality control and monitoring**, which is responsibility of the Ministries of Environment, Energy and Water, of Public Health, of the water authorities and of the municipalities without the establishment of any data communication procedures.

Table 45: Water resources planning matrix

ACTIVITY	MEW	MPH	MOE	MOA	MOPWT	MIM	B&ML WWA	BIWA	BWA	MUNICIP	LRA	CDR	GPLAN	LIBNOR	MOD
Surface waters															
Use	X			X			X	X	X				X		
Storage	X			X	X		X	X	X			X	X		
Groundwater recharge	X						X	X	X			X			
Diversion (recreational water)	X	X				X				X					
Quality monitoring	X		X								X				
Assessment	X										X				
Groundwater															
Use	X						X	X	X			X			
Storage	X				X		X	X	X	X		X			X
Recharge	X		X		X		X	X	X			X			
Quality monitoring	X	X	X				X	X	X	X					
Assessment	X														
Well permits	X	X													
Irrigation network															
Rehabilitation	X		X	X			X					X	X		X
Modernisation	X		X	X			X					X	X		X
Reuse															
Drainage water	X		X							X		X			X
Wastewater	X	X	X			X				X					X
Desalination															
Introduction of technology															
Efficient water utilisation															
Domestic	X	X	X				X	X	X			X			
Industrial	X		X				X	X	X			X			
Agricultural	X		X	X			X	X	X			X			
Legislation															
Regulation and codes	X	X	X	X											
Standards	X	X	X											X	
Policy setting	X														
Water allocation	X														
Project financing	X				X							X	X		X
Project design	X											X	X		
Project implementation	X						X	X	X			X	X		
Operation and Maintenance	X						X	X	X				X		
Pricing (tariffs)	X														
Enforcement	X	X	X	X	X	X				X					
Water data records	X	X	X	X			X	X	X	X	X		X		

2.2 Legislation

The Lebanese law governing the water sector dates back to the Ottoman and French regimes. The out-of-date law, coupled with the "political instability" that Lebanon witnessed during the period 1975-1989, brought about many conflicts associated with the mismanagement of the water sector (MOE et al., 2004). However, the recognition of the significance of sustainable water management oriented policy makers towards the development of new laws addressing:

- **The management of the water sector (Law No. 221 of 2000 and its amendments)**, which aimed at fostering institutional change and assigning the responsibilities to parties governing the water sector (mainly the Ministry of Energy and Water and water and wastewater utilities). However, the law was not based on a profound assessment that considered the current political, legal, socioeconomic and environmental situation in Lebanon. This resulted in several drawbacks, such as:
  - The modification of many laws, decrees, and decisions, which are often contradictory, and
  - The generation of conflicting rather than complementary roles among the institutions.
- **Environmental protection (Law No. 444 of 2002)**, which strenghtnened the role of the Ministry of Environment (MOE) in promoting the sustainable use of natural resources, the prevention of environmental pollution and degradation, and public safety within the framework by a stable environment. However, the lack of enforcement decrees and mechanisms for this law results in its ineffective implementation.

The aforementioned weaknesses were the basis for the non-implementation of many laws, decrees, and regulations. The lack of financial, human, and technological resources aggravates the situation. Details on the main national laws, their focus, content, and implementation status are presented in Table 46.

Table 46: List of Main National Laws related to the Water Sector

Reference	Focus	Content	Implementation Status
Decision No. 320 of 1926	Water Quality	Emphasizes on the prohibition of the direct or indirect disposal of animal manure and the formulation of wastes depots within the haram (protection zone) of water springs used for public use.	Not implemented since it is outdated
(General Health Rules) Legislative decree No. 16/L of 1932	Water Quality	Emphasizes on the development of a protection zone around a well or a spring used for drinking water supply, and the prevention of any activity of potential risk within the protection zone.	Not seriously implemented since it is outdated and not revised.
(Protection and Use of Public Water Properties) Decree No. 2761 of 1933 (articles 5&6)	Water Quality	Emphasizes on the prohibition of the direct or indirect wastewater discharge and waste disposal into the sea and water streams.	Not implemented due to lack of enforcement mechanisms

Reference	Focus	Content	Implementation Status
(Drinking water abstraction projects) Legislative decree No. 227 of 1942 (articles 2 &4)	Water Quality	Emphasizes the authorization of the usage of water resources for drinking purposes and the identification of protection zones.	Not implemented
(Water Sources Protection Zone delineation) Decree No. 10276 of 1962 amended by decree 7007 of 1967	Water Quality	Emphasizes on the identification of protection zones for water resources, based on the results of geological studies.	Implemented but the council responsible of determining the protection zone does not have the resources required.
(Water Sector Management) Law No. 221 of 2000, article 2, paragraph 11	Water Quality	Indicates the responsibility of the MEW in the assessment of the water quality.	Implemented by the regional water and wastewater establishments for few physiochemical parameters.
(Environmental Protection) Law No. 444 of 2002, article 35 &36	Water Quality	Indicates the coordination between the MOE and MEW for developing an Integrated Approach towards the management of natural resources, in addition to setting the criteria for implementing and supervising appropriate disposal and discharge methods of pollutants of potential risk to water sources.	Not implemented due to the lack of coordination mechanisms between the ministries
(Guidelines and Criteria for Permitting the Construction and the use of Industries) Decree No. 8018 of 2002, article 20	Water Quality	Indicates the required distances of the industrial zones from the surface and groundwater bodies.	No adequate legislation
(Criteria for the Use of Sand and Rock Quarries) Decision No. 182/1, 183/1, 184/1, 185/1, 186/1 of 1997, Articles 2	Water Quality	Emphasizes on conducting EIA studies for proposed quarrying sites (to protect the water resources)	There is no implementation decree
(Wastewater treatment plants liquid waste and air pollution standards) MOE, Decision 8/1 of 2001, Appendix 4 & 5.	Water Quality	Involves the criteria and standards of wastewater and air pollutants that should be discharged or emitted from a wastewater treatment plant for the protection of the water resources and the environment.	Partially implemented
Decision No. 320 of 1926	Water Quantity	Emphasizes on the problems of water usage and allocation	Still implemented

Reference	Focus	Content	Implementation Status
(Environmental Criteria to Permit the Construction and the Use of Tanneries) Decision No. 75/1 of 2000, article 3, paragraph 1-3	Water Quantity	Emphasizes on: a) the rationalization of water use along the industrial production course, and b) water reuse.	There are no specific guidelines.
(Environmental Criteria to Permit the construction of buildings within the protection zones of rivers belonging to the Ministry of Environment) Decision No. 90/1 of 2000, (article 2, paragraphs 1&2)	Water Quantity	Emphasizes on rationalizing water use in construction activities.	Not implemented due to the lack of enforcement mechanisms.
(Environmental Criteria to permit the construction and the use farms, dairy processing plants, plastic industries, and fruit processing plants) Decision No. 3/1of 2000, (article 3, paragraphs 1&3), Decision No. 5/1 of 2000, (article 3, paragraph 1&3). Decision No. 16/1 of 2001, (article 3, paragraphs 1&3), Decision No. 29/1 of 2001, (article 3, paragraphs 1&3) Decision No. 61/1 of 2001, (article 3, paragraph 1&3),	Water Quantity	Indicates water conservation methods to limit water consumption in production and cleaning in industrial settings. Examples are: dry cleaning, high pressure nozzles, and the" BATCH" method used for cleaning fruits and vegetables.	Not implemented due to the lack of enforcement mechanisms.
(The Management of Water Abstraction and its Use) Decree No. 14438 of 1970, articles 2, 11, 16	Water allocation (water abstraction)	Emphasizes the necessity of getting a 4 -year permit for groundwater abstraction (springs), and drilling boreholes exceeding 150 m of depth. The permit should also include the purpose of use (domestic, agricultural, or industrial).	Not totally enforced due to the inadequacy of the law given that the government cannot provide secure water resources.
(General Health Rules) Legislative decree No. 16 of 1932, article 14	Water allocation (Domestic use)	Indicates that a minimum drinking water quantity of 5L/capita/day is to be allocated for an area of at least 500 inhabitants. NB. The exact amount of required domestic and drinking water has not been yet estimated.	Not implemented since the law is outdated.
(General Industrial Health Criteria) Decision No. 6/1 T of 1936, appendix 2	Water Allocation (Industrial use)	Emphasizes the prevention of the use of wells or cisterns/tankers as sources for water supply. Instead, water should only be supplied from the public piped water network, or springs.	Not implemented since the government cannot secure enough water.

Reference	Focus	Content	Implementation Status
(Management of Water Abstraction and Its Use) Decree No. 14438 of 1970, article 9	Water tariffs	Indicates the annual fees for water abstraction in public (1,000,000 LL/yr) or private (500,000 LL/yr) properties. This also includes the cost of property damage and the cost of utilizing the property.	Implemented
(Water Use System in Tripoli) Decree No. 10231 of 1955, article 1, paragraph A	Water tariffs (domestic use)	Flat annual rate is charged for areas without a metering system.	Not yet implemented
(The Management of Water Abstraction and Its Use) Decree No. 14438 of 1970, article 15	Water tariffs (Agriculture and industry)	Indicates the annual rates per 1 m3 of the total amount of water licensed for irrigation (100 LL/m3), and industrial activities (600 LL/m3). This may also include the cost of damage of the property.	Not enforced
(Water Sector Management) Law No. 221 of 2000, (article 4, paragraph 1)	Water tariffs	Indicates the necessity for recommending a new tariff structure for drinking and irrigation, taking into account the socioeconomic situation.	Partially implemented
Decision No. 320 of 1926	Water Rights	Emphasizes the problem of water rights	Implemented as water code
(Public Property) Decision No. 144/S of 1925, article 2	Water Rights	Indicates the water resources owned by the public sector (shores, lakes, waterfalls, rivers, dams, hydraulic infrastructure used for public use…)	Implemented
(The Law of Real Estate) Decision No. 3339 of 1930, article 60.	Water Rights	Indicates that water springs that cannot be used for the public benefit can be owned by individuals.	Implemented
(Environmental Protection) Law 444 of 2002, article 57	Sanctions	Identifies the set of administrative penalties by the MOE, which are; a) payment for the restoration of damaged sites, b) annulment of permits, c) setting mitigating measures for projects to reduce their impacts, d) charging of penalties.	Not implemented due to the absence of enforcement mechanisms
(The Law of Penalties) Legislative decrees No. 340 of 1943, paragraphs 745-749	Sanctions	Imprisonment of those who executed any offensive activity, such as unauthorized drilling, pollution of water sources… This also involves paying of penalties.	Implemented

Up to now, the water sector has been governed by a centralized system and is under the jurisdiction of the following governmental institutions:

(p) the Ministry of Energy and Water (MEW),
(q) the Ministry of Environment (MOE), and
(r) the Ministry of Public Health (MPH).

Other parties such as the Ministry of Agriculture (MOA), the Ministry of Public Works and Transportation (MPWT), the Ministry of the Interior and Municipalities (MIM), the Ministry of Displaced (MOD)[29], the Regional Water and Wastewater Establishments, the Litani River Authority (LRA), and the Council for Development and Reconstruction (CDR) also play a role. The municipalities are responsible for implementing water projects according to the National Master Plan set by the MEW.

MEW is responsible for developing the National Master Plan for water management. Additionally, the law states the responsibility of the MEW in supervising and coordinating the activities of all institutions concerned with water management-related issues. However, those activities are presently not undertaken by the MEW, due to lack of human resources. Moreover, the activities of the different institutions are not being coordinated, since a framework implementing cooperation and coordination mechanisms is not advocated by the law. Figure 54 presents the organizational chart of the main actors involved in water management in the country.

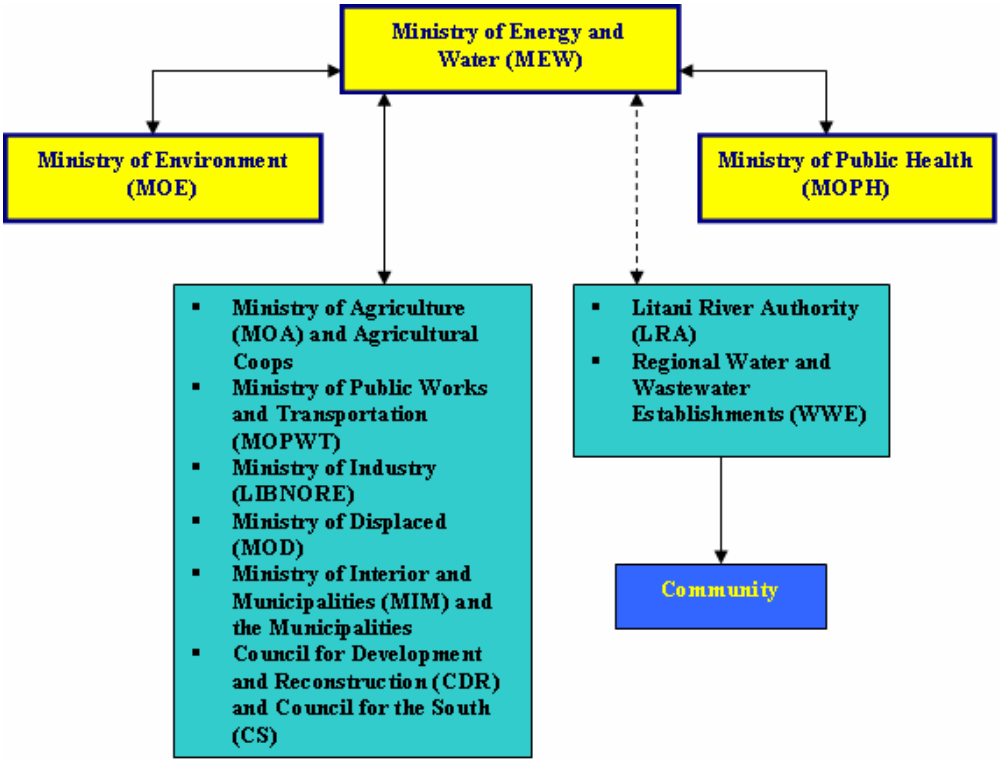


Figure 54. An organizational chart of the institutions governing the Water Sector

2.3 Financial Framework

Law 221 empowers regional water authorities to set and collect water tariffs for domestic and agricultural use. Connection charges for domestic water supply vary among Water Boards and are determined according to water availability and distribution costs, as distribution by gravity is the cheapest, while distribution by pumping is far more expensive.

[29] Ministry of Displaced is a temporary ministry that aims at the rehabilitation of displaced areas destructed during the period of "political instability" (1975-1989). Once its mission is completed, the ministry will be liquidated.

Most households undertake additional expenses to meet their water needs. Assuming that households with a 1 m^3/day meter subscription actually receive and consume this amount of water per day, they would be bear a cost ranging from US$ 0.12/m^3 to US$ 0.42/m^3. However, in reality, most households end up paying much more per cubic meter for two reasons mainly:

- Frequent and periodic water shortages (some areas report receiving water only a few hours per day) and
- Need to buy water from private suppliers, at costs ranging US$5 to US$10 per cubic meter.

In particular, secondary residences pay the full annual water subscription tariff, even though they use the residence only a few weeks or months during the year. In short, and as long as water meters are not installed, water tariffs will not be associated with consumption volumes, and people will pay the same amount regardless of the quantity of water actually delivered/consumed. Users have no incentives to conserve water and wasteful use is a common phenomenon.

In view of the projected water shortages that Lebanon will face, the MEW has initiated several programs to better manage Lebanon's water resources through the formulation of a 10-year plan for the period 2000-2009 for water and wastewater management. The proposed plan contains actions that deal with water issues and with electricity infrastructure.

Nearly two-thirds of the budget are allocated for the development of additional water resources (i.e. supply-side measures). Such infrastructure investments aimed at alleviating water shortages by increasing water supply. Combined efforts should be made for improving water efficiency (water metering, elimination of illegal connections, introduction of on-farm practices for the efficient use of irrigation water), and securing alternative water resources, such as treated wastewater.

On the other hand, and while the government has been advocating private sector participation in many sectors including water, there are still many factors hindering private sector involvement. Reasons include gaps in the current legislative framework and unclear procedures for creating and sustaining public-private partnerships. In the absence of an overall strategy, the Government is pursuing a piecemeal approach, proceeding with a management contract with a private operator in the city of Tripoli and considering other arrangements supported by the World Bank in Baalbeck. As these specific efforts succeed, different donors may encourage different or contradictory approaches. Private sector participation efforts grow, partly due to the recognition of the weak performance, inadequate staffing, and poor resources of the regional water authorities. These efforts are closely linked to a planned merger of authorities, but a clear and broadly accepted understanding of the operational partnership among the central, regional authorities, and the private operators has not yet emerged and probably is a premature step in the overall process.

3. Identifying Focal Problems in Water Management

3.1 Constraints facing the Water Sector

3.1.1 Natural constraints

The water sector of the Damour area suffers from different problems, due to various causes and constraints. The main natural cause can be linked to the sustainability and availability of water in terms of quality and quantity, mostly during the summer. The short period of precipitation and the torrential flow of the Damour River influence the disparity in water availability. In order to resolve this problem, both water authorities and private users resort to the overexploitation of the coastal aquifer, which in turn results to different technical threats.

3.1.2 Technical constraints

The main technical problems are the:

- Overexploitation and pollution of the Damour River,
- Overexploitation of the BWA public wells,
- Overexploitation of private wells in the Saadiyat Area, and
- Water losses in distribution networks and improper irrigation practices.

These issues are aggravated by the absence of legislation for the management and monitoring of both surface and groundwater resources in the village and the basin as a whole, and the lack of awareness among the community to prevent or mitigate such issues.

Overexploitation and Pollution of the Damour River

There has been a decrease in the volume of water discharged at river mouth between the years 1992 and 2001. In the year 2000-2001, around 96% of the discharge occured during the wet season (December-April) with a total yield of 55,468 million m^3/yr. This amount corresponded to a 55.07% reduction when compared to the average annual yield of 100,717 million m^3/yr. This can be attributed to the:

- Drop in the precipitation levels, and
- Overexploitation of groundwater (springs and/or aquifers) and surface water sources.

In addition, there are several industrial activities in neighboring villages, such as olive pressing, stone cutting, cement and asphalt production. Such industries tend to dispose their waste in the river. The detected Chemical Oxygen Demand (COD) levels confirm the possible release of such wastes. Additionally, sewage disposal, from restaurants and houses into the river is also practiced due to the absence of wastewater treatment plants. Moreover, agricultural activities along the river are a major cause for the presence of agrochemicals. This has been confirmed through the measured levels of phosphates' concentrations.

Overexploitation of BWA Public Wells

The 14 BWA wells are utilized for external water supply (western Beirut) from July to January. The extracted volume of water reaches 7.2 million m^3/yr (Table 43). This practice puts pressure on the aquifer, leading to seawater intrusion, as was confirmed by the elevated TDS and chlorides levels in well water samples.

Overexploitation of Private Wells in the Saadiyat Area

The Saadiyat area is an agglomeration of displaced population residing in illegal dwellings and depending on private wells for potable water supply. The heavy reliance on these wells, due to the absence of piped water networks, and the uncontrolled utilization of such sources led to the abstraction of excessive amounts of water. The daily values of water consumption have reached 340 to 400 l/capita/day, exceeding the normal average domestic consumption values of 150 l/capita/day. Such values could explain the elevated TDS and chlorides levels in the analyzed water samples from private wells, as a result of seawater intrusion.

Water losses in distribution networks and inefficient irrigation practices

Water losses in distribution networks were estimated to range between 25 and 50% during the winter season and 45 and 61% during summer. This is in line with the general situation in Lebanon with respect to water losses. Such figures are estimates, since water metering is considered inefficient. Irrigation depends mainly on the Damour River, in addition to few artesian wells. Results confirmed the overexploitation of the river water and the wells, when comparing actual water consumption values with theoretical ones. The highest level of water consumption occurs during the summer season and is coupled with the use of surface irrigation methods.

All the aforementioned factors have led to the degradation of the quality of the water resources in the area. Water quality measurements have revealed an increasing trend in the levels of chlorides over the years (1990-2003) in water samples taken from the public wells of the BWA, thus confirming the possibility of seawater intrusion. Water samples from the municipal and private wells in the area have further confirmed seawater intrusion, as the chlorides and TDS levels were found to be high, exceeding the corresponding Guidance Value and the Maximum Acceptable Value of the MOE, and ranging between 20 to 1240 mg/l and 239 to 1850 mg/l, respectively. The highest chloride and TDS levels were detected in Saadiyat due to the existence of numerous wells, in addition to the direct contact of the Sannine Aquifer with the sea.

Despite the deficiencies in sanitation services, contamination has not been detected in any of the well and network samples. However, this does not necessarily reveal the absence of any risk of contamination of the groundwater resources by sewage discharge. Conversely, sewage contamination was detected in two river samples. This is due to sewage directly discharged into the river without prior treatment. Moreover, the increased Chemical Oxygen Demand (COD) levels in those samples indicate the existence of industrial waste in the river. This was expected, given the presence of several industrial activities along the river, such as olive pressing, stone cutting, concrete, and asphalt which tend to discharge their wastewater in the river without any prior treatment.

3.1.3 Financial, administrative & institutional constraints

Financial constraints can be summarized in the inadequate recovery of costs for water supply provision. Water supply agencies can barely cover their operating expenses. On the other hand, and as mentioned above, the administrative and institutional framework is outdated in its majority and there are significant overlaps. Political intervention in the attempts to recruit personnel adds more burden on water resources management.

3.2 Identification of Focal Problems

3.2.1 Conflicts over Water Use

Based on the discussions held with different stakeholders, several conflicts over water use are experienced in the Damour area, between:

- Stakeholders and policy makers, primarily between the Damour Municipality and the Beirut Water Authority, since the BWA overexploits groundwater resources.
- The stakeholders themselves, primarily between the municipality and the upstream water users.

On the one hand, the BWA is facing major problems in providing sufficient water to meet the constantly increasing water demand in Beirut, and needs to rely on external sources of water (groundwater from Damour being one of those). On the other hand, the municipality of Damour is concerned by the increased salinity of groundwater due to excessive pumping, and by the overall deterioration of groundwater quality. Furthermore, the Damour municipality does not have access to the records of BWA to monitor the quantity of water being pumped and its quality. In addition to the groundwater management issues, the Damour municipality protests on the inappropriate allocation of the Damour river water to upstream users and the excessive upstream pollution of the river. The coastal agricultural plain is often suffering from water shortages due to overexploitation of surface water resources by upstream users. Nevertheless, upstream users are not willing to discuss the issue and reach consensus on the amounts of water to be used. With respect to water quality, there is no sufficient enforcement of discharge standards to ensure proper treatment of both domestic and industrial wastewater prior to river discharge. The main conflicts over water use, including those mentioned above, are summarized in Table 47.

Table 47: Summary of Conflicts over Water Use

Stakeholder	**Variable of interest**	**Preference**	**Willingness to compromise**
Beirut Water Authority	Groundwater from Damour Area	Maximize groundwater mining	Limited given rapid increase in water demand and limited options for water supply
Damour municipality	Groundwater quantity and quality	Maintain the quality of groundwater; avoid sea water intrusion	Local aquifer can be mined by BWA as long as groundwater quality is not affected
	Surface water quantity	Maintain minimum water flow for use in irrigation	Willing to compromise with upstream users, as long as minimum flow for irrigation is maintained downstream
	Surface water quality	Suitable standard of water	Not willing to compromise surface water quality
Farmers	Water for irrigation	More water	Willingness to compromise as long as enough water is available for irrigation
Upstream users	Surface water	More water	Limited willingness to compromise

The results of a SWOT analysis (Figure 55) undertaken in the area identify the strengths, weaknesses, opportunities and threats that the water sector is currently facing. Strengths and weaknesses refer to issues internal to the area and related to its inherent characteristics. Opportunities and threats originate from outside the Damour area boundaries.

Strengths	**Weaknesses**
– Availability of groundwater – Presence of major surface water courses – Presence of the Litani River Authority which manages major irrigation projects – Limited industrial activities – Acceptable level of urbanization – Feasibility study for water supply in the area already prepared	– Peak demand for irrigation occurs during summer when water is least available – Geologic formations with fissured karstic bedrock and narrow steep valleys do not always favor construction of dams for surface water storage – Water establishments and offices are established by geopolitical boundaries rather than by water basin limits – Old water supply infrastructure leading to excessive losses – Lack of wastewater management infrastructure – Lack of adequate monitoring data for the proper assessment of water resources – Seawater intrusion in coastal aquifers due to overexploitation – Insufficient level of awareness and knowledge of best management practices in agriculture – Inadequate water pricing and lack of economic incentives for efficient water use and less polluting practices
Opportunities	**Threats**
– Interest from international funding sources in the development of the new liberated south, leading to potential financial assistance that can be used in water resource management activities/projects	– Difficult climatic conditions with most rainfall occurring within a short period of time – Attraction of new investments that could pose a stress to water resources if not properly planned – Sensitivity to the geo-political context that hinders economic development

Figure 55: SWOT Analysis for Water Resources Management in the Damour Area

3.3 Summary of Focal Problems

Table 48 presents a tentative classification of the issues at hand in the three dimensions analysed within the frame of the INECO project.

Table 48: Classification of Focal Problems

Type of Focal Problem	Description
Sharing water	– Conflicts among different water users – Peak demand for irrigation occurs during summer when water is least available – Geologic formations with fissured karstic bedrock and narrow steep valleys do not always favor construction of dams for storage of surface water – Old water supply infrastructure leading to excessive losses – Lack of wastewater management infrastructure – Seawater intrusion in coastal aquifers due to overexploitation
Valuing water	– Inadequate water pricing – Lack of economic incentives for efficient water use and less polluting practices
Governing Water	– Conflicts among authorities regarding water allocation – Distribution of water establishments and offices by geopolitical boundaries rather than by water basin limits – Lack of adequate monitoring data for proper assessment of water resources – Insufficient level of awareness and knowledge of best management practices in agriculture – Attraction of new investments could pose a stress to water resources if not properly planned – Sensitivity to geo-political context hinders economic development

4. Stakeholder Mapping

4.1 Description of Main Stakeholders

Several policy makers and stakeholders, at the national, regional, and local levels have interests in the integrated management of the water resources in the area:

- **Constitutional Level:**
  - Ministries of: Energy and Water, Public Health, Environment, Agriculture, Public Works and Transportation
  - Public agencies: NCRS, CAS, CDR, LRA
  - Practitioners associations: ALI, Chambers of commerce
  - Political parties
  - International Organizations: ESCWA, UNDP, UNEP, FAO, WHO
- **Organizational and Operational Levels**:
  - Beirut and Mount Lebanon Water and Wastewater Establishment
  - Municipalities of villages located along the river basin
  - Community represented by CBOs, such as the Damour Youth
  - Academic institutions : AUB, ESIB, UL
  - Private consultancy companies
  - The industrial, agricultural, and recreational sectors

Table 49 presents the main representatives of civil groups, associations and volunteers with interest in water management in the region, whereas Table 50 summarizes the main policy makers and their role in water management.

Table 49: Representative Citizen Groups, NGOs, Associations, Volunteers

Category/Group Name	Number of Groups /Associations /Volunteers	Population/interested parties represented (in absolute and relative numbers - %)
Citizen groups	**5**	
Damour Youth Club		
C.A.D.I.R.		
ESIB		
AUB		
Consumers Associations	**1**	
Hotel & Resorts owners	**3**	
Oceana 07-990991/03-747423		
Janna sur Mer 03-182233		
Al Jisr Resort 05-601245/05-601246		
Private company/Small Industry	**12**	
NGOs (environmental organisations)	**3**	
Envirotech		
Ecodit		
MADA		

Table 50: Policy Makers

Governmental Institutions	Role/Main Activities in relation to water management
Ministries	
Ministry of Energy and Water (MEW)	– Development of the Master Plan for the management of the water and wastewater sectors. (Law No. 221 of 2000, article 2, paragraph 8). – Planning, implementation, and supervision of water projects (Decree No. 5469 of 1966, article 9, paragraph 1). – Designing and construction of hydraulic structures (e.g. construction of dams, artificial lakes, etc.) for water abstraction. (Law No. 221 of 2000, article 2, paragraph 4). – Design of irrigation networks (Decree No. 5496 of 1966, article 18). – Issuing permits for water abstraction and the use of public water and public properties (Law No. 221 of 2000, article 2, paragraph 7). – Conducting assessment studies of water demand in the domestic, agricultural, and industrial sectors (Decree No.5469 of 1966, article 16). – Development and implementation of laws and regulations aiming at the protection and use of water resources. – Supervision and coordination of activities of institutions dealing with the water sector (Decree No. 5469 of 1966, article 1). – Monitoring and surveillance of the surface water and groundwater quality (Law No. 221 of 2000 modified by the law No. 377 of 14 December 2001, article 2, paragraph 3). – Protection of the natural resources (Law No. 444 of 2002, article 35, paragraph 1/J).
Ministry of Public Health (MPH)	Monitoring the safety of drinking water (microbiologically and physio-chemically) (Decree No. 8377 of 1961, article 61).
Ministry of Agriculture (MOA)	– Management of water supply for irrigation (Legislative decree No. 31 of 1955, article 1). – Construction of small agricultural hydraulic structures (artificial lakes, storage tanks...) – Conservation and utilization of water resources (Decree 5246 of 1994, article 96). – Enhancement and monitoring of irrigation systems and management of small and medium irrigation projects (Decree No. 5246 of 1994, article 103).
Ministry of Public Works and Transportation	– Provision of meteorological data through its Meteorological Department of the General Directorate for Civil Aviation. – Installation of infrastructure. This includes the water infrastructure.
Ministry of Environment (MOE)	– Monitoring the quality of the water resources (Law No. 216 of 1993, modified by the Law 667 of 1997, article 2, paragraph 2). – Protection of natural resources (Law No. 444 of 2002, article 35, paragraph 1/J). – Establishment of national microbiological and physiochemical standards for the quality of water resources, and development of methodologies for monitoring and analysing water quality (Law 444 of 2002, article 36).
Regional/Local Authorities	

Governmental Institutions	Role/Main Activities in relation to water management
Beirut and Mount Lebanon, B&MLWWA	– Planning, implementation and maintenance of water projects for the provision of water for irrigation and drinking, according to the Master Plan (Law No. 221 of 2000, article 4, paragraph 1). – Recommendation of tariffs for drinking water and irrigation services, taking into account the socioeconomic situation (Law No. 221 of 2000, article 4, paragraph 1). Such tariffs are the revenues for these establishments, in addition to funds, grants etc. (Decrees No., 9626 of 1996, article 6; No. 9627 of 1996, article 6; No. 9628 of 1996, article 6; No. 9629 of 1996, article 6; No. 9630 of 1996, article 6)
Council of Development and Reconstruction	Implementation of water projects, according to the National Master Plan
Damour Municipality	– Preservation and protection of drinking water (Legislative decree No. 16 of 1932, article 17). – Rehabilitation of water, wastewater, and stormwater drainage networks (Decree No. 7563 of 1961, article 8, paragraph d). – Implementation of water works within their municipal boundaries, in addition to maintenance and rehabilitation of the networks (Decree No. 9496 of 1962, article 10).

4.2 Summary of Stakeholder Interests

The Ministries of: a) Energy and Water, b) Public Health, c) Environment, d) Agriculture, and e) Public Works and Transportation are the policy makers, especially given that the water sector is under the jurisdiction of these governmental institutions. The Beirut and Mount Lebanon Water and Wastewater Establishment is also considered as a policy maker. It has however also a role in securing potable water to local users. In this sense it can also be considered as a key stakeholder.

Regarding private companies and international organizations, they are considered to be secondary stakeholders since they are involved in research that would facilitate the process of decision making. The municipality is considered to be the key stakeholder since it facilitates the process of implementing the project within its municipal boundaries. As for the community, which is represented for example by the Damour Youth Club, it is considered as the primary stakeholder since they are positively or negatively influenced by the decisions taken.

All the stated stakeholders have a direct interest in water management, due to the following reasons:

- The ministries are involved in the development of policies for the proper management of the water resources and implementation of the policies.
- The Water and Wastewater Establishments are involved in the implementation of regional water projects according to the plans.
- The international organizations and private companies are involved in research activities that facilitate the decision making process,
- The municipalities facilitates the water works within its boundaries, and
- The water users are affected by the quality of the services provided.

As previously mentioned, the coordination and cooperation among governmental institutions does not exist. As such, it is difficult to indicate the periodicity of interaction among the different stakeholders.

In summary, the MEW would be primarily responsible for water availability issues, and would give advice and technical support to local water authorities and municipalities related to such issues. The MOE in turn would be primarily responsible for water quality and environmental issues. The MOPH is mainly concerned with the quality of potable water. The MOA is responsible for the agricultural practices, including irrigation practices in the study area, and therefore is concerned with water availability issues as well as water quality issues related to agro-chemicals use. MOPWT is mainly responsible, through its General Directorate for urban planning, for the spatial planning in the area. The water authority is responsible for the distribution of potable water to the local communities and deals mainly with water availability and quality issues. Private consultants, universities and international organizations are key advisors and provide technical support to the different governmental and local authorities, as well as local communities with respect to water availability, water quality and environmental issues. The municipality is also a local provider of water resources (particularly in the case of Damour), and is responsible for the implementation of local infrastructure works and the provision of necessary services to the local communities. These in turn are main users of water resources, and would like to have sufficient water quantity of appropriate quality.

Table 51: Stakeholder interests

Category/Group	Interests in relation to water management, provision and pricing of water services	Potential impact to the application of institutional and economic instruments (+, - , N/A)	Priorities of interest in relation to water management (1-lowest to 5 highest)	Relationship with other stakeholders (e.g. through partnership or conflict)
Representatives of Groups, NGOs, Associations, Volunteers				
Damour Youth Club	Water management	-	4	Partnership with Damour Municipality & NGOs for water management awareness
C.A.D.I.R.	Water management	-	4	Partnership with Damour Municipality & NGOs for water management awareness
Representatives of Stakeholder Associations				
Association of Lebanese Industrialists	Provision & Pricing of water services	+	4	Partnership with Damour municipality & water authorities for water distribution to industrial zones
Representatives of Governmental Institutions				
Ministry of Energy & Water (MEW)	Water management, provision and pricing of water services	+	5	Partnership with water agencies & Damour Municipality for water provision & pricing
Ministry of Public Health (MPH)	Provision	+	2	Partnership with Damour Municipality & water authority for water sanitation program
Ministry of Agriculture	Water management, provision and pricing of water services	+	5	Partnership with water agencies & municipality for water provision & pricing for agricultural sector

Category/Group	Interests in relation to water management, provision and pricing of water services	Potential impact to the application of institutional and economic instruments (+, - , N/A)	Priorities of interest in relation to water management (1-lowest to 5 highest)	Relationship with other stakeholders (e.g. through partnership or conflict)
Ministry of Public Works & Transportation	Water management, provision	+	2	Partnership with water agencies & CDR for water provision
Ministry of Environment	Water management, Provision	+	5	Partnership with water agencies, Municipalities & NGOs on water protection program
Council of Development & Reconstruction	Water management, provision and pricing of water services	+	5	Partnership with Ministries & Municipalities on infrastructure studies and project realization
CNRS – NCRS	Water management	+	4	Partnership with Ministries on research and studies
Damour Municipality	Water management, provision and pricing of water services	+	5	Partnership with Ministries of interior and public works as well as with community for development of Damour region
Municipalities of villages surrounding Damour Basin	Water management, provision and pricing of water services	+	5	Partnership with Damour Municipalities & NGO's for development of region and water management
Representatives of Water Utilities				
Beirut & Mount Lebanon (B&MLWA)	Water management, provision and pricing of water services	+	5	Partnership with Ministry of Hydraulic Resources & Municipalities for ideal water management & distribution

Category/Group	Interests in relation to water management, provision and pricing of water services	Potential impact to the application of institutional and economic instruments (+, - , N/A)	Priorities of interest in relation to water management (1-lowest to 5 highest)	Relationship with other stakeholders (e.g. through partnership or conflict)
Barouk Water Agency	Water management, provision and pricing of water services	+	5	Partnership with Ministry of Hydraulic Resources & Municipalities for ideal water management & distribution
Representatives of Related Services				
ELARD	Water management, provision and pricing of water services	+	5	Partnership with Municipality, Ministry of Environment & NGO's for establishing field & case studies
Environmental NGOs				
Envirotech	Water management, provision and pricing of water services	+	5	Partnership with Municipalities & community & Ministry of Environment for ideal usage of management of water resources
Ecodit	Water management, provision and pricing of water services	+	5	Partnership with Municipalities & community & Ministry of Environment for ideal usage of management of water resources
MADA	Water management, provision and pricing of water services	+	5	Partnership with Municipalities & community & Ministry of Environment for ideal usage of management of water resources

INSTITUTIONAL ANALYSIS AND FOCAL WATER MANAGEMENT PROBLEMS IN THE BARADA RIVER BASIN, SYRIA

Prepared by Studies and Integration Consulting

1. General overview

1.1 Country overview

1.1.1 Geography and topography

Syria, with a total area of 185,180 km², is bordered in the north by Turkey, in the east and southeast by Iraq, in the south by Jordan, in the south-west by Palestine and in the west by Lebanon and the Mediterranean Sea. Administratively, the country is divided into 14 governorates, one of which corresponds to the capital of Damascus.

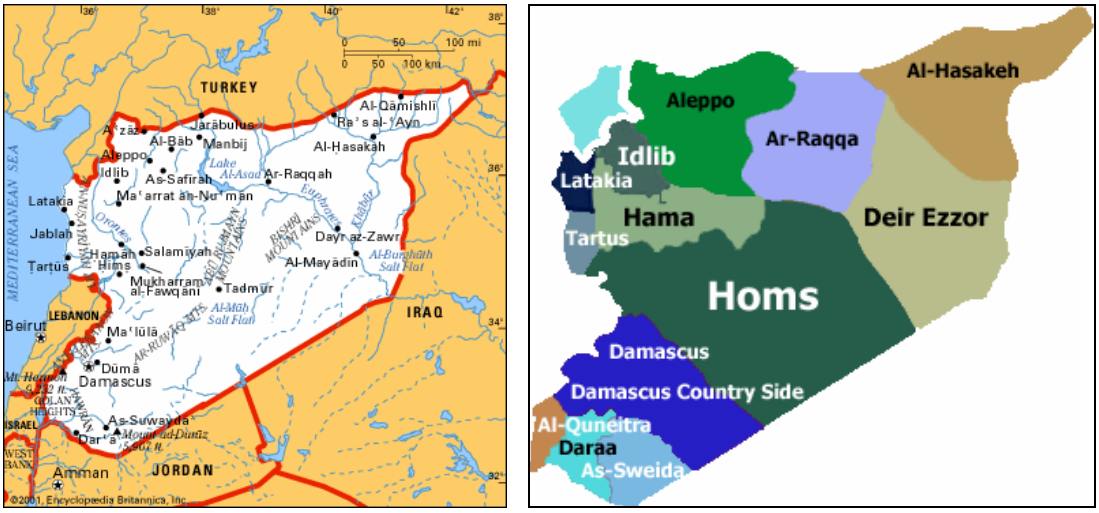


Figure 56: Overview map and governorates of Syria

The country can be divided into 4 physiographic regions:

- The coastal region between the mountains and the sea;
- The mountains and the highlands extending from north to south, in parallel to the Mediterranean coast;
- The interior plains, located east of the highlands and including the plains of Damascus, Homs, Hama, Aleppo, Al-Hassakeh and Dara'a;
- The Badiah and the desert plains in the south-eastern part of the country, bordering Jordan and Iraq.

The total population is 18 million (2004), of which 48% is rural. Actual population growth is 3.3%. In 1993, agriculture employed around 17.1% of the total labour force, accounted for nearly 22% of GDP and 60% of non-oil exports.

1.1.2 Climate and water resources

Climate

Syria's climate is Mediterranean with continental influence, including cool rainy winters and warm dry summers, with relatively short spring and autumn seasons. Large parts of the country are exposed to high variability in daily temperature, with the maximum difference being as high as 32°C in the interior and about 13°C in the coastal region. The total annual precipitation ranges from 100 to 150 mm in the north-west, 150 to 200 mm from the south towards the central and east-central areas, 300 to 600 mm in the plains and along the foothills in the west, and 800 to 1000 mm along the coast, and increases to 1400 mm in the mountains.

The average annual rainfall in the country is 252 mm, yielding an annual water crop of 46.6 km³.

Syria is considered an arid to semi-arid country, characterized by water scarcity and the unbalanced spatial distribution of water resources, which does not match the distribution of population. This exposes available water resources to significant quantitative and qualitative pressures, with high water demand exceeding the locally available water resources in certain regions.

Surface water

The country has a relatively dense hydrographical network, when taking into account that approximately 2/3 of its area is dry. This network comprises several permanent and temporary rivers and streams with flow for only a few days. These are concentrated in the western and northwest areas of the country. In general, the network can be classified in accordance with the natural system to three categories:

1. **Permanently running rivers**, which include 24 rivers, three of which are tributaries to major ones (e.g. Euphrates, Tigris, the Great Northern River, Yarmouk etc.).
2. **Temporarily running rivers**, with seasonal flow (for only a few months): There are more than fifty rivers located in the western part of the country (in the basins of coastal areas, and those of Tigris and Yarmouk), and few others at the Euphrates basins (e.g. Snoubar, Haweez and AlHosn) etc.
3. **Seasonal streams**, which flow only for a few days per year, and are spread throughout the country but are mostly concentrated in the northern and eastern parts.

The volume of available surface water resources in Syria, excluding its share on the Tigris River, is estimated at 11,515 billion m³. Surface water resources correspond to 60% of the country's overall water resources, excluding the Tigris share (and 67% inclusive). However, at present, river flow has been reduced to the extent that several rivers are seasonally dry (e.g. the Barada, Khabour, Aawag and most coastal ones). Furthermore, several river beds have been actually converted to drainage canals of liquid and solid waste. This is the case of Tartous, where there are 350 waste drainages that run in streams, valleys and rivers, and where part of this waste ends to the river mouth and is discharged to the sea.

Table 52: Major rivers entering, bordering and leaving Syria

Name of river	Inflow into Syria (km³/yr)			Outflow from Syria (km³/yr)		
	From	Natural	Actual	To	Natural	Agreement
Euphrates	Turkey	26.29	15.75	Iraq	30	9
Tributaries of Euphrates	Turkey	1.74	1.74		-	
Afrin	Turkey	0.19	0.19	Turkey	0.25	
Orontes, El Kebir	Lebanon	0.51	0.43		1.2	
Yarmouk		-	-	Jordan	0.4	0.2
Baniyas		-	-	Occupation Arab lands	0.125	
Sub-total		28.73	18.11		31.975	9.2
Bordering Tigris	50% of total	9	9			
Total	**Inflow**	**37.73**	**27.11**	**Outflow**	**31.975**	**9.2**

Groundwater

Several assessments have confirmed the presence of groundwater in most rocky masses of the Syrian territory. Those surveys have also revealed that the quantity, quality and depth of those waters depends on geology, i.e. the nature of rocks, their physical quality, their geographical distribution and location. The aquifers of the country can be categorized into three major groups:

1. **Cracked carbonate and karstic rocks**, which contain low salinity water with concentrations ranging between 250 and 500 mg/l. These aquifers are characterized by high productivity, supplying hundreds of springs (e.g. the Al-Feejeh, Al-Sin, Ain Arous). They are spread particularly at the coastal areas and the valleys of Aleppo, Hama, Homs, Upper Jazeera and at the Palmyrian Mountain Range, and lie at relatively large depths, 200 to 250 m on average.
2. **Detritus rocks**, which form porous mediums and in general contain water of good quality. Their water production is lower than the karstic aquifers, and the average depth ranges between 10 and 80 m. They are mostly located in the detritus valleys (e.g. the Damascus Ghouta and Al-Jazerah), in intermountain basins and valleys (e.g. Jairoud and Al-Dow, etc).
3. **Igneous rocks** which widely spread in the southwest of Syria and also in Homs and Al-Jazeera. These rocks are made of basalt, which contains water in its cracks or in the sand layers found among the different basalt layers. They are characterized by good water quality, i.e. 150-300 mg/l. Water flow in their wells ranges between 5-15 l/s, varying according to the degree of cleavage and aquifer depth (20-300 m).

In all areas, aquifers are severely depleted; the constant overexploitation is manifested by the significant drop of water levels in most basins (e.g. more than 60 m at Oteibah in the Damascus Basin). Furthermore, several springs have dried out (e.g. springs in the Damascus Valley, such as the Kallaya and the Ras Al-Ein springs) or their flow has been reduced (e.g. the Mzeireeb spring in the Al-Yarmouk basin).

Non traditional water resources

The total agricultural and industrial discharge has been estimated by the Ministry of Irrigation to 3,526 billion m³ for the period 2003-2004. This volume naturally increases, as a result of the inter-annual water demand growth. Untreated effluents are discharged throughout the country and constitute the primary source of pollution for surface and groundwater resources, and soil. In this regard, the treatment of wastewater is currently one of the main priorities of the State for ensuring environmental protection.

Overall water budget and spatial distribution

The total maximum volume of renewable water resources is equal to 18,209 billion m³/yr (Table 53). Furthermore, on an average year, rainfall volumes are sufficient for the cultivation of 3 million ha (in 2003 3.3 million ha of non -irrigated land were cultivated) of rainfed crops and for improving the condition of natural pastures.

Table 53: Renewable water resources in Syria (billion m³)

Nature of water resources	Quantity
Groundwater resources	6044
Surface water resources	4288
Minimum amount of Syria's share of Euphrates water, according to the protocol signed with Turkey in 1987 and the agreement signed with Iraq in 1990	6627
Tigris river water allocated to Syria as agreed upon with Iraq in the year 2003. A similar agreement is needed with Turkey.	1250

Overall, the water resources of the country are distributed to seven basins, namely: the Barada and Aawag basin, the Orontes basin, the Al-Yarmouk basin, the coastal basin, the desert basin, the Aleppo and Euphrates basin, and the Tigris and Khabour basin. Water availability in each is presented in Table 54. The table clearly demonstrates the imbalance between the spatial distribution of population and available water resources. For example, available water in the Damascus basin represents less than 5% of the country's water resources. However, the Damascus basin accounts for 29.7% of the total population. On the other hand, the population of the Euphrates basin represents a share of 31.6% of the total, and concentrates 60.5% of water available, not including Syria's share of the Tigris river water.

Renewable water resources per capita are equal to 1,000 m³/cap/yr. This rate is decreasing, as a result of population growth. Furthermore, according to data of the Ministry of Irrigation, this decrease in the per capita share of available water reaches the level of water poverty, as it can fall from the average value of 1,015 m³/cap/yr to the value of 747 m³/cap/yr, and even to 577 m³/cap/yr during drought episodes.

Water use

Available water resources in Syria are used for urban and industrial water supply, hydroelectricity production and crop irrigation. Available estimates show that in 2003 the total volume of water used exceeded the amount of 16 billion m³, as illustrated in Table 54.

More than 90% (92.88% according to the Ministry of Agriculture and Agrarian Reform) of available resources is used in irrigated agriculture. Water is used for the irrigation of approximately 1,350 thousand ha, throughout the country. However, the cultivated area

represents less than 23% of the total arable land of 5.8 million ha, most of which is not irrigated (Ministry of Agriculture and Agrarian Reform, 2003). Those areas are irrigated through boreholes, surface water, irrigation schemes developed by the Government, and through river and spring water.

Estimates and figures for water resources are very difficult to obtain due to the lack of reliable data. Groundwater recharge is about 4.2 km³/yr, of which 2 km³ discharge into rivers. Total groundwater inflow has been estimated at 1.35 km³/year, of which 1.2 km³ are inflows from Turkey and 0.15 km³ from Lebanon. Although not quantified, the amount of groundwater flowing into Jordan may be significant.

Dams and lakes

There are 141 dams in Syria with a total storage capacity of 15.8 km³. The largest dam is located at Al-Tabka on the Euphrates. It forms the Al-Assad Lake with a storage capacity of 11.2 km³. Medium-sized dams include the Al-Rastan (225 million m³), the Mouhardeh (50 million m³) and the Taldo (15.5 million m³). There are some 20 dams classified as small, the largest of which is the Dara'a, with a storage capacity of 15 million m³. The majority of these dams are located near Homs and Hama.

Apart from the Al-Assad Lake, there are five lakes in Syria, the largest being Lake Jabboul near Aleppo with a surface area of about 239 km². Lake Qattineh near Homs is the most significant perennial lake of the country.

Overall water balance

Table 54 illustrates the evaluation of the average annual water balance of Syrian water basins as calculated by the Ministry of Irrigation for 2003. The calculation takes into consideration the renewable surface and ground water resources as well as non-traditional resources and the utilization of water by the different sectors. It should be noted that renewable water resources and the Syrian portion of shared water are to elements of the balance that need to be recalculated.

1.2 Overview of the Barada River Basin

1.2.1 General features

The Barada Basin, the area selected for the implementation of INECO in Syria, is located in the southwest part of the country, and stretches from the western mountainous of Damascus including Sheikh and Kalamon Mountain in the north to the Qunatera and Jolan highlands in the south and from Lebanon in the west to the Syrian Desert in the east (Figure 57).

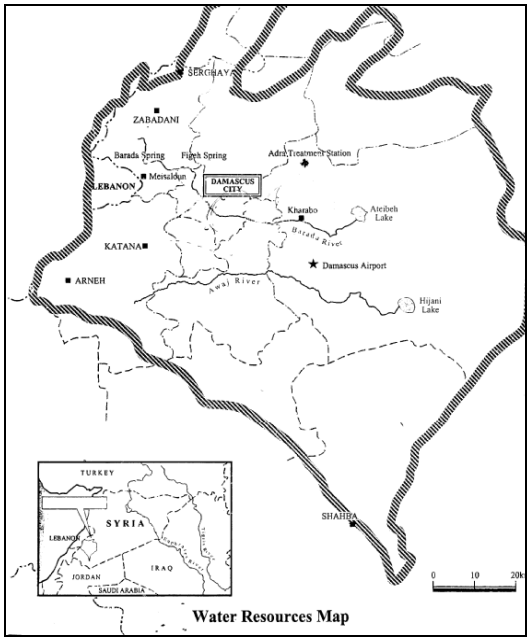


Figure 57: Location of the Barada Basin

The basin extends over an area of 8,630 km², and can be divided into two distinct regions:

- The mountainous area in the northwestern mountain range which occupies an area of 3,500 km² approximately, and includes the East Lebanese and Palmyra Mountains. The altitude reaches the maximum of 2,814 m at the Al-Sheikh Mountain Peak.
- The plain comprising the Ghouta forest and surrounding areas, which extends over an area of 5,100 km² approximately, and has an altitude ranging between 595 m to 1,400 m above sea level.

The basin includes the prefectures of Damascus, and parts of the Rural Damascus Darra and Sweida prefectures (70%, 11% and 19% respectively).

The **climate** varies, as a result of the altitude difference, from desert climate in the plains, to mild wet in areas where altitude exceeds 2,000m. The rainfall spatial distribution varies considerably: the largest amount, around 1,500 to 1,800 mm is observed in the western part of the basin, in the high-altitude areas (Haramon and Sheer Mountains). Rainfall is least in the plain (Ateibeh and Hijane Lakes), being equal to about 90 mm/yr. Annual evaporation in the mountainous region is between 300-350 mm and 90-100mm in the plain, but reaches the value of 380 mm/yr in the forest of Ghouta. Prevailing winds are northwestern in the NW part of the basin and south-western in the southeastern region.

The total **population** of the basin is more than 4.5 million, accounting for approximately 21% of the total population of Syria. Population growth varies between 1.68% in the Damascus City and 4.48% in other zones of the Basin.

1.2.2 Environmental issues

The Barada Basin is the area where the capital of Syria, Damascus, is located, and therefore the region that concentrates most of the human activities in the country. According to the list of policy priorities set by the Ministry of Local Administration and Environment, an immediate action plan should be drafted and implemented in order to address **water pollution issues**. At present, the efforts undertaken in order to address the problem are incomplete due to: (a) the absence of environmental law, (b) legislative limitations, and (c) lack of

environmental awareness. Most manufactories discharge contaminants to the sewerage system or simply to land and rivers without treatment, free of charge and without penalties being enforced. In addition, the spatial dispersion of micro- and small-scale industries hinders the effective control over discharges. The current agricultural practices, which include excessive application of fertilizers and pesticides, overexploitation of water resources and application of inefficient irrigation methods have also contributed to the exacerbation of water pollution in the area.

These issues and their causes and effects are further described in Section 3.2 of this document.

Figure 58: The Barada Spring in North Damascus

Table 54: Water balance of an average year of water basins in Syria

Water balance components	Unit	Khabour & Tigris	Euphrates & Aleppo	Orontes	Coastal Basin	Barada & Aawaj	Yarmouk	Badia basin	Total
Basin area in Syria	km²	21,129	51,238	21,624	5049	8630	6724	70,786	185,180
Total basin area/area of Syria	%	11.7	28.3	10.1	2.8	4.8	3.2	39.1	100
Surface water	million m³	788	7105	1110	1557	12	180	163	10,915
Ground water	million m³	1600	771	1607	778	838	267	183	6044
Total surface and ground water	million m³	2388	7876	2717	2335	850	447	346	16,959
Degree of organization	million m³	95	95	85	65	90	85	60	575
Available water resources	million m³	2269	7482	2310	1518	765	380	208	14,932
Recycling of treated drainage water	million m²	95	306	325	0	260	72	35	1120
Reclaimed agricultural drainage	million m³	430	575	210	57	89	32	0	1.402
Total water resources	million m³	2794	8363	2872	1575	1123	484	243	17,454
Demand on irrigation water	million m³	4300	5755	2093	566	983	400	68	14,165
Demand on drinking water	million m³	38	322	240	124	270	89	44	1127
Demand on water for industry	million m²	89	86	229	85	76	7	2	574
Evaporation	million m³	132	1.614	148	16	6	31	15	1962
Total Demand	million m³	4559	7777	2710	791	1335	527	129	17,828
Water Balance	**million m²**	- 1765	586	162	784	-212	-43	114	-374

2. Institutional & Financial Context

Overall, the Ministry of Irrigation is in charge of irrigation projects, dams, planning, research, operation and maintenance of major hydraulic infrastructure and pollution control. The Directorate of Irrigation is involved in water resources studies and surveys, water legislation and the sharing of transboundary waters.

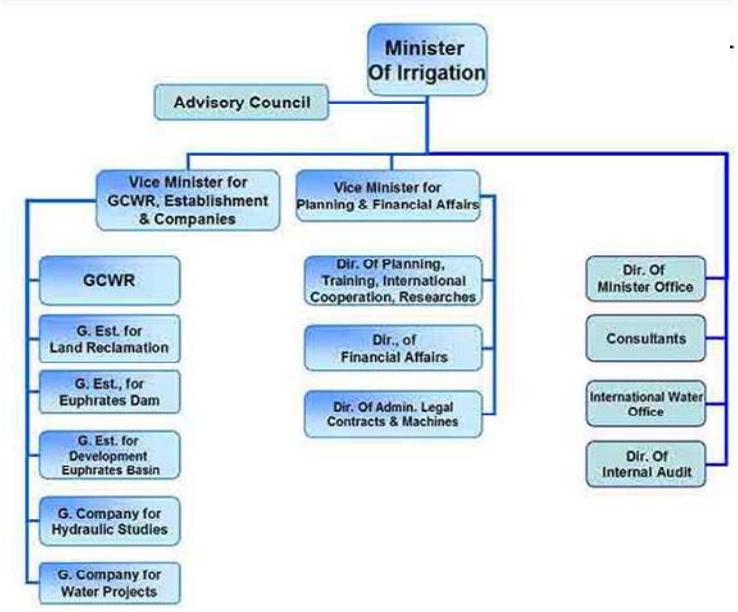


Figure 59: Organisational structure of the Ministry of Irrigation

There are six other departments/entities under the responsibility of the Ministry of Irrigation: (a) the Euphrates Basin Development Authority, (b) the Euphrates Basin Land Reclamation Authority (c) the General Company for Hydraulic Studies, (d) the General Company for Water Projects (e) the General Commission for Water Resources (GCWR) and the (f) General establishment for land reclamation (Figure 59). Furthermore, the Ministry of Irrigation is in charge of groundwater monitoring and the issuing of licenses for well and borehole drilling. In some areas with a high concentration of wells, such as parts of the Aleppo and Salamieh areas, water tables are dropping, and the Ministry is exploring alternative options of increasing recharge in shallow aquifers.

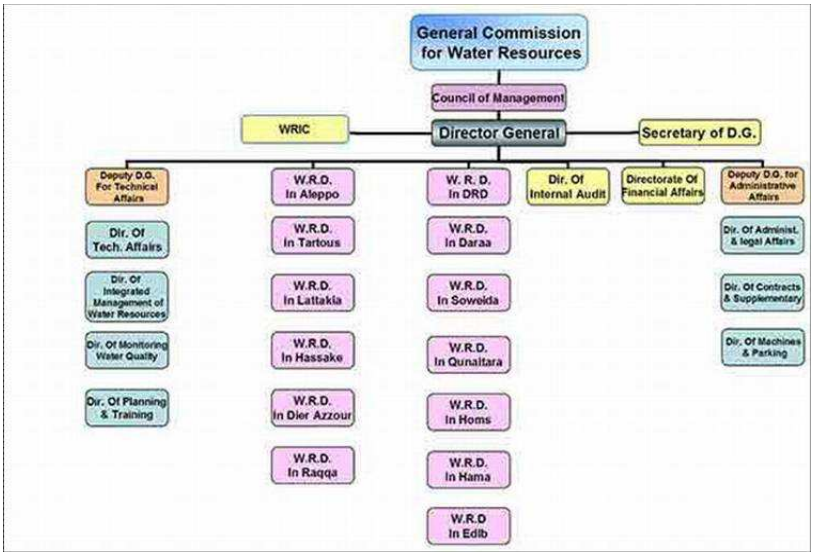


Figure 60: Organizational chart of the General Commission for Water Resources

The General Commission for Water Resources in the ministerial department which deals with issues on integrated water management and with the coordination of the various water resources directorates, established in the different river basins (Figure 60). Furthermore, the GCWR controls the Water Resources Information Centre (Figure 61).

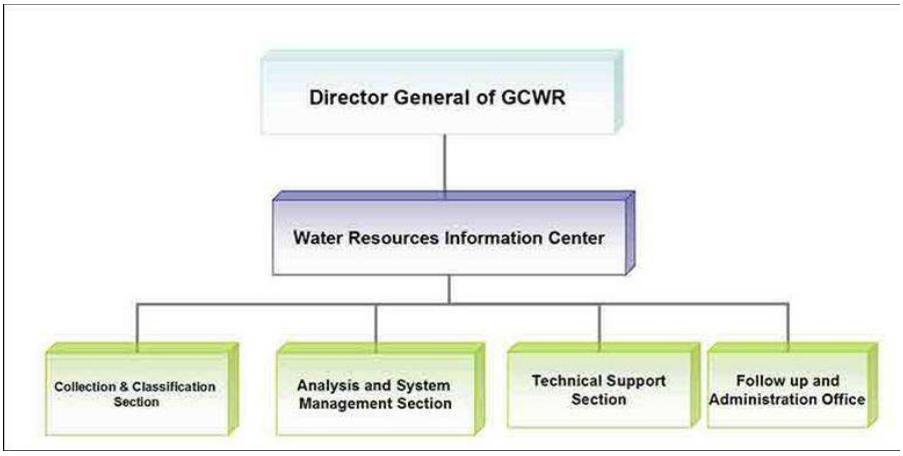


Figure 61: The organization of the Water Resources Information Centre

2.1 Institutions & responsibilities

Overall, the water sector in Syria is administrated by different Ministries and institutions, with a slight overlap in responsibility. Those ministries are all represented in the Higher Water Committee, which is presided by the Deputy Prime Minister for services affairs.

There are five ministries (Ministry of Housing & Construction, Ministry of Health, Ministry of Irrigation, Ministry of Local Administration & Environment and Ministry of Agriculture & Agrarian Reform) involved in monitoring the quality of ground and surface waters, through their own specialized laboratories and according to their mandates and responsibilities (Table 55).

Table 55: Responsibilities in water quality monitoring

Authority (Ministry)	Responsibility	Types of analysis	Periodical occurrence
Housing and construction (MoHC)	Drinking water analyses	Chemical-bacterial-heavy metals-hydrocarbon components	Regular for chemical and bacterial analysis
Health (MoH)	Drinking water analyses	Chemical and bacterial	In cases of epidemics
Irrigation (MoI)	Drinking water-river and well water analyses	Chemical-bacterial and heavy metals	On demand-regularly for some rivers
Local administration and environment (MoLE)	Drinking water analyses	Chemical-bacterial-hydro carbonate elements	In case of emergency
Agriculture and agrarian reform (MoAA)	Soil analyses	Heavy metals	According to research requirements

Additionally, Directorates for Water Pollution Abatement in river basins, which are controlled by the Ministry of Irrigation, undertake periodic analyses for monitoring surface and ground water resources throughout the country, and the potential pollution sources of rivers, canals and the surrounding environment. The overall process includes obtaining water samples from rivers and monitored wells throughout each basin, and the undertaking of physical, chemical, bacterial and biological analyses as well as analyses on heavy metals and toxic elements. Results are documented by the Directorate, and copies are sent to all parties involved, including the explanation of results, the identification of pollution sources and suggestions for their elimination.

In summary:

- The **Ministry of Irrigation and its Directorates** are responsible for administering the development of water resources, for the regular monitoring of surface and ground water quality and for ensuring that water is available for irrigation purposes. Furthermore, the Ministry of Irrigation is also responsible for the monitoring of groundwater abstractions and for the issuing of licenses for future wells and boreholes.
- The **Ministry of Agriculture and Agrarian** reform is responsible for water conservation in the agricultural sector. This includes promoting the application of provision of modern techniques for water conservation, and the cultivation of crops with lower water demand.
- The **Ministry of Housing and Utilities** is responsible for the distribution of drinking water in urban and rural areas and for domestic wastewater treatment.
- The **Ministry for Local Administration and the Environment**, which is responsible for monitoring and controlling water quality, and for issuing national standards for the protection of water resources.

Table 56 outlines responsibilities in water management, through the illustration of the water resources planning matrix.

Table 56: Water resources planning matrix

ACTIVITY	MoI	MoHC	MoH	MoLE	MoAA
Surface waters					

ACTIVITY	MoI	MoHC	MoH	MoLE	MoAA
Use	×	×			
Storage	×				
Groundwater recharge	×				
Diversion	×				
Quality monitoring	×	×	×	×	×
Assessment	×	×			
Groundwater					
Use	×	×			
Storage	×				
Recharge	×				
Quality monitoring	×	×	×	×	×
Assessment	×				
Well permits	×				
Irrigation network					
Rehabilitation	×	×			×
Modernisation	×	×			×
Reuse					
Drainage water	×	×		×	
Wastewater	×	×		×	
Desalination					
Introduction of technology	×	×		×	×
Efficient water utilisation	×	×		×	
Domestic	×	×			
Industrial		×		×	
Agricultural	×				
Legislation					
Regulation and codes	×	×	×	×	×
Standards	×	×	×	×	×
Policy setting	×	×		×	×
Water allocation	×	×			×
Project financing	×	×		×	×
Project design	×	×		×	×
Project implementation	×	×		×	×
Operation and Maintenance	×	×			×
Pricing (tariffs)		×			
Enforcement	×	×		×	
Water data records	×	×			

2.2 Legislation

Table 57 outlines the main list of laws and regulations governing the water sector, their focus, content and status of implementation.

Table 57: List of Water Laws and regulations

Reference	Focus	Content	Implementation Status
Establishment of the Higher Institute for Water Management *Legislative decree No. 27 for the year 2007. Dated: 13/4/2007*	Establishment of the State scientific board, for the "Higher Institute for Water Management (HIWM)", placed under the authority of the Minister of Higher Education. HIWM aims at developing human resources in the field of IWRM.	The law describes the tasks of HIWM, which include the following: - Undertaking research and scientific experiments, in collaboration with Ministries related to water management. - Designing and implementing training programmes at various levels and themes in the field of water management. - Reforming technical resources in the ministries involved in water management within a framework to be agreed between HIWM management and the relevant Ministries. - Providing of technical and scientific assistance and consultation to the State, the public and private sectors. - Cooperating with local, Arab and foreign societies for water-related research and studies, training, post-graduate studies and exchange of information and experience. - Providing PhD studies and degrees in the field of water management.	New decree, HIWM is currently being launched.
Water legislation *Law No. 31 for the year 2005. Dated: 16/11/2005*	General framework for water resources management	- Definition and arrangement of all rights on water resources. - Regulation of the use of State water networks and infrastructure. - Procedures for the licensing of well and borehole drilling and the exploitation of pumping equipment. - Penalties for destruction, sabotage, dissents and water theft. - Implementation of water police (a committee for identifying law offences). - Organisation of water assessments and surveys by the State. - Establishment of Water Users Associations.	The most important law for water sector. It is considered comprehensive, but not fully effected because the Government granted a "grace" period to industries and the owners of illegal wells and boreholes to comply with the law.
Establishment of the "General	The General Board for Water Resources (GBWR), is a	The law defines the following GBWR responsibilities: - Management, development and	GBRW has prepared many studies and taken many decisions

Reference	Focus	Content	Implementation Status
Board for Water Resources" *Legislative decree No. 90 for the year 2005 Dated: 29/9/2005*	state board of admininstrative character, controlled by the Ministry of Irrigation. This board will gradually replace (a) all State Water Departments for water basins, (b) the technical centralized departments of the Ministry, which deal with relevant, water-related issues and (c) Irrigation management departments which belong to the General Establishment of the Euphrates Dam.	protection of water resources in all river basins of the Syrian Arab Republic. - Supervision of investments and control of water resources and water infrastructure in all river basins (Euphrates, Orontes, Tiger, Khabour, Barada & Awaj, Yarmouk and semi desert areas). - Formulation of strategies for executing the adopted water policy, for ensuring the comprehensive and sustainable development of water resources. - Identification of ways of further exploiting water resources, under the coordination of specialized Ministries and other institutions. - Formulation of mechanisms and options for exploiting water resources in a way that protects all river basins, with the coordination/collaboration with other, relevant Ministries. - Exploitation, maintenance and development of projects and water infrastructure, definition of standards for assessments, implementation and supervision of commissioning and operation of facilities. - Training and education of technical staff within and outside the country, in cooperation and coordination with various scientific boards to achieve the targets of the HIWM. - Proposal of relevant legislation needed for the implementation of HIWM tasks, etc.	related to its mission. Overall, it can be considered that the Law is being implemented.
Establishment of the General Company for Water Projects" *Decree No. 167 for the year 2004 Dated: 7/5/2003*	The Law foresees the establishment of a General Construction Company under the title "General Company for Water Projects-GCWR. The company is under the control of the Minister of Construction and Buildings.	The law foresees that the GCWR will integrate different, already established companies, such as the General Company for Land Reclamation and General Company for Irrigation and Potable Water. The newly established institution will undertake the implementation of water-related projects, including those for sanitary drainage, land reclamation, maintenance and other public works in the country.	Implemented
Establishment of the "General	The law foresees the establishment of a General	The company undertakes all assessments, surveys, and studies for irrigation projects, land reclamation schemes, groundwater	Implemented

Reference	Focus	Content	Implementation Status
Company for Water Studies" *Law No. 16 1983 Dated: 27/10/1983*	Company under the title: "General Company for Water Studies", controlled by the Minister of Irrigation.	management, and the management of all relevant infrastructures, and of everything required for those projects, which are of agricultural and social character. Furthermore, the company undertakes all surveys, assessments and studies for the construction of small and medium-scale dams on rivers and flood protection schemes, and the use of water stored for irrigation and energy production. Finally, it is authorized to check and validate engineering design for irrigation and dam projects.	

2.3 Financial framework and pricing

Water pricing can be viewed as an economic instrument to improve water allocation. Water can have two sets of prices: one corresponding to supply costs and one corresponding to the full economic cost. Supply cost recovery corresponds to covering the costs arising from the operation and maintenance of water utilities to which one can add investment cost, interest and depreciation on borrowed capital to obtain the full supply cost. Economic costs include the opportunity cost relating to the fact that water should be allocated to its highest value uses in order to maximize social welfare, adding resource costs arising if water is economically scarce. In addition to supply and economic considerations one can integrate the fact that a certain use of water may impose costs on other users (social costs) and the fact that environmental damage costs arise if water is used (environmental damage costs), in order to present the full cost pricing. Almost nowhere do farmers pay anything near the supply cost of water, let alone its economic cost.

Because water in general and irrigation water in particular often require initially large capital investments in infrastructure development, governments are often required to allocate water resources using various mechanisms, some more efficient and some easier to implement than others. Decision makers generally apply water pricing of one type or another. Yet, and against any rational expectation, irrigation water prices in most of the countries of the Middle East are low and reflect neither the scarcity of the resources nor the important investments required for the mobilization of water. In fact, since the 1960s and 1970s, the economic and urban development has compelled public authorities to promote irrigated agriculture as the unique way of satisfying the food needs of explosively increasing populations. This policy considered essentially providing water at low prices, largely lower than mobilization costs and with increasing subsidies.

In Syria, beneficiaries from public irrigation systems are subject to service charges which intend to recover some of the investment made as well as the cost of operation and maintenance of public networks. This makes Syria one of the few countries in the developing world where an attempt to recover capital costs is implemented. The capital cost of construction of irrigation and drainage projects and rehabilitation is recovered by the government from farmers taking into consideration the development cost for an amortization period of 30 years with no interest charged nor corrected by inflation. The amounts paid range from the equivalent of US$ 40 to 120 per hectare. Capital costs are calculated as average costs in each basin, and the users cannot sell part or all of the reclaimed land

before all the 30-year payments are made. Table 58 provides the cost of irrigation development in selected basins. Capital cost payments are funnelled into the National Debt Fund which is autonomous, within the Ministry of Finance.

Table 58: Cost of irrigation development in selected basins (Source: FAO-MAAR)

Basin	Cost ($US/ha)
Tigris and Al-Khabour basin (Al-Hasakeh)	2740
Euphrates basin (Maskeneh Gharb)	3560
Euphrates basin (Beer Al-Hashem)	1230
Yarmouk basin	1210
Coastal basin	1092

Like in many other developing countries, operation and maintenance costs of irrigation and drainage systems in Syria is charged as a flat rate per unit of area. The charge is based on average rather than marginal costs of supply and does not include provisioning for depreciation. According to the Ministry of Irrigation, Syrian farmers pay about 80% of the operation and maintenance costs. As of December 1999, farmers have been charged for the cost operation and maintenance equivalent to US$ 75/ha, when the estimated average total regular operation and maintenance costs for the delivery of water up to farm gates, excluding dams, are estimated at about US$ 90 per hectare. The fee is only for irrigated areas and is not applied when no irrigation water is available.

This operation and maintenance charge is regarded as a property tax, since the amount to be paid is notified by the Ministry of Finance to each Governorate based on the irrigated area for each landholder and is paid at the local branch offices of the Central Bank. No penalties are imposed if the user fails on a payment. Surcharges are applied on late fees in accordance with the laws governing late payments on taxes in the country. This may be due to errors in the preparation of lists of users at the Governorate level by the Ministry of Irrigation, underestimating the number of farmers compounded by inefficiencies in the billing and collection processes.

Similarly, the structure of the water tariff for supplying safe drinking water to consumers partially recovers the costs of water treatment, network maintenance and operation. Its structure is based on social considerations, and applies the Increasing Block Rates, according to the volume of water consumed. Values are outlined in Table 59.

Table 59: Domestic water tariffs

Sector	Water consumed (m^3)	Tariff (S.P./m^3)
Household	1 to 20	3
Household	20 to 30	4.5
Household	30 to 60	13.5
Household	Over 60	19
Governmental Agencies		8.5
Industrial, commercial and tourism sectors		22

This situation is becoming unsustainable. Firstly, and also as a result of low prices, water demand is increasing so rapidly that it will soon be hard to satisfy with only mobilized resources. Secondly, easily mobilizable resources have already been exploited and the development of new resources would be possible only at high costs.

3. Identifying Focal Problems in Water Management

3.1 The national context

3.1.1 Constraints facing the water sector

The agriculture sector is a major source of income, foreign exchange and employment in Syria. More than 50% of the total value of agricultural production is produced from irrigated land, which constitutes only 18.6% of the total land cultivated. A large part of cereals' production, as well as all significant cash crops including cotton, tobacco and sugar beets are produced on irrigated farms. The development and use of water has been carried out thus far on an ad hoc basis, mainly by responding to the various demands. The need to increase food production has resulted in the construction of dams for irrigating lands in their vicinity. Furthermore, the rather high prices for food crops, and especially the recent ones for wheat, have resulted in a rapid increase of wells and in the overexploitation of groundwater. In addition, population growth and the proliferation of industries in major cities have contributed to the further exploitation of the limited water resources.

Under the latest development plans, almost 60 to 70% of public investment in agriculture was allocated to irrigation development, in particular for the construction of the Tabqa dam and the establishment of the Assad reservoir. In the Damascus basin, irrigated agriculture has to compete with the increased land and water demand linked to the residential and industrial expansion, and has been considerably reduced over the past decades.

Irrigation development depends to a large extent on how Syria reaches agreement with neighbouring countries on the sharing of transboundary water resources (Turkey, Lebanon, Jordan and Iraq). The identification and implementation of policies, programmes, projects and techniques to improve efficiency in water use and to better control surface water and groundwater exploitation are the important challenges currently faced by Syrian policy-makers. Future projects have been planned by the Government for the development of major irrigation schemes, including 91,000 ha in the Euphrates basin, 150,000 ha in the Khabour (tributary of the Euphrates) basin with the construction of a reservoir north of Al-Hassakeh, 150,000 ha in the Tigris basin by pumping from the Tigris river and 72,000 ha in the Orontes basin (AlGhab).

3.1.2 Focal water management problems at the national level

The water sector should face up to different challenges, particularly related to the management of the available water resources. Problems mostly emerge from the weak linkage between water planning and management and societal needs, and the large pressures associated with most economic activities. The major problems affecting the entire water sector, and depicting the need for reviewing and adapting the overall water management framework are:

- The **lack of knowledge and assessment on the water budget** throughout the country and at the river basin level. Several, exploitable reserves remain unknown, as well as the rate of annual recharge and other water balance elements. The absence of this knowledge base is considered a major impediment in achieving comprehensive management and balanced investment in the exploitation of water sources.
- The **lack of integration of functions** among the different parties involved in water management operations, especially with regard to water policy and legislation formulation, water allocation and investment plans. Legislation is not targeted at achieving sustainability,

and at present, there is no master plan specifying a long-term framework for the sustainable development of water resources.

- **Applied economic tools and incentives are ineffective** in reducing water demand and in providing funds for increasing water availability and efficiency in water use, while reducing water waste. Such goals cannot be achieved by the water sector alone, in isolation from the economic and social options adopted by the State and without taking into account other important political considerations.
- Throughout the country, there is **lack of efficient systems for monitoring** the quantity and quality of water resources. This results in the insufficiency of data which are necessary for formulating policies and processes for preventing overexploitation and pollution of water resources.
- The **role of water users and beneficiaries** in planning and water management is not being adequately considered. However, individual water users are responsible for the extensive arbitrary exploitation of water resources, and for groundwater overpumping. The most important effects of those practices are manifested in the:
    - Drop in groundwater levels (which indicates a decrease in the volume of water stored), in several parts of the country. This decrease has continued over the years, up to the point that several springs and wells have dried up, and several aquifers have been pumped to exhaustion. This is the case in the Damascus, Kalamoun, North Aleppo, Hama Kneitra, Rikkah and Hasakeh areas.
    - Deterioration of water quality and increased salinity, experienced in the Eastern Damascus Valley, and Beida to the west of Palmyra, Damsarkho, Hamidieh, Akkar valley at the Syrian coast and other areas.
- The **inability of the current institutional framework**, which is characterized by the multiplicity of authorities and overlaps in responsibility, to achieve sustainable water management.
- The **lack of communication and data exchange** among decision-makers, engineers, and water management specialists and professionals, and the lack of human resources which would enhance the development of an integrated water management plan. Regulatory principles for establishing a system of specialists were recently drawn under the supervision of the Syndicate of Engineers.
- The present policy has failed in developing and providing opportunities for the **development of the required human resources**. There is lack of high-level expertise, equipment, supplies, laboratories, raw materials, spare parts and financial transparency. Those difficulties are themselves problems, and result in the exacerbation of some of the aforementioned issues.

3.2 Water management constraints and problems in the Barada River Basin

As already presented in Section 1.2, the Barada river basin, where Damascus is located, is a region which faces intense water pollution issues, which have resulted in the significant degradation of the Barada river ecosystem. Efforts to address the problem have been thus far limited and ineffective, and new initiatives are being undertaken, with the aim of better coordinating programmes, raising awareness among water users and building the infrastructure required for addressing the issue.

At present, and with the exception of the Damascus city and few suburban areas, all the settlements of the basin discharge their wastewater onto land or the two rivers of the basin, causing a high level of

contamination. Furthermore, almost all the wastewater generated from industrial activities is discharged mainly to Barada River without prior treatment, except for some large and rather new factories. The amount of BOD resulting from industrial effluents discharged to the Barada River is estimated at approximately 12.5 ton/d. Although groundwater contamination from industrial activities has not been yet confirmed, it is quite probable, as aquifers are recharged by the river.

Figure 62: The polluted Barada River

Historically, the Barada river was a vital water resource, as it sustained forest of the "Ghouta", which was a source of food for the populations of the region, and a very rich ecosystem. The river was at that time not only a water source, but also considered as a cultural heritage. However, in recent years, the river ecosystem has been extremely damaged due to:

- The significant pollution loads, which exceed the river's dilution and self-purification capacity.
- Climate change and the significant decrease of rainfall in the area.
- The diversion of water from the main river spring of Feige, which is currently used for drinking water supply.

With regard to pollution, the uncontrolled discharge and disposal of waste into the river has led to the significant deterioration of water quality and does not allow for its safe use for industrial and/or agricultural activities. Furthermore, the uncontrolled disposal of toxic, chemical products, primarily from lead industries and battery manufactories, has also resulted to severe soil pollution.

The Syrian government is working on several important projects in order to improve water quality in the Barada Basin. It should be noted that new legislation requires that tanning manufactures move from the river vicinity to the new industrial area of Adra (in northern Damascus), where a new wastewater treatment plant has been built. However, the law is not adequately enforced and there is significant delay in its implementation. Furthermore, the State, with the support of JICA has undertaken a new monitoring initiative addressing also surface and groundwater quality, especially along the Barada basin rivers. More details on this project are presented in the Annex.

4 Identification of Stakeholders

The main organizations involved in water management and water pollution issues in the region are outlined in Table 60.

Contact details for representatives from these organizations are presented in the corresponding section of the Appendix.

Table 60: Organizations with role/interest in water polluction issues in the Barada River Basin

	Organization
1	Ministry of Irrigation.
2	Damascus Water Authority.
3	Damascus Wastewater Company.
4	Damascus Rural Water Authority.
5	Ministry of Housing and Construction / Water department
6	Ministry of Local Administration and the Environment
7	Ministry of Finance
8	General Commission for Scientific Agricultural Research
9	Higher Scientific council
10	Chamber of Industry
11	Representatives from key industrial sectors disposing effluents (tanneries, textile, food, refineries, metal)
12	The Syrian Association for environment protection and sustainable development. (NGO)
13	the Fund for Integrated Rural Development of Syria (FIRDOS) (NGO)
14	Damascus Friends Association (NGO)

Annex: The JICA project

Project overview

In August 1996, the Japan International Cooperation Agency (JICA) conducted "The Study on Water Resources Development in the Northwestern and Central Basins of the Syrian Arab Republic (PHASE I)" "JICA development study (Phase I)" in response to a request from the Government of Syria. The purpose of the study was to prepare a master plan for the comprehensive development of water resources in the areas of five water basins: Barada-Awaj, Orontes, Coastal, Aleppo, and Steppe.

Based on the results of these studies, the Government of Syria requested from the Government of Japan to provide project-type technical cooperation for the establishment of Water Resources Information Center (WRIC) in order to help in improving water resources information management throughout the country, and develop decision-makers that can utilize such information.

Preparatory studies indicated that Ministry of Irrigation (MOI), which is the agency responsible for water resources development and management, could not undertake its responsibilities properly due primarily to a lack of accurate and reliable water resources information based on precise hydrological and meteorological observations. It was also recognized that the absence of accurate water resources information is derived mainly from:

- Insufficient hydrological and meteorological observation facilities.
- Poor observation skills
- Inefficient information exchange between the MOI headquarters and the General Directorates.
- Inadequate information sharing among water-related agencies,
- Inappropriate data saving.
- Insufficient information processing skills.

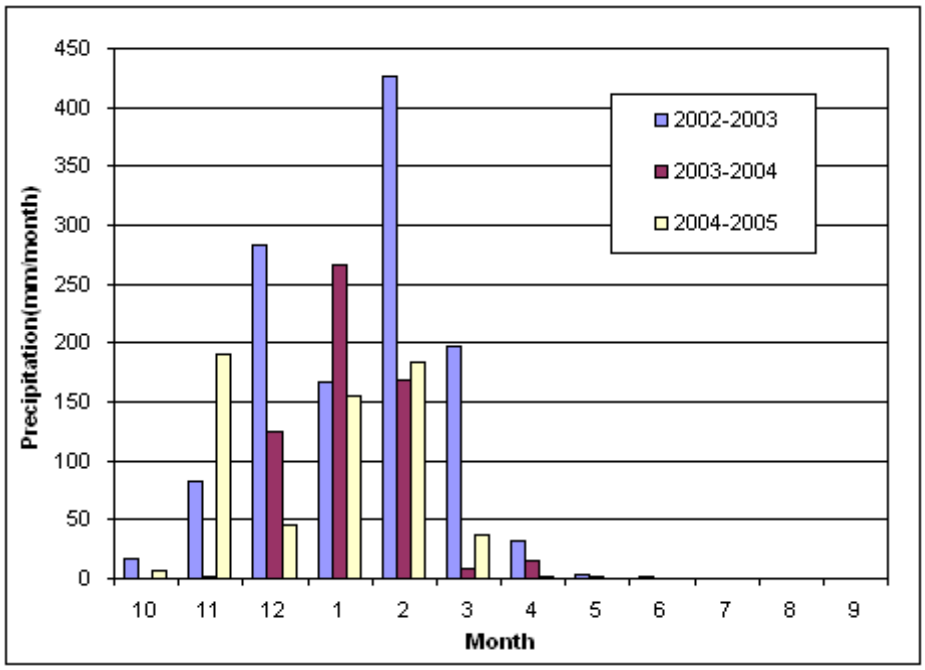
In order to solve these problems in the water resources management sector of Syria, the Government of Japan formulated the Project on the establishment of a comprehensive water resources information management system. Cooperation activities would include improvement of basic meteorological and hydrological observation skills and establishment of computer systems for the Barada-Awaj Basin and the Coastal Basin, which are areas having the highest priority.

Overview of specific system results

Monitoring stations in the Barada Awaji Basin

Type of Station		**Station name**
Surface		Attkia
Groundwater	Water Level	Harasta
	Water Level & Quality	Fasrya
Meteorological		Zabadani

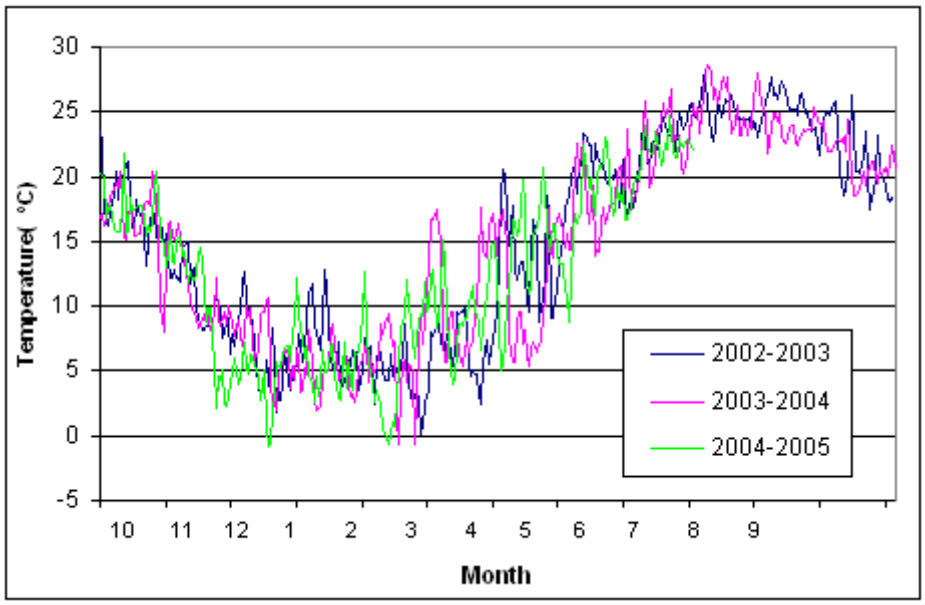
Precipitation



Precipitation in Zabadani (Barada Spring)

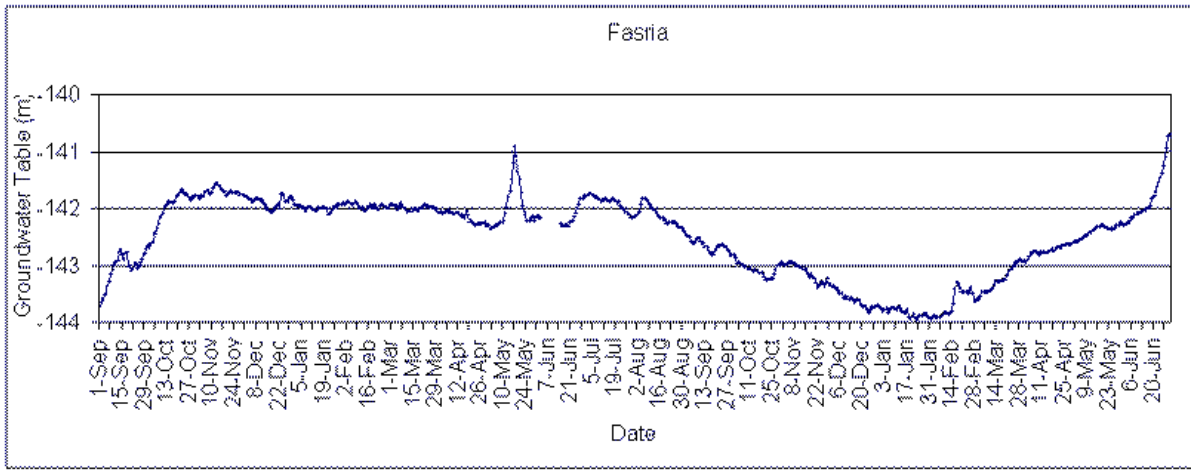
2002-2003		**2003-2004**		**2004-2005**	
month	mm/month	month	mm/month	month	mm/month
10	17.2	10	0.2	10	7.5
11	82.6	11	1.2	11	190.5
12	283.6	12	124.8	12	45.4
1	166.2	1	266.8	1	155.6
2	426.9	2	169.1	2	184.4
3	197.1	3	8.3	3	37.3
4	32.6	4	15.6	4	1.3
5	3.4	5	1.5	5	0.7
6	1.0	6	0.0	6	0.0
7	0.0	7	0.0	7	
8	0.0	8	0.0	8	
9	0.0	9	0.0	9	
Total	1209.6	Total	587.5	Total	622.7

Temperature

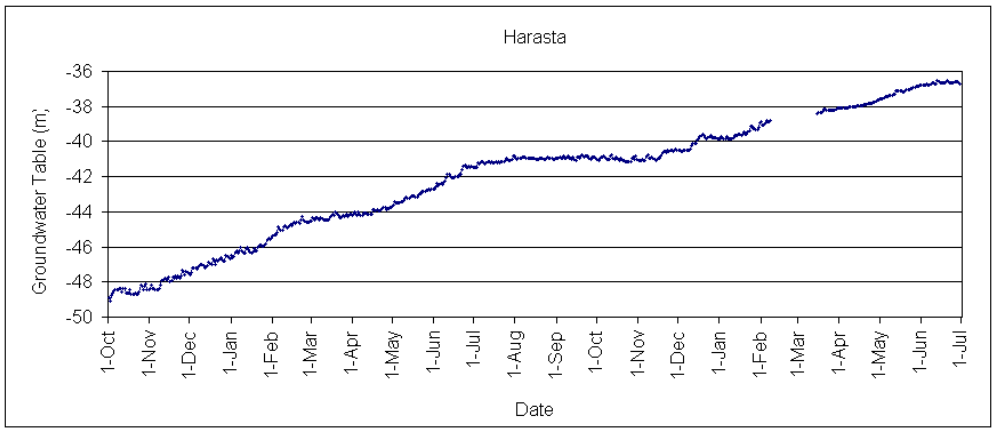


Month	2003			2004			2005		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
1	7.0	12.8	3.5	5.1	8.6	2.0	5.7	19.6	3.7
2	4.6	8.6	0.1	6.1	13.2	-0.6	5.5	12.0	0.7
3	6.6	9.8	2.5	11.2	17.6	5.4	9.9	15.1	3.9
4	13.6	20.6	8.7	11.1	17.6	5.4	14.2	20.6	5.1
5	20.1	23.4	15.2	18.2	23.6	13.9	17.6	23.0	8.8
6	22.6	25.7	17.5	22.6	26.8	17.5	23.7	25.3	21.8
7	24.9	27.8	22.7	25.6	28.6	23.1			
8	25.3	27.7	21.6	23.7	25.3	21.8			
9	20.9	26.2	17.4	21.0	24.5	18.5			
10	16.8	20.4	8.1	17.3	21.8	13.0			
11	11.2	16.5	8.2	10.2	15.9	2.1			
12	6.8	10.6	1.9	5.3	20.9	5.8			

Groundwater

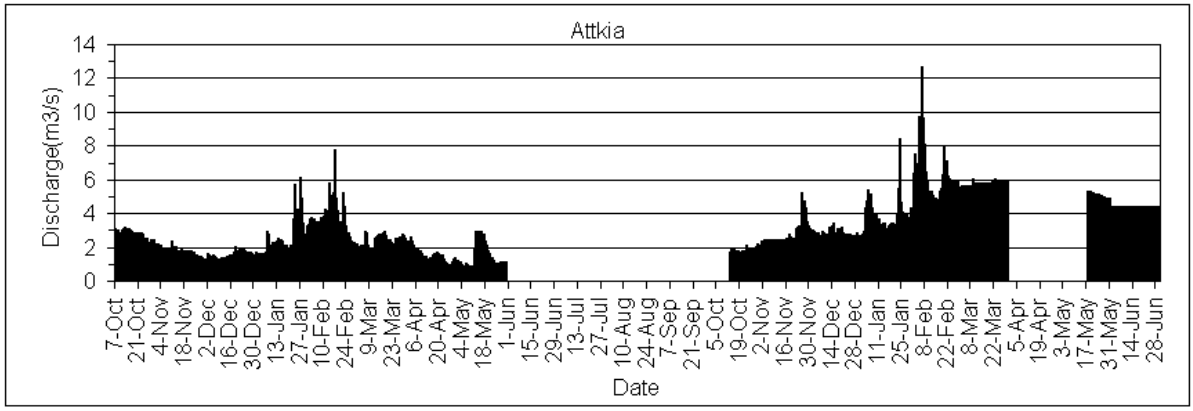


Year	Month	Water Level			Year	Month	Water Level		
		Ave	Max	Min			Ave	Max	Min
2003-2004	10	142.0	142.7	141.7	2004-2005	10	143.1	143.3	142.8
	11	141.7	141.8	141.6		11	143.1	143.4	142.9
	12	141.9	142.1	141.7		12	143.7	143.8	143.4
	1	142.1	141.9	142.0		1	143.8	144.0	143.7
	2	142.0	142.0	141.9		2	143.8	143.9	143.3
	3	142.0	142.1	141.9		3	143.3	143.6	142.9
	4	142.2	142.3	142.0		4	142.6	142.9	142.7
	5	142.0	142.4	140.9		5	142.2	142.6	142.4
	6	142.0	142.3	141.7		6	141.8	142.3	141.7
	7	141.9	142.2	141.7		7			
	8	142.1	142.4	141.8		8			
	9	142.7	142.8	142.5		9			



Year	Month	Water Level			Year	Month	Water Level		
		Ave	Max	Min			Ave	Max	Min
2003-2004	10	48.5	49.1	48.1	2004-2005	10	41.0	41.2	40.7
	11	47.9	48.5	47.3		11	40.8	41.1	40.4
	12	46.9	47.6	46.5		12	40.1	40.6	39.6
	1	46.6	45.5	46.1		1	39.6	39.8	39.0
	2	44.8	45.4	44.3		2	38.9	39.1	38.8
	3	44.3	44.5	44.0		3	38.1	38.2	38.4
	4	44.0	44.2	43.8		4	37.9	38.1	37.6
	5	43.1	43.6	42.7		5	37.2	37.6	36.8
	6	42.0	42.7	41.3		6	36.7	36.8	36.5
	7	41.2	41.5	40.8		7			
	8	41.0	41.0	40.9		8			
	9	40.9	41.1	40.7		9			

Surface water



Year	Month	Monthly Discharge(m3)	Year	Month	Monthly Discharge(m3)
2003-2004	10	6,066,830	2004-2005	10	3,127,132
	11	4,739,333		11	7,446,337
	12	4,286,046		12	7,774,128
	1	7,343,257		1	10,788,721
	2	9,791,248		2	15,856,070
	3	6,587,136		3	15,067,296
	4	4,201,632		4	no data
	5	4,231,505		5	6.163.776
	6	no data		6	11.560.320
	7	no data		7	
	8	no data		8	
	9	no data		9	

Water Quality Monitoring

Monitoring stations in the Barada Awaji Basin	
Type of Station	**Number of Station**
Every 2 months monitor	102
Every 6 months monitor	78
Heavy Metals (Every 3 months)	21
Monitored parameters (every 2 and every 6 months)	
Surface Water: pH, Conductivity, Cl, NH4, BOD, S.S, Do, Temperature, Heavy Metals	
Groundwater: pH, Conductivity, PO4, NO2, NO3, HCO3, CO3, SO4, Cl, Ca, Mg, Na, NH4, Total Hardness	
Heavy Metals: Pb, Cr, Fe, Cu, Cd, As, Zn, He	

INSTITUTIONAL ANALYSIS AND FOCAL WATER MANAGEMENT PROBLEMS IN THE SEYBOUSE RIVER BASIN, ALGERIA

Prepared by the Agence de Bassin Hydrographique de Constantinois, Seybousse, Mellegue

1. General Overview

1.1 Country overview

1.1.1 General features

Algeria, with an area of 2.4 million km², is the largest country of Northern Africa. Most of its area corresponds to the Sahara Desert, an area rich in mineral resources. More than 90% of the population lives in the northern part of the country that includes the coastal Mediterranean zone, mountainous areas, plains and highlands. In this area, the annual amount of rainfall varies between 300 and 1000 mm/yr. whereas in the Sahara region and southern of the Saharian Atlas, the annual amount of rainfall does not exceed 100 mm.

The country is divided 17 major hydrographical basins, of which 5 are transboundary: the Medjerda basin is shared with Tunisia, and the Tafna, Draa, Guir and Daoura basins are shared with Morocco. With regard to administration, the country is divided into 48 wilayas (provinces), 567 dairas (counties) and 1540 municipalities.

Figure 63: General map of Algeria

In 1998, Algeria had a population of 29.27 million inhabitants (official census data). This figure corresponds to an annual growth rate of 2.28% since the previous (1987) census, when a population of 22.71 million was recorded. The share of urban population has been continuously increasing from 56.1% in 1966 to 61.2% in 1977, to 70.8% in 1987 and to 80.8% in 1998. The 5 wilayas of Algiers, Setif, Oran, Tizi Ouzou and Batna regroup more than 25% of the total population. Irrigated agriculture accounts for approximately 65% of the total water consumption, as modern irrigation techniques have not been yet extensively applied.

According to the 1998 census, 70.78% of households are connected to the drinking water supply network, and 66.34 % to the sewerage network. It should be noted that the average household size was reduced from 7.54 members in 1987 to 7.14 in 1998; this was the first time since the country's independence in 1962 that such a decrease was recorded.

1.1.2 Water resources

The average annual water crop is estimated at 100 billion m³, of which approximately 80% is lost to evapotranspiration. Water resources are equal to 19.1 billion m³, of which 12.4 billion are surface water and 6.7 billion are groundwater. Of the total surface run-off of 12.4 billion m^3 only 6 billion can be exploited by means of dam construction. At present, the 110 dams of the country mobilize 4 billion m³. Between 1995 and 1998, the average annual regularized volume was equal to 2.7 billion m³.

From the 6.7 billion m³ of groundwater, 5.1 billion are located in the Sahara. The remaining 1.6 billion m³ are exploited at a rate of 80%, principally through wells and boreholes.

Therefore, it is evident that an additional volume of 7.6 billion could become at least theoretically available for meeting domestic, agricultural and industrial water needs. This amount, according to recent studies, would be sufficient only up to 2015. Afterwards, it will be necessary to seek alternative water sources, by employing solutions such as wastewater reclamation and reuse, seawater desalination, and pumping of non-renewable groundwater resources from the northern Sahara, in order to meet water needs.

1.2 The Seybouse river basin

The region selected for the implementation of INECO in Algeria is the Seybouse Basin (Figure 64). The river basin extends over an area of 6,471 km^2 and is located in the northern part of Algeria.

The Seybouse River is an important water source, used mainly for the irrigation of large agricultural plains, extending from the Guelma region and up to Annaba city. The river has a total length of 240 km. Overall the basin extends over the administrative boundaries of 68 municipalities located in 7 wilayas. Its water resources are vital for sustaining the majority of economic activities in the region.

At present, there are significant water pollution issues associated with the discharge of both domestic and industrial effluents from the cities and the industries located along the river banks. The annual effluent discharge is approximately 4.5 million m³, of which 3 million are used oils. This is due to the lack of wastewater treatment plants in the cities (domestic sewage) but also and in industrial units. The most vulnerable areas are Meboudja. Bouchegouf and Guelma, where industrial activities are most concentrated. In those areas aquifer pollution is also a major concern. Furthermore, the mountainous areas, such as Edough and Gelaat Bou Sbaa contribute to high surface run-off which conveys polluted effluents and recharges groundwater tables. At present, there is risk for human health, as children often play at the river banks but also in irrigation, as many farmers abstract water directly from the river. Fauna and flora are also seriously threatened, as well as soil productivity and the overall river ecosystem.

1.2.1 Water quality assessments

In order to evaluate the current state of the river and aquifers concerned, a survey was carried out during the period 1998-2003. The monitored water quality parameters included nitrates, nitrites, chloride, conductivity and turbidity, BOD and COD, dissolved oxygen and ammonia. The results show that there has been a significant degradation of water quality during the past

5 years, in both surface and groundwater resources of the basin. Results are outlined in Annex I.

1.2.2 Industrial pollution

Of the 86 major industrial units operating in the river basin, only 8 have their own wastewater treatment plant. It should be noted that some, mostly located in the Guelma region, are highly polluting industries (e.g. paper. engine and dairy production units). A relevant list is provided in Annex II.

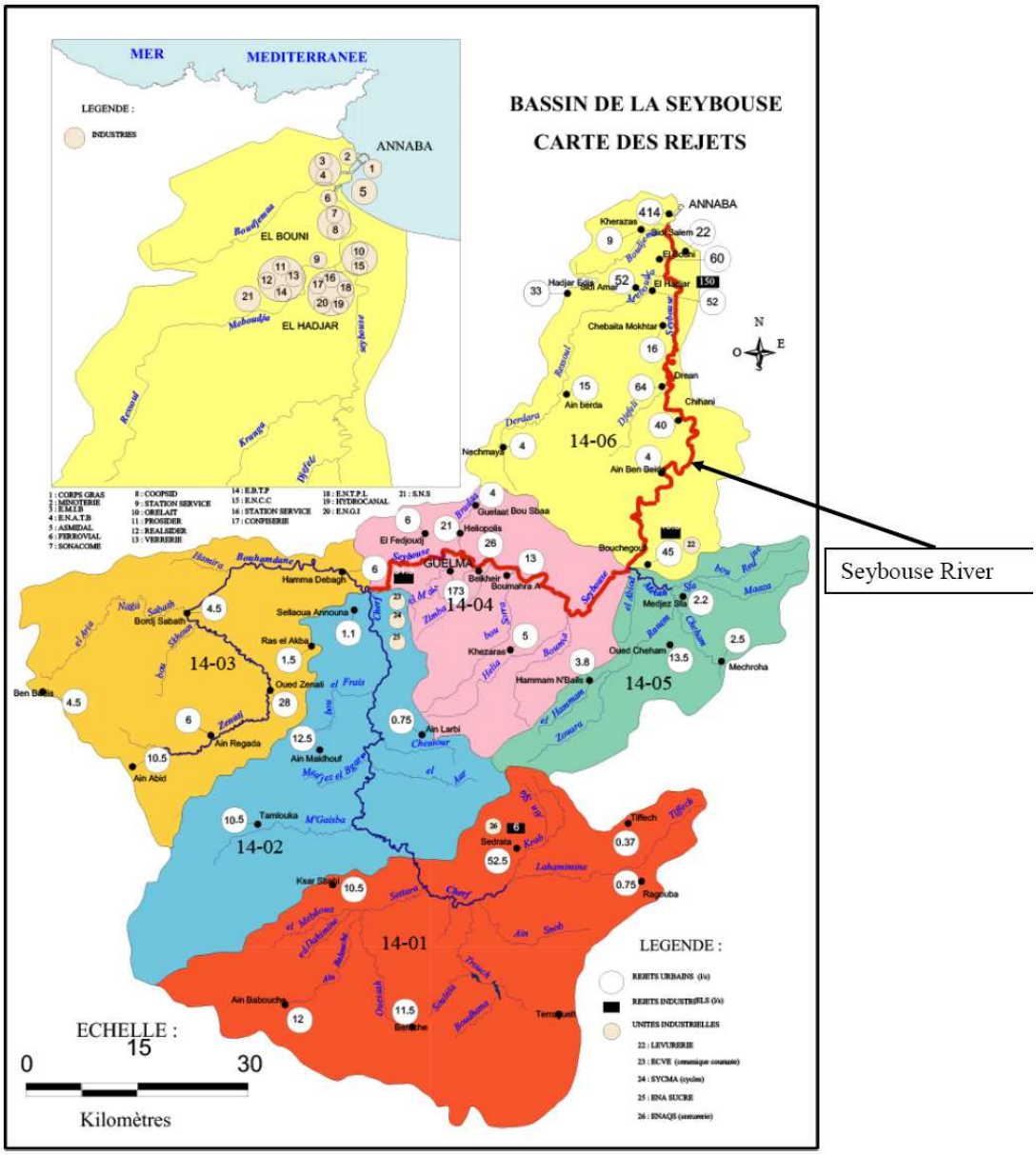


Figure 64: The Seybouse River Basin – Location of main pollution sources

1.2.3 Domestic pollution

Domestic effluents in the basin are not treated, as at present, there are no wastewater treatment plants. Five units, with a total capacity of 130,000 m³/d, are under construction. Two more plants with a total capacity of 180,000 m³/d are at the planning stage in Annaba and Oued Zenati, and will be operational in 2008 and 2010 respectively.

Table 61: Sewage treatment plants under construction and planning - Seybouse River Basin

Community/ Municipality	Capacity (population equivalents)	Operation Year	Purification capacity (m^3/day)
Under construction			
Sedrata	100,000	2007	25,000
Guelma	200,000	2008	32,000
El Fedjoudj	5,000	2008	2,000
MDaourouch	64,533	2008	10,000
Bir Bouhouche	10,580	2008	60,000
Planning stage			
Oued Zenati	100,000	2010	20,000
Annaba	780,700	2008	156,000

2. Institutional and financial context

2.1 Institutions & Responsibilities

2.1.1 The Ministry of Water Resources

On a national level, water management falls solely under the responsibility of the Ministry of Water Resources, established in 1999. Before that, water resources were managed either by the Ministry of Public Works, or in 1978 by another Ministry, also in charge of environmental protection, including forests, and territorial planning and management.

The Ministry is responsible for water resource planning, investments on all issues relevant to water resources protection and exploitation, such as hydraulic infrastructure, inter-basin transfers, drinking water supply networks, and sewage treatment plants. It is also responsible for allocating available water among the different uses (agricultural. domestic and industrial), and for controlling all water-related infrastructure (public and private). Additional tasks include the monitoring of water resources, in terms of both quantity and quality. For achieving this task, the Ministry can implement all the necessary surveys and assessments, and is responsible for data collection on all the above issues.

Following its central role in water management, the Ministry has also control over:

- Five national agencies: Agence Nationale des Barrages et des Transferts (National Dam and Inter-Basin Transfer Agency), Agence Nationale des Ressources Hydrauliques (Hydraulic Resources National Agency), Agence Nationale de l' Irrigation et du drainage (National Agency for Irrigation and Drainage), Algerienne des Eaux, and Office National d' Assainissement (National Office for Sanitation).
- Five hydrographical basin agencies, which coordinate water management activities at the regional level.

The roles and responsibilities of the above institutions are summarized in Table 62. Table 63 summarizes water resource responsibilities for the authorities listed in Table 62.

Furthermore, the Ministry of the Environment and the Ministry of Water Resources are responsible for defining the overall environmental policy. The MWR is responsible for water pollution abatement. Although legislation on emissions is in place, there are problems in law enforcement, as most industries could not afford wastewater treatment. It therefore becomes evident that government incentives should be offered either as grants as rebates on environmental taxation.

It should be noted that water management responsibilities have been modified several times during the past 15 years. Especially water distribution has been often centralized and then decentralized. For example, irrigation water, previously managed by the Ministry of Agriculture (see below), is now managed by the Ministry of Water Resources through the corresponding agency. The frequent changes have not contributed in simplifying the overall water management framework, and in developing the appropriate technical and human capacity and resources in the different departments/agencies.

Table 62:The organisation of the water sector

	Ministry of water resources	National Agencies	Local Administration	End-users
Planning	Direction of planning and economic assessment (DPAE)		Regional directions at the wilayas Municipalities (reform in progress)	
Large hydraulic infrastructure	Direction for water resources mobilization and planning (DMRE)	National Agency of dams and transfers (ANBT). *Feasibility studies. implementation and management*		
Irrigation	Direction of agricultural hydraulics (DHA)	National Office for Irrigation and Drainage (ONID) *Management of irrigation perimeters*		Farmers & irrigation associations
Water Distribution	Direction of potable water (DAEP) Planning and legislation	Algerienne des Eaux (ADE) *Elaboration of feasibility studies. implementation of water works and overall management*	Regional directions at the wilayas Municipalities (reform in progress)	
Sewage water	Direction of sewage (DAPE) *Planning and legislation*	National Office for Sewage (ONA) *Feasibility studies. implementation and management*	Regional directions at the wilayas Municipalities (reform in progress)	
River Basin Management	Direction of studies and hydraulic development (DEAH)	Hydrographic Basin Agencies (ABH) National Agency for Water Resources (ANRH)		

Table 63: Water resources planning matrix

ACTIVITY	MWR	ANB	ANRH	ADE	ONA	ONID	ABH
Surface waters		X					
Use							
Storage							
Groundwater recharge							
Diversion							
Quality monitoring			X				X
Assessment							
Groundwater							
Use							
Storage			X				
Recharge							
Quality monitoring			X				X
Assessment							
Well permits							
Irrigation network							
Rehabilitation						X	
Modernisation						X	
Reuse							
Drainage water					X		
Wastewater					X		
Desalination				X			
Introduction of technology							
Efficient water utilisation							
Domestic				X			
Industrial				X			
Agricultural						X	
Legislation							
Regulation and codes	X						
Standards	X						
Enforcement							
Policy setting							
Water allocation	X						
Project financing	X						
Project design		X	X	X	X	X	X
Project implementation		X	X	X	X	X	
Operation and Maintenance		X	X	X	X	X	
Pricing (tariffs)	X						
Water data records			X				

2.1.2 The Ministry of Agriculture

Before the establishment of the Ministry of Water Resources, the Ministry of Agriculture was in charge of all issues related to agricultural water use. However, at present it is only considered as representing a major water user.

2.1.3 The Ministry of Health

In collaboration with the Ministry of Water Resources, the Ministry of Health is responsible for monitoring drinking water quality, especially with regard to microbiological parameters.

2.1.4 The Ministry of the Interior

In spite of the creation, in 2004, of the Algerienne des Eaux (ADE) and Office National d' Assainissement (ONA), there are municipalities (falling under the responsibility of the Ministry of the Interior), which are still responsible for the management of water distribution and sewerage networks in urban and rural areas. However, it is expected that the role of the Ministry will gradually diminish, as the ADE and ONA are progressively taking charge of all networks.

2.2 Legislation

Water-related legislation mainly comprises three laws and their amendments:

- The Water Law ("Code de l'eau") of July 1983;
- A Law of June 1996. which amended the Code de l'Eau;
- A law of August 2005, dealing with water-related issues.

Specific regulations and norms, issued in the form of additional laws and decrees are elaborated by the Ministry of Water Resources.

The Water Law of 1983 set the framework for water management in Algeria, by defining the public ownership of water resources (surface and groundwater) of the country, and the priorities for water allocation. Allocation priorities are of the following order: first priority is given to domestic water use, second to agricultural, and finally, to the industrial sector. Furthermore, the Law introduced the concept of issuing private contracts for providing public services, which would be specifically assigned to public authorities and institutions.

The 1983 Water Law was significantly amended in 1996. The law allowed for extending contracts for water service provision to private companies. It also introduced the concept of river basin management, through the definition of hydrographical basins as the appropriate geographic entities for water resource planning and management. The 1996 amendment also established the National Consultative Council for Water Resources (Conseil National Consultatif des Ressources en Eau), in charge of agreeing to the water management plan, and acting as a consulting body on the development of water management strategies at the national level. At present, the Council's procedures have not been yet defined.

Water-related legislation was further updated in 2005. The 2005 Law introduced the concepts of environmental sustainability and defined the necessary planning framework, through the development of regional water management schemes, to be elaborated at the hydrographical basin level. This law also introduces the participation of stakeholders, policy and decision-makers on all water-related decisions.

Water quality standards for physico-chemical parameters are national and based on the guidelines published by WHO. The ANRH (Agence Nationale des Ressources Hydrauliques) and the hydrographical basin agencies monitor, through a surface and groundwater monitoring network, all relevant data and regularly publish water pollution maps for each region.

In general, the continuous updating ensures that water-related legislation meets emerging needs and the increasing environmental concerns over water resource sustainability. However, law enforcement, especially with regard to water abstraction and pollution control can be possibly considered insufficient.

The main water laws are summarized in Table 64.

Table 64: Water-related legislation

Reference	Focus	Content	Implementation Status
Water Law no 83-17 16 July 1983	General provisions on water governance. allocation and water rights	On the uses of water. property of water resources and the rights of consumers	Generally implemented. Some aspects, especially with regard to monitoring and control are not enforced.
Law 96-13 15 of June 1996 Amending and completing the Water Law of 1983	Establishment of a new water policy framework	Introduces the concept of Integrated Water Resources Management. Provides for the establishment of the Hydrographical Basin Agencies.	In the process of implementation, but possibly with some delay.
Water Law no 05-12 4th August 2005	Introduction of the general principles of environmental sustainability, and provisions for new tools in water resource planning.	About the sustainable management of water in relation to the environment. Provides for the drafting of the National Water Management Plan and for the corresponding Regional Water Development Programmes.	Recent law, has not been yet fully implemented, especially with regard to the development of Regional and National Water Management Plans.

2.3 Financial framework

At present, all water sector investments are public and financed from the national budget. A distinction can be made between funds:

- Funds provided to the Ministry of Water Resources, to finance "sectorial" projects, such as dams, water transfers, assessments, important networks for water supply and sewerage, drinking water and wastewater treatment plants and irrigation perimeters. These funds are then allocated or distributed among the different agencies, controlled by the Ministry.
- Funds provided to the local administration (wilayas and municipalities), aimed at financing small-scale networks at the local level.

Although the pertinent legislation provides the relevant opportunities, the private sector is not actively involved yet. During the past two years there has been an extensive debate in involving foreign investment parties in the management of the Algerienne Des Eaux and the Office National d' Assainissement (ONA). This initiative is now in the process of implementation.

Water tariffs for each use are decided at the national level, and are not differentiated per region. Additional environmental taxes were introduced in 1996: (a) a water abstraction charge and (b) a water pollution charge. These are paid by all consumers connected to a water

supply network (domestic, agricultural and industrial). An additional tax was introduced in 2005 for industrial and other (service) facilities which operate their own water supply infrastructure, with the aim to progressively introduce and apply the "polluter-pays" principle.

It should be noted that the country faces a serious lack of information with regard to cost accounting and financial and economic assessments, and institutional studies. At present, there are no general or important assessments on investments and water pricing, although several attempts have been made in the past.

Mostly due to social and political reasons, water prices for industrial and agricultural use are considered to be well below the real cost of water provision. This imposes a financial burden on the public companies responsible for water distribution, which are further subsidized through the national budget.

3. Constraints facing the water sector at the national level

Algeria, due to its climate, is a country with limited water availability and increasing water scarcity. The mobilization of groundwater (with the exception of the Sahara mineral resources – the albian nappe) has been nearly completed.

Damming started recently, in the late 1980s, and is still being pursued. It is expected that in the next 25 years nearly all exploitable surface waters will have been mobilised. Furthermore, the Ministry of Water Resources is studying the possibility of implementing seawater desalination. Algeria has an extensive coastline, of about 1.000 km. and all major cities are ports. The concept would be to employ desalination for meeting urban and industrial water needs along the coastal zone, and to divert surface and groundwater to the interior of the country.

There is need for significant efforts in rehabilitating existing water distribution networks, where losses are estimated at nearly 50% of water distributed. This can be considered an enormous amount when compared to the increasing water scarcity the country is facing. The Ministry of Water Resources has initiated a relevant programme for the three major cities of Algiers, Oran and Constantine, which is expected to be extended to at least 10 other important ones. Similarly, important efforts are in progress for managing water resources in a way that ensures environmental protection.

In general, the Algerienne des Eaux, the enterprise in charge of drinking water supply networks, should become more efficient in reducing water leaks, and in the recovery of its costs. In this field, the country seeks technical and economic assistance from foreign companies through international tenders. The first contract was initiated in Algiers in 2006, with Suez Environnement (France). Other contracts are under preparation for Oran, Constantine and Annaba.

A further issue concerns the lack of information on the real economic value of water and the actual water exploitation cost. There are no analytical accounts from the companies previously in charge of water service provision, and the implementation of the Algerienne des Eaux is too recent to result to an adequate dataset. Enhancing the knowledge base upon these issues is an emerging need that should be addressed in the next years. The water price is decided by national authorities and is uniform throughout the country. There is no actual

information about costs and the costs of "reasonable" management and water supply provision; therefore, there is no estimate of whether consumers are actually charged with the real cost of water.

In the forthcoming years, water pollution will be a major problem, due to two major causes:

- The strong urbanization has rendered cities major contributors to river pollution (most rivers are "oueds". i.e. of seasonal flow and dry during the summer). Furthermore, the programme for building sewage treatment plants has been significantly delayed, and only a few cities receive wastewater treatment.
- Agricultural development, liberated in the 1990s after a long socialist period, has resulted in the significant use of fertilizers, with the aim to further increase agricultural production. This is now clearly manifested in the increasing concentrations of nitrates in both surface and groundwater. Furthermore, a large number of wells and boreholes are being drilled, at many cases without prior authorization or permit. In 2006, authorities decided to develop an inventory of water extraction points; however, this is considered a difficult task as, at present the number of illegal wells or boreholes is estimated at several thousands.

Similarly, data and information systems and analytical tools on water resources have to be created, maintained and regularly updated. Towards this end, an effort was initiated at the national level by the Ministry of Water Resources, and at the regional level, through the Basin Agencies, in order to collect and organise all existing water-related data. Along the same lines, simulation tools on water resource assessment, demand and allocation are being developed/implemented.

Although the pertinent legislation advocates the principle of public participation, the participation of the different actors is rather weak, with all important decisions being taken at the national level. Basin committees were established in 1996 (at the same time as the Basin Agencies), but are not yet fully efficient.

As mentioned above, several environmental taxes were introduced during the past decade. Basin Agencies are, according to the relevant legislation, in charge of collecting the 2005 tax for industrial and service facilities, but actually lack in sufficient human and financial means.

All the above constraints are encountered throughout the country, and at the Seybouse river basin, where difficulties in enforcing legislation on discharge control, especially with regard to industries have led to significant water pollution.

4. Annex I: Evolution of surface water pollution in the Seybouse River Basin (1998-2003)

4.1 Water quality classification

Water quality for each measured parameter (BOD, COD, Dissolved O_2, NH_4^+, NO_3^-, NO_2^-, PO_4^{3-}, Conductivity and Turbidity) is classified into 5 classes, according to the 1994 WHO classification. These are outlined in the following tables.

Organic Matter

Quality class	Unit	Excellent	Good	Average	Bad	Excessive Pollution
COD	mg/l	20	30	40	80	> 80
BOD	mg/l	3	5	8	10	> 10

Dissolved oxygen

Quality class	Unit	Excellent	Good	Average	Bad	Excessive Pollution
Dissolved O2	%	90	70	50	30	> 30

Ammonia and Nitrites

Quality class	Unit	Excellent	Good	Average	Bad	Excessive Pollution
NH4+	mg/l	0.1	0.5	2	5	> 8
NO2-	mg/l	0.03	0.1	0.5	1	> 1

Nitrates

Quality class	Unit	Excellent	Good	Average	Bad	Excessive Pollution
NO3-	mg/l	2	10	25	50	> 50

Phosphates

Quality class	Unit	Excellent	Good	Average	Bad	Excessive Pollution
PO43-	mg/l	0.1	0.5	1	2	> 2

Conductivity

Quality class	Unit	Excellent	Good	Average	Bad	Excessive Pollution
Cond.	µS/cm	2500	3000	3500	4000	> 4000

Turbidity

Quality class	Unit	Excellent	Good	Average	Bad	Excessive Pollution
Turb.	NTU	2	35	70	105	> 105

4.2 Water quality measurements

The above parameters are measured in 4 monitoring points, located on the Seybouse River. This section provides details on those measurements. It should be noted that the Meboudja oued inflows to the Seybouse River, and that both rivers are very polluted.

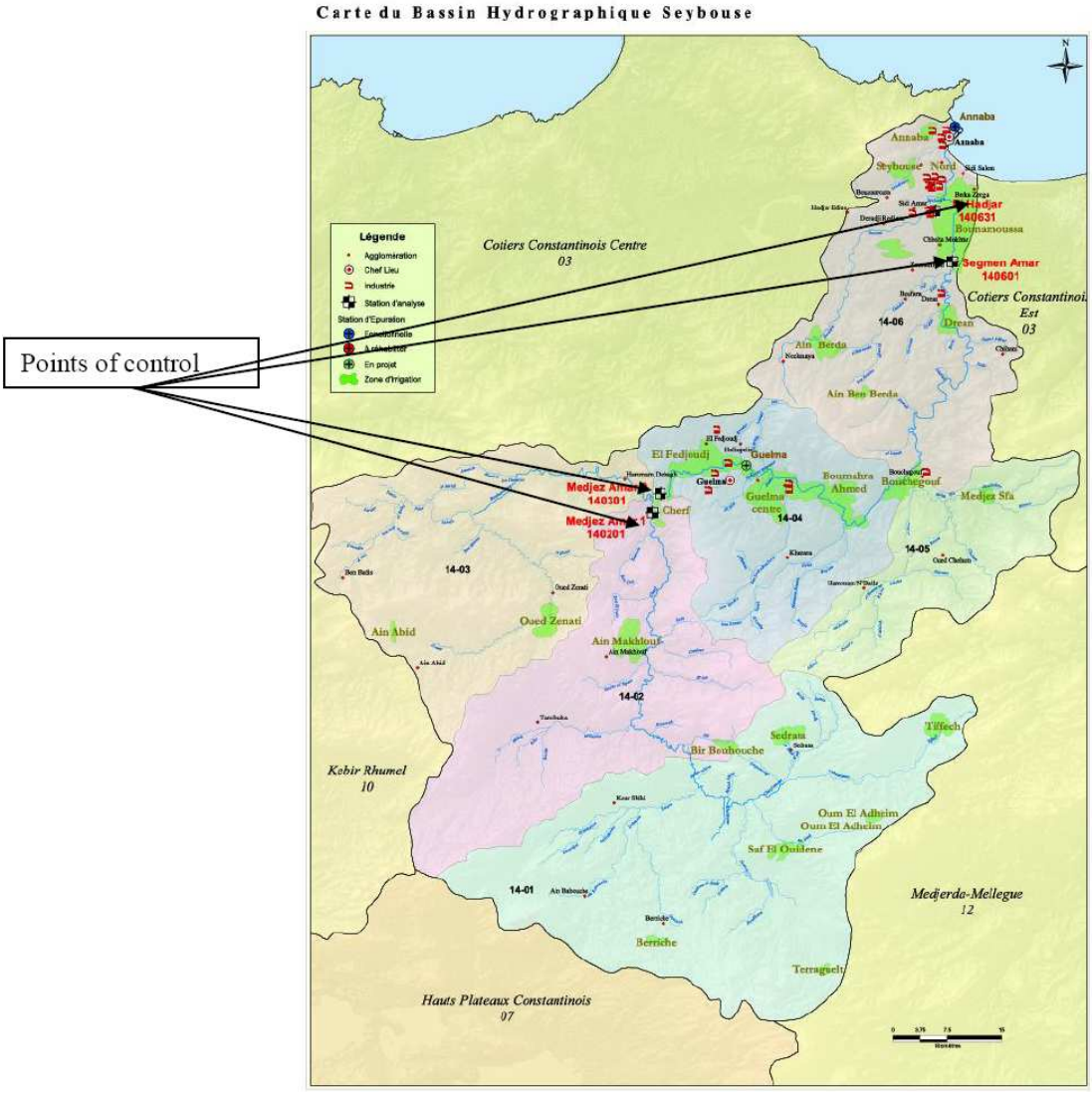


Figure 65: Points of water quality control

4.2.1 Medjez Amar 1 Station 140201

Water is rather polluted. Pollution originates from urban and agricultural sources.

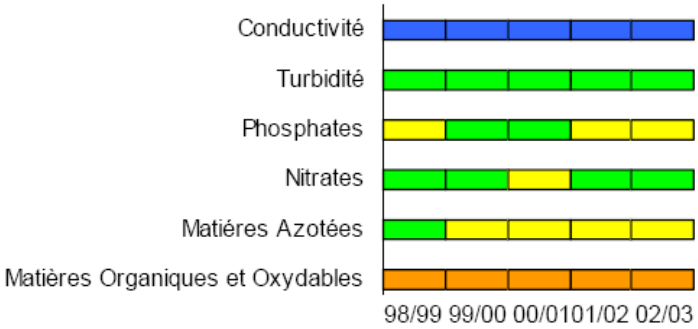


Figure 66: Water quality in Medjez Amar 1 Station 140201 (1998-2003)

Table 65: Water quality classification and water pollution sources in the Medjez Amar 1 St. 140201

Medjez Amar 1 St. 140201		**Pollution**	**Overall quality**	**Observations**	
				Comments	**Water pollution sources**
Pollutants	Organic and Oxidisable matter, Nitrogen and Ammonia, Phosphoric matter	Important	Average	Good self-purification capacity and therefore adequate oxygenation	Urban Agricultural
	Phosphates	Weak	Acceptable		
	Nitrates		Good		
Dissolved Oxygen			Good		

Water pollution sources			
Agglomerations (1998 population)	Abid Mabrouk (3448)	Houari boumediene (4515)	**Total (7963)**
Industry	-		
Agriculture	Ain Makhlouf		

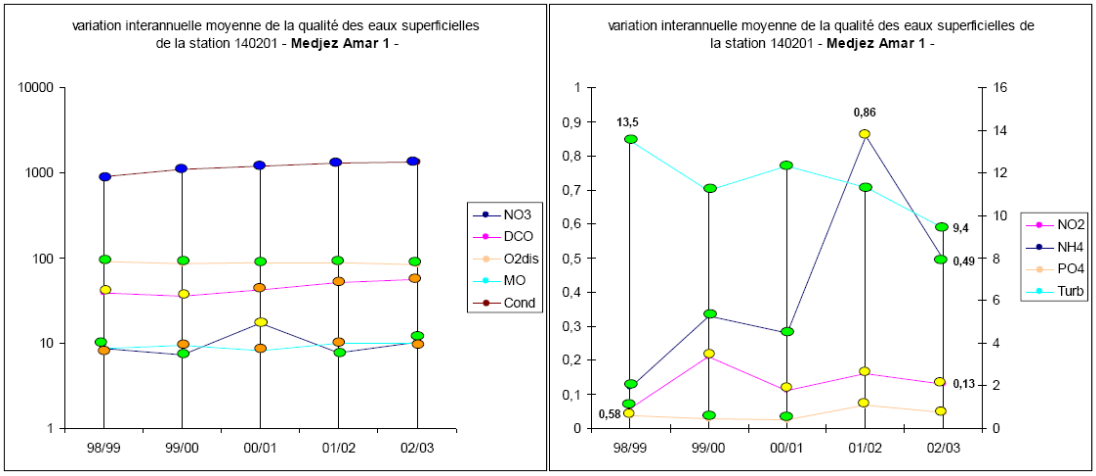


Figure 67: Water quality measurements at the Medjez Amar 1 St. 140201 (1998-2003)

4.2.2 Medjez Amar 2 St. 140301

Water is not significantly polluted. Pollution originates from urban and agricultural sources.

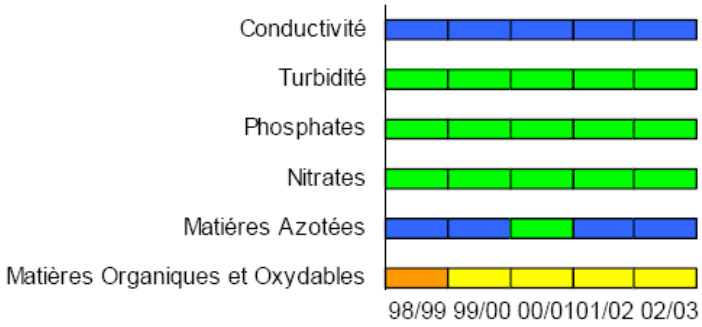


Figure 68: Water quality in Medjez Amar 2 St. 140301 (1998-2003)

Table 66: Water quality classification and water pollution sources in the Medjez Amar 2 St. 140301

Medjez Amar 2 St. 140301		**Pollution**	**Overall quality**	**Observations**	
				Comments	**Water pollution sources**
Pollutants	Organic and Oxidisable matter, Nitrogen and Ammonia, Phosphoric matter	Weak	Adequate	Water dilution from the Bouhamdane river (oued) Good self-purification capacity and therefore adequate oxygenation	Confluence of Cherf and Bouhamdane rivers Water pollution sources: – Urban – Agricultural
	Phosphates		Good		
	Nitrates		Good		
Oxygenation			Good		

Water pollution sources	
Agglomerations (1998 population)	Hammam Debagh (10178)
Industry	-
Agriculture	Houari boumediene, Medjez Amar

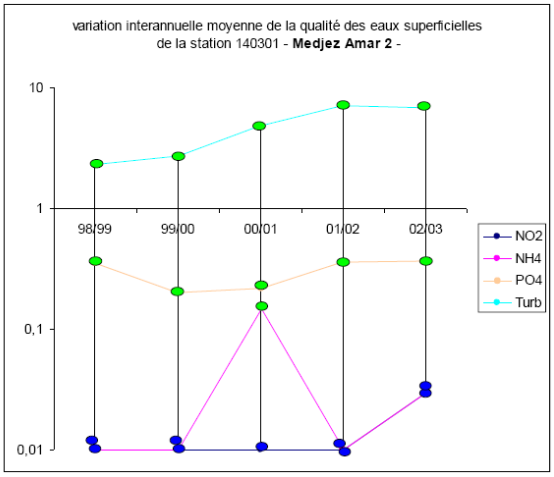


Figure 69: Water quality measurements at the Medjez Amar 2 St. 140301 (1998-2003)

4.2.3 Segmen Amar St. 140601

Water is much polluted. Pollution originates from urban, industrial and agricultural sources.

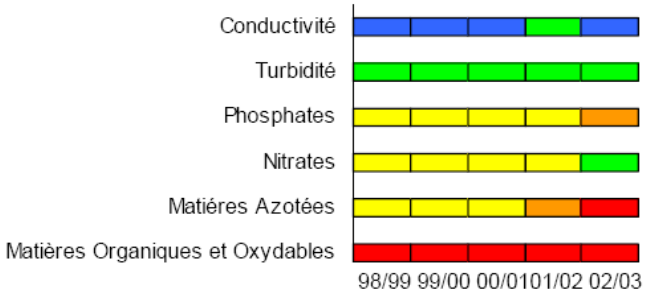


Figure 70: Water quality in Segmen Amar St. 140601 (1998-2003)

Table 67: Water quality and water pollution sources in the Segmen Amar St. 140601

Segmen Amar St. 140601		**Pollution**	**Overall quality**	**Observations**	
				Comments	**Water pollution sources**
Pollutants	Organic and Oxidisable matter, Nitrogen and Ammonia, Phosphoric matter	Excessive	Very bad	Good self-purification capacity and therefore adequate oxygenation	– Urban – Industrial – Agricultural
	Phosphates	Weak	Adequate		
	Nitrates		Good		
Oxygenation			Good		

Water pollution sources						
Agglomerations (1998 population)	Bouchegouf (15086)	Oued Fragha (1171)	Ain Ben Berda (3686)	Chihani Bachir (7442)	Drean (17957)	**Total (45342)**
Industry	EPE (yeast), SACA (transf. tomatoes),LES AURES (transf. tomatoes)					
Agriculture	GPI Bouchegouf, Guelma, Boumahra A. Belkheir, El Fedjoudj, GPI Bounamoussa					

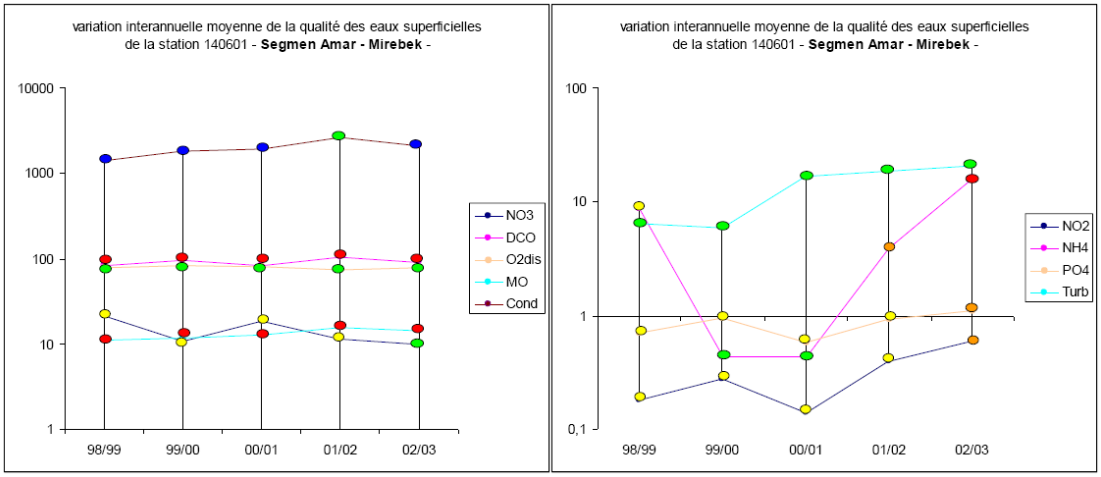


Figure 71: Water quality measurements at the Segmen Amar St. 140601 (1998-2003)

4.2.4 El Hadjar St. 140631

Water is much polluted. Pollution originates from urban, industrial and agricultural sources.

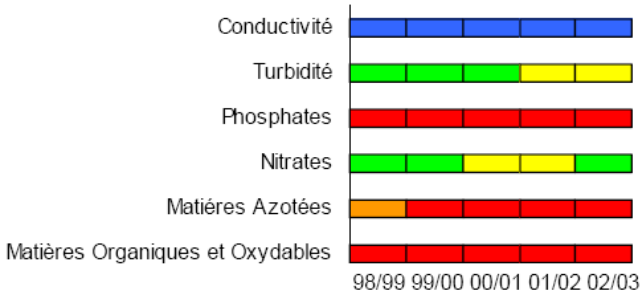


Figure 72: Water quality in El Hadjar St. 140631 (1998-2003)

Table 68: Water quality classification and water pollution sources in the El Hadjar St. 140631

El Hadjar St. 140631		**Pollution**	**Overall quality**	**Observations**	
				Comments	**Water Pollution Sources**
Pollutants	Organic and Oxidisable matter, Nitrogen and Ammonia, Phosphoric matter	Excessive	Very Bad	Bad oxygenation, due to the small purification capacity of the river, as compared to water pollution received	– Urban – Industrial – Agricultural
	Phosphates	Excessive	Very Bad		
	Nitrates	Weak	Adequate		
Oxygenation			Bad		

Water pollution sources							
Agglomerations (1998 population)	El Hadjar (23777)	Sidi Amar (40706)	El Karma (1218)	El Horaicha (3679)	Deradji Redjem (7440)	Hadjer Eddiss (18610)	**Total (95430)**
Industry	ZI Pt. Bouchet, ZI Sidi Amar,						
Agriculture	El Hadjar, Sidi Amar						

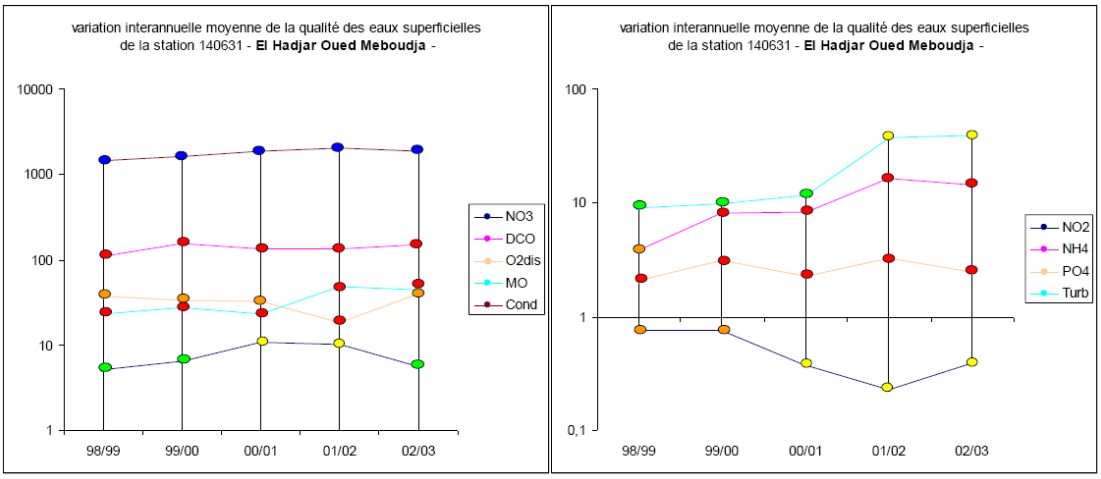


Figure 73: Water quality measurements at the El Hadjar St. 140631 (1998-2003)

Annex II: Characteristics of main industries located in the Seybouse River Basin

INDUSTRY NAME	COMMUNITY/MUNICIPALITY	WILAYA	TYPE OF ACTIVITY	CAPACITY	WATER DEMAND	REJECTED VOLUME	DISCHARGE POINT	TREATMENT	RECYCLING
TRANS CANAL EST EL HADJAR	EL HADJAR	ANNABA	UNITE DE FABRICATION DE TUYAUX EN BETON ARME	32000 ml/yr	25			YES	NO
MITTAL STEEL ENTREPRISE DE COMMERCIALISATION	EL HADJAR	ANNABA	COMMERCE DE PRODUITS SIDERURGIQUE		43		SEWERAGE NETWORK	NO	NO
SOCIETE DES TRAVAUX ET DE LA CONSTRUCTION DE ANNABA S.T.C.A	EL BOUNI	ANNABA	BATIMENTS TOUS CORPS D'ETATS	100 LOGEMENTS /yr	5		RIVER	NO	NO
REFRACTAL	EL HADJAR	ANNABA	FABRICATION ET COMMER PRODUITS REFRACTALE	1500tonnes/an	5			NO	NO
PAPIREC	SIDI AMAR	ANNABA	RECUPERATION DU PAPIER	3000 ton/yr	1	0.8	SEWERAGE NETWORK	NO	NO
SOFAMESTE ZIANE MAHMOUD ET FILS	SIDI AMAR	ANNABA	EBENISTERIE		1	0.8	SEWERAGE NETWORK	NO	NO
SONELGAZ CENTRAL THERMIQUE DE ANNABA	ANNABA	ANNABA	PRODUCTION DE L'ENERGIE ELECTRIQUE	143000 kW	872		SEWERAGE NETWORK	NO	NO
MITTAL STEEL	SIDI AMAR	ANNABA	PRODUCTION DE L'ACIER ET DERIVEES	1400000 ton/yr	32877	3287	MEBOUDJA RIVER	NO	NO
SUCCURSALE EST SPOA	SIDI AMAR	ANNABA	VENTE EN GROS DE PEINTURE		0.6			NO	NO
MOKA ELECTROLUX	SIDI AMAR	ANNABA	MONTAGE DES APPAREILS ELECTRO-MECANIQUE	12000 pieces/yr	2	2	SEWERAGE NETWORK	NO	NO
NAFTAL CENTRE MARINE	ANNABA	ANNABA	AVITAILLEMENT DES NAVIRES	30000 ton/month	2	1.6	SEWERAGE NETWORK	NO	NO
MAIN D'OR	EL BOUNI	ANNABA	PRODUCTION SEMOULE	400 Qt/d	1.5	0.5	FOSSE SEPTIQUE	NO	NO

INDUSTRY NAME	COMMUNITY/MUNICIPALITY	WILAYA	TYPE OF ACTIVITY	CAPACITY	WATER DEMAND	REJECTED VOLUME	DISCHARGE POINT	TREATMENT	RECYCLING
TARSI ANNABA	EL HADJAR	ANNABA	MONTAGE ET MAINTENANCE INDUSTRIELLE		5			NO	NO
EL DJORF	EL HADJAR	ANNABA	IMPORTATION DU BOIS ET DERIVES		2			NO	NO
ATH ARAB TRADING HOUSE	SIDI AMAR	ANNABA	COLLECTE DES DECHET FERREUX ET NON FERREUX					NO	NO
RAYANE PAPIER	EL BOUNI	ANNABA	TRANSFORMATION DE PAPIER		0.3		SEWERAGE NETWORK	NO	NO
STA / UMPA	SIDI AMAR	ANNABA	PRESTATION ET MAINTENANCE		37		PUBLIC NETWORK	NO	NO
FERROVIAL	EL BOUNI	ANNABA	CONSTRUCTION DE MATERIELS ET EQUIPEMENTS FERROVIAI	800WAGONS STD/AN +PF=3000 T/yr	150	30	ALLELICK RIVER	NO	NO
ENGI-ANNABA ENTREPRISE NATIONALE DES GAZS INDUSTRIELLE	EL HADJAR	ANNABA	PRODUCTION ET CONDITIONNEMENT DES GAZ INDUSTRIELS	C2H2 (120000 m3+O=570000 m3/yr	400	2.3	CANAL D'EVACUATION D'EAU USEES	YES	NO
TREFILEST SOCIETE DE TREFILAGE DE L'EST	EL HADJAR	ANNABA	TRANSFORMATION DES PRODUITS LONGS		60		LA SOCIETE ETANT DOTEE D'UN CIRCUIT FERME	NO	NO
FCM	EL BOUNI	ANNABA	PRODUCTION DE CARREAUX MONOCOUCHE	350 m^2/d	5			NO	NO
SELMA SEMOULE	EL BOUNI	ANNABA	PRODUCTION DE SEMOULE +FARINE	2500ton/d	2		SEWERAGE NETWORK	NO	NO
C.E.C.C.O NOUBLI ET FILS	SIDI AMAR	ANNABA	FABRICATION D'EMBALLAGE CARTON COMPACT ET ONDULE	20 CAISSES / d	0.5	0.4	PUBLIC NETWORK	NO	NO

INDUSTRY NAME	COMMUNITY/MUNICIPALITY	WILAYA	TYPE OF ACTIVITY	CAPACITY	WATER DEMAND	REJECTED VOLUME	DISCHARGE POINT	TREATMENT	RECYCLING
LES MOULINS SEYBOUSE	ANNABA	ANNABA	PRODUCTION-COMMERCIALISATION-TRANSFORMATION ISSUES	SEMOULE1000QX/J+FARINE 1400QX/d	168.5		SEWERAGE NETWORK	NO	NO
CAFE SAFIA	SIDI AMAR	ANNABA	TORREFACTION ET CONDITIONNEMENT DE CAFE	200 kg/d	0.5		CANALS	NO	NO
VERRERIE BEN KHALIFA	EL BOUNI	ANNABA	PRODUCTION ET USINAGE DE VERRE CREUX	1460 ton/yr	4		SEWERAGE NETWORK	NO	NO
LAITERIE DE L'EDOUGH	EL BOUNI	ANNABA	FABRICATION ET DISTRIBUTION DU LAIT ET SES DERIVES	150000 l/d of milk	500		SEYBOUSE RIVER	NO	NO
KHENOUS HAMANA	EL BOUNI	ANNABA	LIMONADERIE	360000 l/yr	1.1			NO	NO
ALPHA	EL BOUNI	ANNABA	PRODUCTION INDUSTRIELLE	3000 ton/yr	2			NO	NO
ENTREPRISE PUBLIQUE ECONOMIQUE	EL HADJAR	ANNABA	RECUPERATION .TRAIT +COMMERCIALI/ DECHET FERREUX	40000 ton/yr				NO	NO
PROCIM	SIDI AMAR	ANNABA	PRODUCTION CONSTRUCTION INDUSTRIELLE ET METALLIQU	3500 ton/yr	14	13	MEBOUDJA RIVER	NO	NO
UNITED CO	EL BOUNI	ANNABA	INDUSTRIE ELECTRIQUES		3.3	3.3	SEWERAGE NETWORK	NO	NO
MIDOU	EL BOUNI	ANNABA	PATES ALIMENTAIRES	750 kg/h	4			NO	NO
CHOCOTEK	EL HADJAR	ANNABA	CHOCOLATERIE	2 ton/d	10	8	SEWERAGE NETWORK	NO	NO
KHEZZANE ABDEKADER HIPPONE - NATTES	SIDI AMAR	ANNABA	TRANSFORMATION DU PLASTIQUE	2000 m/day	0.4			NO	NO
ALGAL	EL BOUNI	ANNABA	COMMERCIALISATION ET FABRICATION D'ALUMINIUM					NO	NO

INDUSTRY NAME	COMMUNITY/MUNICIPALITY	WILAYA	TYPE OF ACTIVITY	CAPACITY	WATER DEMAND	REJECTED VOLUME	DISCHARGE POINT	TREATMENT	RECYCLING
SOCIETE DES ABATTOIRS DE L'EST UNITE CENVOIR ANNABA	EL BOUNI	ANNABA	AVICULTURE	520000 POUSSINS /AN	10.91		BOUKHMIRA CANAL	NO	NO
S.A.E.I SOCIETE ALGERIENNE D'EQUIPEMENTS INDUSTRIELS	SIDI AMAR	ANNABA	FABRICATION D'EQUIPEMENTS FRIGORIFIQUES INDUSTRIEL	500 units/yr	15		SEWERAGE NETWORK	NO	NO
SILO A SUCRE SORA SUCRE GUELMA- DEPOT	ANNABA	ANNABA	DEPÖT A SUCRE	15000 tons	2	1.6	SEWERAGE NETWORK	NO	NO
SOFARM	EL HADJAR	ANNABA	FABRICATION ET COMMERCIALISATION ARTICLES MEDICAUX		2	1	SEPTIC TANK	NO	NO
CHERIAK MECANIQUE DE PRECISION C.M.P	EL HADJAR	ANNABA	FABRICATION ET REPARATION DE PIECES MECANIQUE		0.1		SEWERAGE NETWORK	NO	NO
SODIPAP	SIDI AMAR	ANNABA	VENTE EN GROS PAPIER		0.5			NO	NO
FETIMI P.M.R.	EL HADJAR	ANNABA	FABRIQUE DALLES ET MONO COUCHE	105600 m^2/yr	9	4	SEWERAGE NETWORK	YES	NO
A.T.F ALGERO TURQUE DU FER	EL HADJAR	ANNABA	FABRICATION CORNIERE A CHAUD	4000 to 5000 ton/month	15	7	MEBOUDJA RIVER	NO	NO
SIDEST SOCIETE INDUSTRIELLE DES DETERGENT DE L'EST	SIDI AMAR	ANNABA	INDUSTRIELLE ET COMMERCIALE	10000 ton/yr	432		SEWERAGE NETWORK	NO	NO
LOGITRAME ANNABA	SIDI AMAR	ANNABA	TRANSPORT ROUTIER(MARCHANDISE)		0.5	0.15	SEWERAGE NETWORK	NO	NO
A.L.T EST ANNABA	EL BOUNI	ANNABA	TORREFACTION ET CONDITIONNEMENT DE CAFE	1500 ton/yr	3			NO	NO
S.A.E-U.P.C EL KARMA	EL HADJAR	ANNABA	PRODUCTION POULET DE CHAIR	508000 Poulet/an	100			NO	NO
MESSAADI	EL HADJAR	ANNABA	TOLERIE	10 PORTE/JOUR	0.06	0.06	SEWERAGE NETWORK	NO	NO

INDUSTRY NAME	COMMUNITY/MUNICIPALITY	WILAYA	TYPE OF ACTIVITY	CAPACITY	WATER DEMAND	REJECTED VOLUME	DISCHARGE POINT	TREATMENT	RECYCLING
BAIBA AZIZ MODELAGE MECANIQUE	EL HADJAR	ANNABA	MODELAGE MECANIQUE		1	1	SEWERAGE NETWORK	NO	NO
SELMI MOHAMED MILOUD MENUISERIE GENERAL DU BOIS	EL HADJAR	ANNABA	MENUISERIEDU BOIS	2 m^3 of wood	99	0.07	SEWERAGE NETWORK	NO	NO
S.T.R.I.A	EL BOUNI	ANNABA	REVETEMENT DES ROUTES	100 ton/d		0.2	SEPTIC TANK	NO	NO
SCMCE ANNABA	SIDI AMAR	ANNABA	ENSACHAGE ET COMMERCIALISATION	200 ton/d	1			NO	NO
ENTREPRISE NATIONAL D'APPROVISIONNEMENT EN BOIS ET DERIVES U	SIDI AMAR	ANNABA	VENTE DE BOIS ET DERIVES ET PRODUITS SIDERURGIQUES					NO	NO
UAB ANNABA 2	EL BOUNI	ANNABA	FABRICATION +COMMERCIALISATION DES ALIMENTS BETAIL	27000 ton/yr	17		SEWERAGE NETWORK	NO	NO
FERTIAL (ex GROUPE ASMIDAL) SOCIETE DE FERTILISANTS -ALGERIE	ANNABA	ANNABA	AMMONIAC ET ENGRAIS PHOSPHATES	4500 ton/d	3836	24000	SEA	NO	NO
SATPAP ALIF	SIDI AMAR	ANNABA	TANSFORMATION PLASTIQUE ET PAPIER	7000 ton/yr	20	0.5	SEWERAGE NETWORK	NO	NO
DECOPLAST	EL BOUNI	ANNABA	FABRICATION DE MAITRES COLORANTS		2	0.5	SEWERAGE NETWORK	NO	NO
PLASTINATTE	SIDI AMAR	ANNABA	FABRICATION DE NATES EN POLYPROPYLENE	1500 NATTES DE 3mm /JOUR	8	8	SEWERAGE NETWORK	NO	NO
COTA CONTRÔLE TECHNIQUE AUTOMOBILE	SIDI AMAR	ANNABA	CONTRÔLE TECHNIQUE AUTO		2		SEWERAGE NETWORK	NO	NO
ETABLISSEMENT DE TRANSPORT ANNABA ETA	SIDI AMAR	ANNABA	TRANSPORT ET MAINTENANCE			0.8	SEWERAGE NETWORK	NO	NO

INDUSTRY NAME	COMMUNITY/MUNICIPALITY	WILAYA	TYPE OF ACTIVITY	CAPACITY	WATER DEMAND	REJECTED VOLUME	DISCHARGE POINT	TREATMENT	RECYCLING
SATPAP SOCIETE DE TRANSFORMATION DE PAPIER ET DE PLASTIQUE	EL HADJAR	ANNABA	TRANSFORMATION DU PAPIER	7000 ton/yr				NO	NO
ALTRO ANTENNE DE MAINTENANCE	EL HADJAR	ANNABA	MAINTENANCE INDUSTRIELLE		11	5	SEWERAGE NETWORK	NO	NO
VITRE KHEZZANE	SIDI AMAR	ANNABA	TRANSFORMATION DU VERRE		0.95	0.8	PUBLIC SEWERAGE NETWORK	NO	NO
ORGANISATION SYSTEME INFORMATIQUE ET BUREAUTIQUE SOSIB	SIDI AMAR	ANNABA	IMPORT EXPORT MATERIEL INFORMATIQUE					NO	NO
HIPPONE EMBALLAGE	SIDI AMAR	ANNABA	TRANSFORMATION DU PAPIER ET CARTONS	10000 units/month	1	0.16	SEWERAGE NETWORK	NO	NO
SNVI - URD 801	EL - BOUNI	ANNABA	COMMERCIALISATION VEHICULES INDUSTRIELS VENTE PIECES DE RECHANGE ET RENOUVATION		1314	1051	MEDJOUBA RIVER	YES	NO
PROMECH - ANNABA SPA	EL - HADJAR	ANNABA		5311	350	350	RIVER	NO	NO
ex EMIB EPBA	ANNABA	ANNABA	PROD . COMMERCIALISATION DE BOISSON ALCOOLISES ET NON ALCOOLISES		1500	150	BOUDJENA RIVER	NO	NO
SOCIETE INDUSTRIELLE DE PRODUITS ALIMENTAIRES	EL - BOUNI	ANNABA		3600	70000		EGOUTS COMMUNANT	NO	NO
UNITE MARBRE GUELMA ENAMARBRE	BOUMAHRA AHMED	GUELMA	EXTRACTION ET TRANSFORMATION DU MARBRE	73000 m^2/yr	1.4			YES	YES

INDUSTRY NAME	COMMUNITY/MUNICIPALITY	WILAYA	TYPE OF ACTIVITY	CAPACITY	WATER DEMAND	REJECTED VOLUME	DISCHARGE POINT	TREATMENT	RECYCLING
E.C.V.E	GUELMA	GUELMA	PRODUCTION DE PORCELAINE	3000 ton/yr	240	24	INDUSTRIAL ZONE NETWORK	NO	NO
UAB BOUDAROUA	OUED FRAGHA	GUELMA	FABRICATION ALIMENT DE BETAIL	15 tonnes/heure	9			NO	NO
SPA COMPLEXE AVICOLE REPRODUCTEURS CHAIR	BOUMAHRA AHMED	GUELMA	ELEVAGE ET REPRODUCTION CHAIR+ PRODUCTION POUSSINS	10239000 OEUFS+6015 000 POUSSIN	96			NO	NO
LES MOULINS DE MERMOURA GUELMA UNITE DE PRODUCTION GASSEM LA	BOUCHEGOUF	GUELMA	PRODUCTION ET VENTE SEMOULE	850 Qt/d			SEYBOUSE RIVER	NO	NO
ENA SUCRE GUELMA	GUELMA	GUELMA	USINE DE RAFFINAGE DU SUCRE	330 ton/d	1507	1000	AERATED LAGOONS	NO	NO
BRIQUETERIE EL RYAD	BENDJERAH	GUELMA	BRIQUE	70000 ton/yr	40		CHAABA	NO	NO
EURL / LAITERIE BENI FOUGHEL	EL FEDJOUDJ	GUELMA	LAIT ET DERIVES	10 to 20000 l/d	25	25	RIVER	NO	NO
LIMONADERIE BOUKABOU FRERES	GUELMA	GUELMA	FABRICATION BOISSONS GAZEUSES	400 cases/d	10		SEWERAGE NETWORK	NO	NO
GROUPE SMIDE CONSTANTINE FILIALE MOULINS MERMOURA GUELMA UPC	HELIOPOLIS	GUELMA	TRITURATION BLE DUR	650 Qx/d	5		SEWERAGE NETWORK	NO	NO
FENDJEL	BELKHEIR	GUELMA	FABRICATION DE BOISSONS GAZEUSESNON ALCOLISES	60000 l/d	40	3	CHAABA	NO	NO
COMPLEXE DE PRODUCTION DE VËTEMENT MILITAIRE	BOUCHEGOUF	GUELMA	CONFECTION		36	25	SEYBOUSE RIVER	NO	NO

INDUSTRY NAME	COMMUNITY/MUNICIPALITY	WILAYA	TYPE OF ACTIVITY	CAPACITY	WATER DEMAND	REJECTED VOLUME	DISCHARGE POINT	TREATMENT	RECYCLING
BORDJIBA	EL FEDOUDJ DAIRA HELIOPOLIS	GUELMA	FABRICATION DE PARPAINGS ET HOURDIS		15		RIVER	NO	NO
UNITE DE CYCLES ET MOTOCYCLES (CYCMA)	GUELMA	GUELMA	MECANIQUE DE CONSTRUCTION	5000 products	240	30	INTERNAL CANAL	YES	NO
LES LEVURES DE L'EST	BOUCHEGOUF	GUELMA	FABRICATION DE LEVURE	15000 ton/yr	1500	1000	MELLAH RIVER	YES	NO
EL SAFIA MINOTERIE	EL FEDJOUDJ	GUELMA	TRANSFORMATION DE BLE TENDRE EN FARINE	40 ton/d	3		SEWERAGE NETWORK	NO	NO

INSTITUTIONAL ANALYSIS AND FOCAL WATER MANAGEMENT PROBLEMS IN THE OUM ER RBIA HYDRAULIC BASIN, MOROCCO

Prepared by ISKANE Ingenierie

1. General overview

1.1 Country overview

Morocco is an arid to semi-arid country, with a fragile endowment of water resources. The yearly average precipitation approximates 1000 mm; however the hydrological context of the country is greatly influenced by the pronounced inter-annual and seasonal variation of precipitation and the heterogeneity in its spatial distribution.

The economy of the country, where agriculture plays an important role, depends strongly on water availability. The evolution of the GDP between the 1970s and 2000 strongly manifests the importance of climate and rainfall in economic growth. Indeed, during the 1990-2000 period, and as a result of droughts' frequency, the GDP growth was less than 3%. According to the respective statistic reports, the price of cereals and other agricultural outputs, increased six-fold and four-fold during the agricultural campaigns of 1989-90 and 1998-99. Water resource deterioration is also expensive for the country as a whole: its cost is estimated to more than 15 billions Dh per year, i.e. 6% of the GDP.

Meanwhile, the average renewable water resources per capita is reaching the threshold of 1,000 m³/cap/yr, considered as the critical doorstep for water scarcity and underlying water crises. This indicator indicates that water shortage is becoming a fact-of-life, which should be taken into account in all future policies and water management strategies. Water management operations have been of concern since the 1960s, when Morocco initiated the implementation of large-scale hydraulic, economic and social programmes.

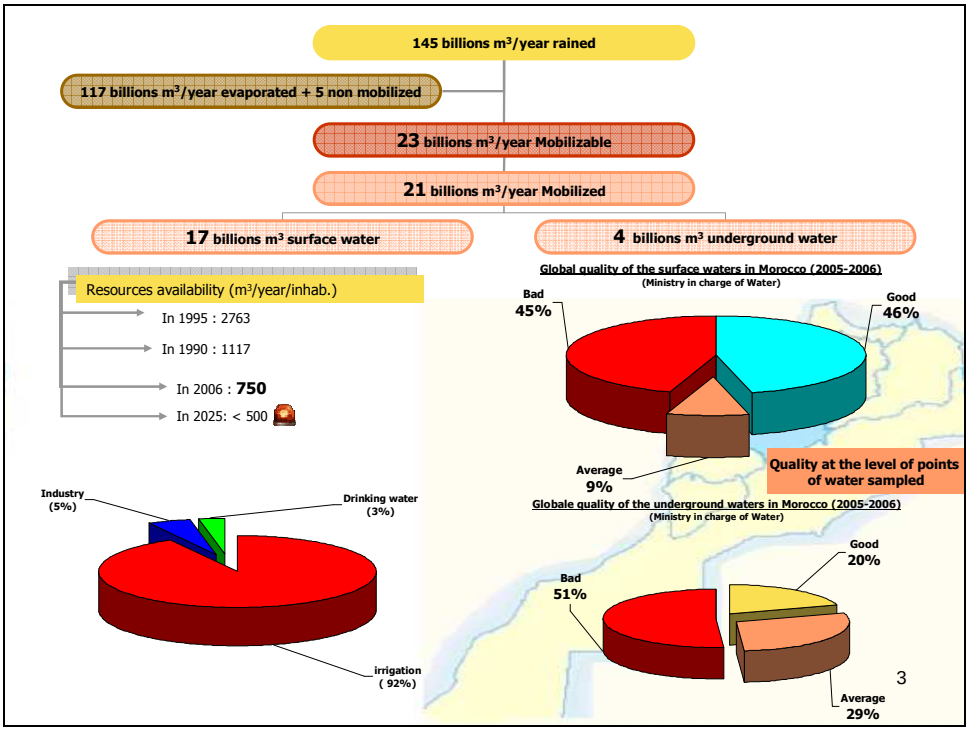


Figure 74: Availability and quality of water resources in Morocco

While groundwater resources had already been subject to assessments and advanced exploitation schemes, surface water was still a weakly valued resource. Unquestionably, it was the decision for the launch of a National Irrigation Programme for 1 million hectares that

led to the adoption of water management at the watershed scale. After a period when water resources were developed only at the project level, planning evolved to regulating surface water at the watershed level. The overall aim was to identify supply enhancement alternatives that would maximize benefits and supply potable water uses, irrigated agriculture, hydroelectricity production, and exploit all possible dam and reservoir construction sites within the basins. The development of hydraulic infrastructure was followed by concerns over the allocation of available supply, particularly during drought episodes when the related problems were more acute.

The fast growth of water demand led to emerging water pollution issues, due to human pressures on the aquatic environment and the limited financial resources available. This in turn, raised the need for a global, coherent vision for water management, which would consider both quantity and quality aspects and where water management practices would be integrated with the general interests of the national community.

Since 1982, public authorities introduced in their administrative practices the concept of water management at the hydrological watershed scale. This resulted in the establishment of administrative divisions (DRH) with territorial planning expertise within the governmental department responsible for elaborating the national water policy. Each DRH corresponded to one or several hydrological watersheds, and was responsible for elaborating upon water management issues.

The long and harsh drought episode, experienced from 1981 to 1986, strengthened national awareness on the crucial and strategic importance of water management for the country's development, and on the necessity for reform in the current institutional setting for water management.

1.2 Overview of the Oum Er Rbia Hydraulic Basin

The area selected for the implementation of INECO in Morocco is the Oum Er Rbia (OER) Hydraulic Basin (Figure 75). This selection was based on the following considerations/criteria:

- The water resources of the basin are extremely important, as they are used in the strategic economic zone of Morocco (Tadla, Doukkala and the inshore zone of Casablanca-Safi);
- The OER basin concentrates a significant part of economic activities (industry and irrigated agriculture), and an important share of the population;
- The OER basin has already been the subject of important investments on hydraulic infrastructure. The basin has the largest number of dams in Morocco.
- The region that includes the OER basin and the adjacent to the south region, which depends for its water supply on the OER resources, is under water stress. Therefore, the Basin Agency is mainly oriented towards water demand management issues.

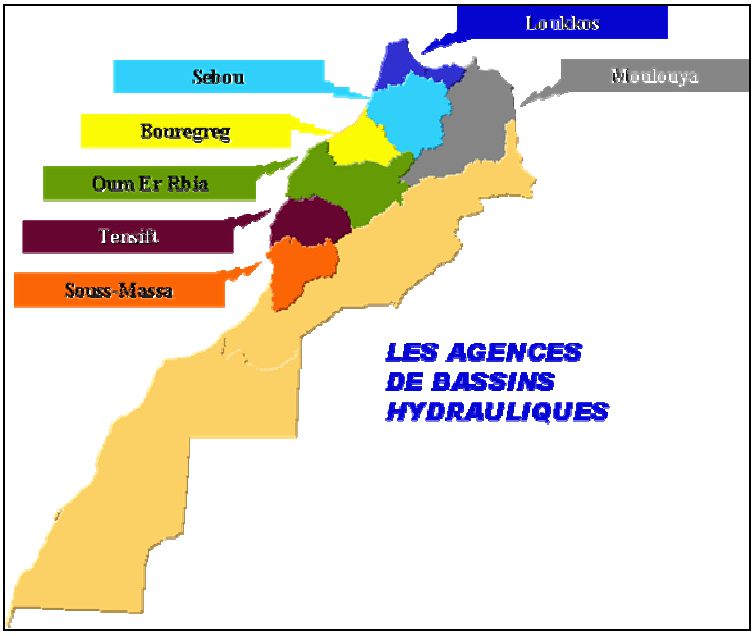


Figure 75: The location of the Oum Er Rbia Basin (marked in green)

In relation to the entire country, the Oum er Rbia basin represents 7% of the total area of Morocco (50,000 km² vs. 720,000 km²) and 14% of the population (4.5 million vs. 32 million). With regard to water resources (Table 69), the basin comprises 19% of exploitable resources (4,350 million m³ vs. 23,000 million m³) and 19% of the exploited resources (3,912 million m³ vs. 21,000 million m³).

Table 69: Water resources of Morocco and of the Oum Er Rbia Basin (million m³)

	Surface water	Groundwater	Total
Mobilizable			
Morocco	18,000	5,000	**23,000**
Oum er Rbia Basin	4,022	328	**4,350**
Mobilized			
Morocco	17,000	4,000	**21,000**
Oum er Rbia Basin	3,604	360	**3,964**

The Basin Agency of Oum Er Rbia was the first to be established in Morocco in 1999; the Basin Agencies of Moulouya, Sebou, Loukoss, BouRegreg, Tensift and Souss-Massa were established in 2002. Being the pilot Basin Agency, it benefited from continuous follow-up activities (e.g. twinning with the French Basin Agency of Adour-Garonne for training programmes, organization of seminars etc).

Morocco is a country that relies mostly on storage reservoirs; in total, there exist 96 dams, with a total storage capacity of 15 billion m³. The Oum Er Rbia Basin has 15 dams and a total storage capacity of 5.22 billion m³.

1.2.1 General features

As mentioned above, the Oum Er Rbia basin extends over an area of approximately 50,000 km² (Figure 76). The Oum Er Rbia river, with a total length of 550 km, originates from the Middle Atlas (altitude of 1,800 m), traverses the Middle Atlas chain, the Tadla plain

and the Meseta area, and discharges in the Atlantic Ocean, at a 16 km distance from the city of El Jadida.

The population of the basin is approximately 4.5 million, of which 65% are rural. Population density is higher in the central part of the region, near water sources and along river and stream courses. The basin has diverse economic activities, including irrigated and rainfed agriculture, mining, agro-processing and numerous large manufacturing industries.

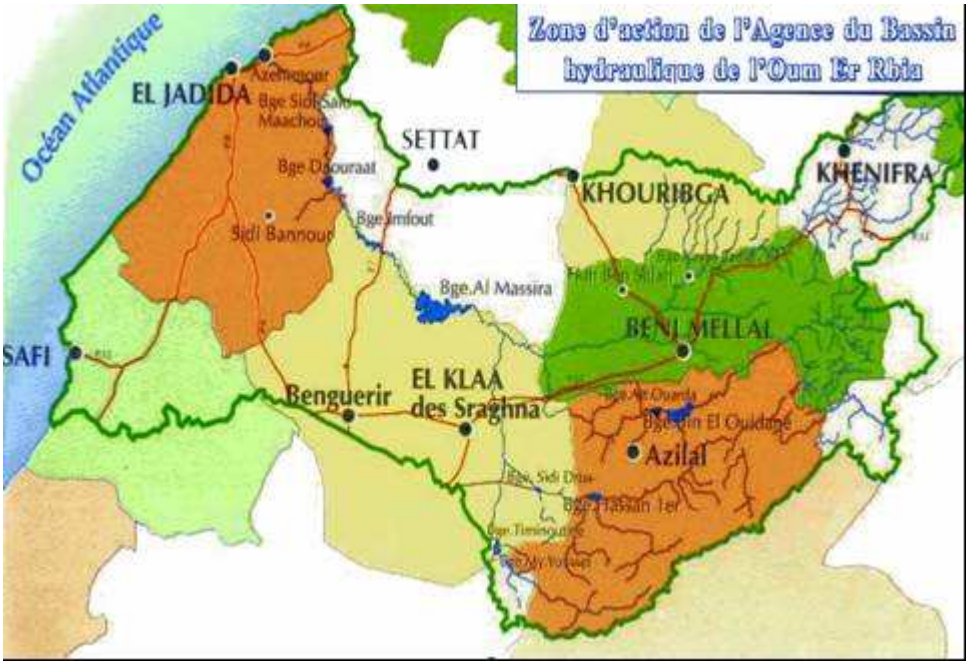


Figure 76: The Oum Er Rbia Basin – Area under the responsibility of the Oum Er Rbia Hydraulic Agency

The yearly average precipitation is 550 mm, ranging between 1,100 mm in the Middle Atlas and 300 mm in the downstream zone of the river. On average, there is snowfall 20 days/yr in altitudes exceeding 800 m. Temperature ranges between 10 and 50°C and potential evapotranspiration accounts for 1,600 mm/yr on average along the coast and 2,000 mm in the hinterland, reaching the maximum value of 300 mm in July and August. As outlined in Table 70, over the last decades, there has been a significant precipitation decrease in large parts of the basin (High Oum Er Rbia, Central Oum Er Rbia, Low and Middle Oum Er Rbia, El Abid and the Tessaout).

Table 70: Precipitation decrease in the Oum Er Rbia Basin

Region	Average precipitation - 1950-1970 (mm/yr)	Average precipitation - 1980-2000 (mm/yr)	Average yearly decrease (mm/yr)
High OER	650	496	-4.8
Central OER	644	404	-7.5
Middle and low OER	431	367	-2.0
El Abid	649	397	-7.9
Tessaout	699	475	-7.0

1.2.2 Water resources

Surface water

The basin's water courses comprise the Oum Er Rbia river and its main tributaries: Tessaout, Lakhdar and El Abid (Figure 77). The average surface run-off of the basin is estimated at 3,680 million m³, ranging between a maximum value of 8,300 million m³ and a minimum of 1,300 million m³. In addition to snowmelt, numerous sources contribute to surface run-off and sustain the flow of the Oum Er Rbia River.

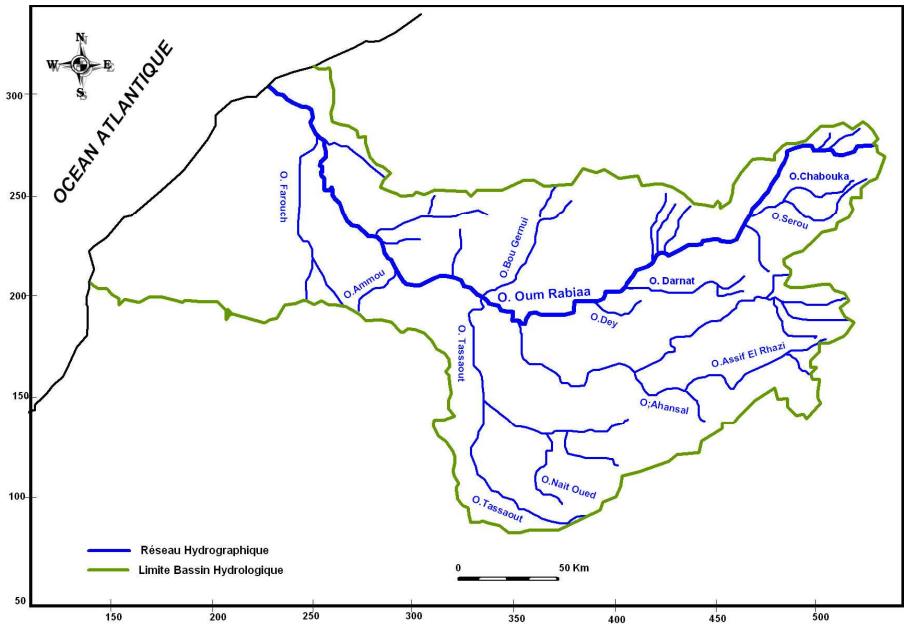


Figure 77: The Oum Er Rbia River and its tributaries

Groundwater resources

The groundwater resources of the Oum Er-Rbia basin are relatively important, distributed among several aquifer units (Figure 78).

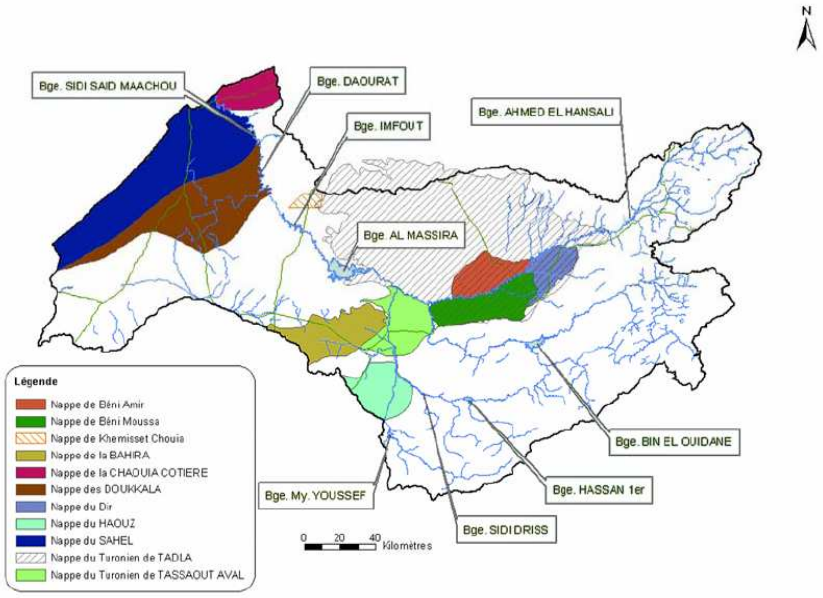


Figure 78: The Oum Er Rbia Basin aquifers

The Tadla aquifers form a multilayered system comprising 4 superimposed aquifers, separated by impervious or semi-impervious layers. From bottom to top, the four aquifer systems are:

- The carbonated Turonian aquifer;
- The Senonian aquifer;
- The sandy calcareous Eocene aquifer;
- The alluvial aquifers of the Tadla and the downstream Tessaout (aquifers of Beni Amir, of Beni Moussa and of the Tessaout).

1.2.3 Water resources' quality

The main water pollution sources in the region are the discharges of untreated urban and industrial effluents, and diffuse pollution from agricultural activities, as a result of fertilizer and pesticide use. The direct and indirect effects of those pollution sources result in the deterioration of the quality of both surface and groundwater.

Surface water

Surface water quality is generally good in the upstream regions of the basin, and gradually degrades downstream, as a result of urban and industrial discharges. The section of the Oum Er Rbia river between Kasba-Tadla and downstream of Ouled Zidouh is excessively polluted from the combined discharge of industrial and domestic wastewater. The situation is further aggravated during the summer months, due to sugar production activities and the discharge from other untreated effluents.

Groundwater

Groundwater quality is continuously deteriorating. During the last 15 years, the measured concentration of nitrates has escalated to alarming levels, exceeding 50 mg/l in the majority of monitoring stations. This adds to the elevated salinity levels measured in particular water tables (Beni Amir, Beni Moussa West).

1.2.4 Water resources exploitation and use

The effort for surface water exploitation – Dams

In view of its importance, the Oum-Er-Rbia basin drew the attention of water managers since 1929, when the Sidi Said Maachou dam was constructed. Since then, 15 dams were constructed, of which 5 can be considered important. The current storage capacity is approximately 5,220 million m³, whereas the total regulated water volume is 3,604 million m³/year, i.e. 33% of the total volume in the country (Table 71 and Figure 80).

Table 71: Existing hydraulic infrastructure

Dam	Operation year	Storage capacity (million m³)	Height (m)	Purpose[30]	Regulated volume (million m³)
Ahmed EL HANSALI	2001	740.0	101	E, I	473
A.MESSOUD	2003	14.0	34	E, I, U	-
Kasba TADLA	1935	-	11	E, I	-
BIN EL OUIDANE	1954	1253 .0	132	E, I	945
AIT OUARDA	1954	4.0	46	E, I	-
HASSAN 1st	1986	245.0	145	E, I U	346
SIDI DRISS	1980	1.3	42	I, U	-
MY YOUSSEF	1969	161 .0	100	E, I	250
TIMINOUTINE	1979	5.3	45	I	-
AL MASSIRA	1979	2744. 0	82	E, I, U	1590
IMFOUT	1940	18.2	50	E, I, U	-
DAOURATE	1950	9.5	40	E, U	-
Sidi Said MAACHOU	1929	1.5	28	E, U	-
Dam of Safi	2001	2			
Dam Sidi Daoui	2003	5			
TOTAL		**5204**			**3604**

Overall, surface water regulation is favourable in the region, mostly due to the existence of the grande Al Massira dam (Figure 79), located in the downstream part of the basin. Water is mainly used for drinking water supply, irrigation and hydroelectricity production.

[30] E: Energy production; I: Irrigation, D: Urban (domestic and industrial water needs)

Figure 79: The Al Massira Dam

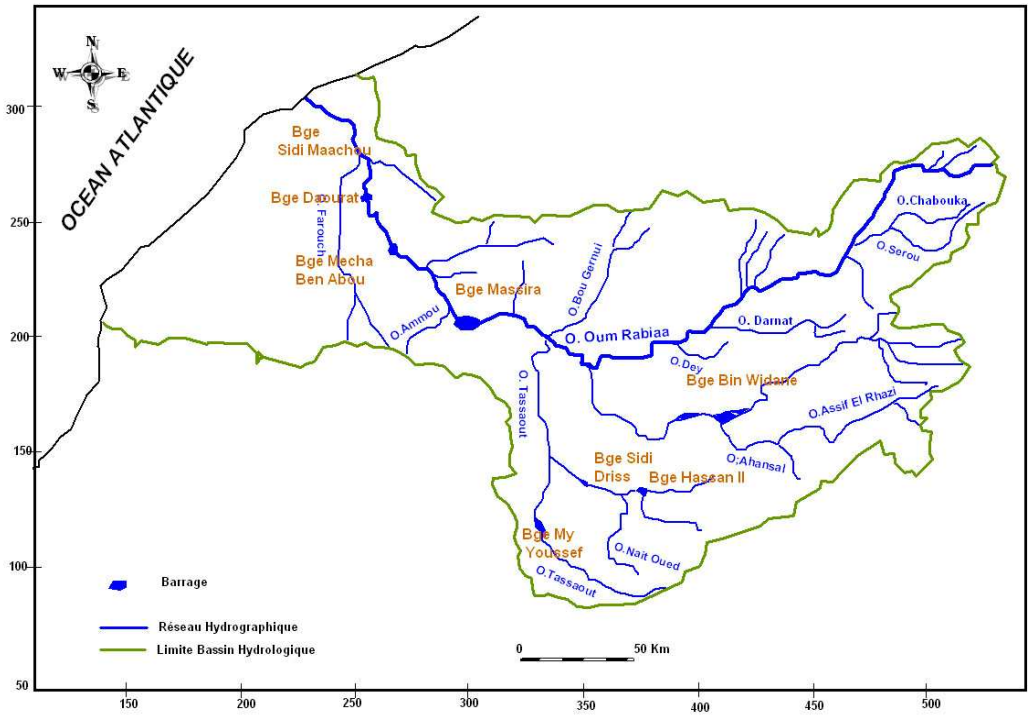


Figure 80: Large storage reservoirs in the Oum Er Rbia Basin

Groundwater

The effort for exploiting groundwater resources currently offers a supply of 3000 million m³ per year, which represents 10% of the mobilised resources of the country. The annual abstractions from the main water tables of the basin are detailed in Table 72.

Efforts for groundwater mobilization currently permit to make available a volume of 300 Mm³/yr, which represents 10% of mobilized resources in the country. Volumes of water annually extracted from the main water tables of the basin are indicated below.

Table 72: Average annual groundwater extraction (million m³)

Use	Phreatic water tables	Eocene	Turonian	Tassaout Downstream
Drinking water supply	17	2	22	2
Irrigation	225	25	4	11
Total	**308**			

1.2.5 Water use

The volume of water used in the Basin escalates to approximately 3,861 million m³. Of this amount 91% originates from the exploitation of surface waters. This volume allows for the irrigation of more than 345,000 ha, the production of 1866 GWh of energy (on an average year), the provision of drinking water supply to 5 million inhabitants and a released volume to ensure the protection of water courses.

Table 73: Water demand and supply in the Oum Er Rbia Basin (million m³)

Use	Surface water	Groundwater	Total
Irrigation	3250	257	**3507**
Drinking and industrial water supply	100	89	**189**
Inter-basin transfer (urban water needs)	165		**165**
TOTAL	**3515**	**346**	**3861**

Drinking and industrial demand and supply

The total demand for drinking and industrial water, to be supplied from the water resources of the basin is approximately 354 million m³. Of this amount, 20 million m³ accounts for water demand in rural areas, whereas 30 million m³ corresponds solely to industrial activities. The demand is met through surface water abstractions of 265 million m³ and 89 million m³ of groundwater. The major cities supplied from the basin's water resources are Beni Mellal, Khouribga, Oued Zem, El Jadida Casablanca, Settat, Berchid Safi and Marrakech.

Irrigation

Within the basin, crop irrigation needs account for 3,507 million m³/yr. Of this amount, 2,533 million m³ are supplied from the large hydraulic works and 974 million m³ are supplied from small and medium-scale infrastructure.

The development of irrigated agriculture was boosted from the implementation of the corresponding hydraulic infrastructure. The total area irrigated from the large hydraulic works is equal to 308,500 ha, including the 35,400 ha currently equipped in the Central Haouz. Small and medium-scale water works are used for the irrigation of approximately 36,000 ha.

Inter-basin transfer

The industrial and domestic demand of cities of Casablanca (approx. 4 million inhabitants) and of Marrakech (approx. 1 million inhabitants) is met through inter-basin transfers from the Oum Er Rbia Basin. The current volume of water supplied for meeting water needs in cities located outside the basin (Casablanca, Settat, Berchid and Marrakech) is approximately 165 million m³/yr, distributed as follows:

- 120 million m³/yr for Casablanca, Settat and Berchid, supplied from the Al Massira complex;
- 45 million m³/yr for the Marrakech city from the Hassan 1er-Sidi-Driss complex.

Energy production

The Oum Er Rbia basin is the basin with the largest hydroelectricity power plants. The currently installed power, not including the plant of Afourer, is 623 MW (50% of the nationally installed hydroelectric power). On average, 1866 GWh/yr are produced, i.e. 60 to 72% of the total hydroelectricity production.

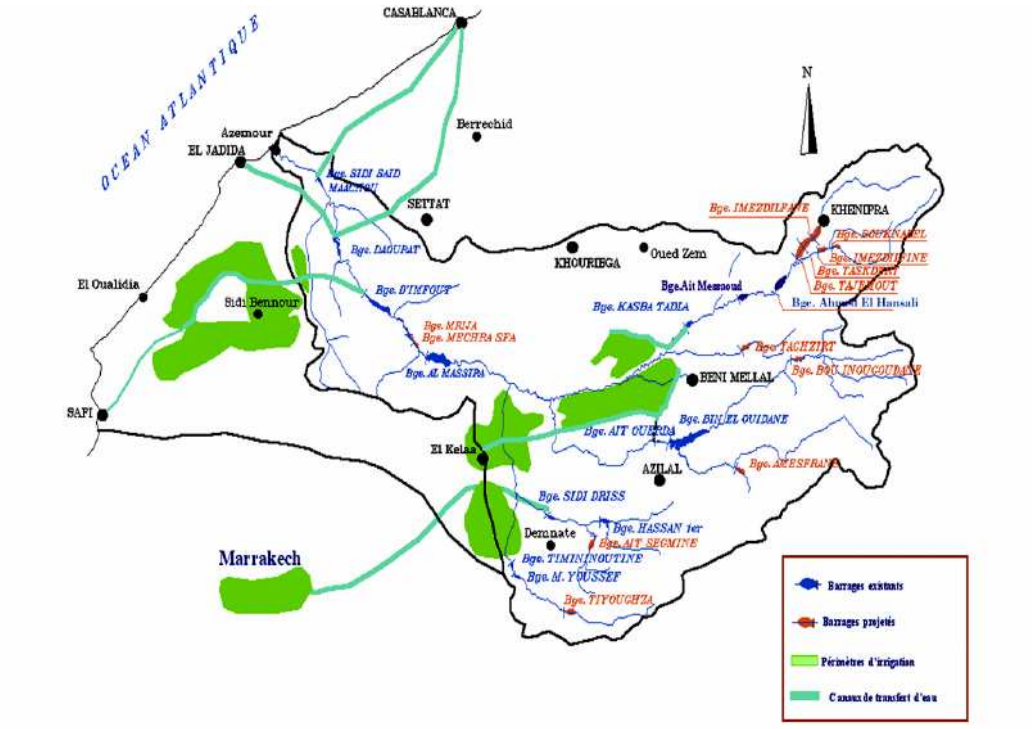


Figure 81: Location of storage reservoirs, canals for inter-basin transfer and irrigation perimeters

2. Institutional and financial context

The legal basis of the formulation of all future water policies is the Law (Water Law) adopted in July 1995. The Water Law was introduced with the aim to address the challenges the country is facing, i.e. increasing water scarcity, significant demand pressures, increase of water supply and treatment costs, deterioration of water quality and of the environment. The main principles adopted by the Water Law are:

- **The public character of water resources:** all waters form part of the public hydraulic property, except for traditional water rights, whose property is already either established or recognized by a suitable procedure;
- **The uniqueness of the resource:** water is unique, and the quantitative and qualitative aspects of surface and ground waters are inseparable;
- **The unit for water management:** water management is undertaken at the hydraulic basin scale, which is recognized as the suitable geographic entity for the development and management of water resources;
- **The recognition of the economic value of water:** the application of the user-polluter-pays principle is more of an incentive than a dissuasive measure to achieve water conservation through the regulation of the demand;
- **The national and regional solidarity:** the establishment of Basin Agencies aims at the implementation of solidarity mechanisms, particularly in water management processes, and among users, sectors and regions.
- **Dialogue in water management:** water management issues must be discussed at all levels (national, regional and local) between administration services, users and the elected representatives. Two major arrangements aim at permitting the penetration and finally the establishment of dialogue in water management:
    - The establishment of the **High Council of Water and the Climate**, which is the forum that allows all national actors concerned by water issues to debate on the national policy and the main orientations of water resource management.
    - The establishment of **Hydraulic Basin Agencies** that will permit a real decentralization of water management, implying that all parties concerned are involved in decision-making.

2.1 Institutions and responsibilities

The water sector draws its general management principles from the Higher Council for Water and Climate, and is organized through national, regional and local institutions. The three institutions which have the strongest involvement in water-related issues are:

1. Local communities and municipalities
2. The Ministry of Territory Planning, Water and the Environment (MATEE)
3. The Ministry of Agriculture.

2.1.1 Local communities and municipalities

Communities are responsible for the distribution of drinking water and wastewater collection and treatment. They can provide these services on their own, through a utility that they can

create, through private concession, or through the National Office for Drinking Water (Office National de l'Eau Potable-ONEP).

2.1.2 The Ministry of Territorial Planning, of Water and the Environment (MATEE)

The Ministry of Territory Planning, Water and the Environment (Ministère de l'Aménagement du Territoire, de l'Eau et de l'Environnement-MATEE) has two entities that are involved in water management:

1. The **Secretariat of State to Water**, who acts as the intermediary of the State to Hydraulic Basin Agencies, and is responsible for the planning, exploitation and management of water resources.
2. The **National Office for Drinking Water** (Office National de l'Eau Potable-ONEP), which is responsible for the planning and operation of infrastructure for drinking water production, for monitoring and controlling water quality of drinking water supply sources, for potable water distribution and sewage collection and treatment.

In this regard, the MATEE is the central authority responsible for the formulation of water policies, water exploitation and conservation, and for the management of the public hydraulic infrastructure. It is also the authority responsible for the allocation of resources among the different uses.

2.1.3 The Ministry of Agriculture

The Ministry of Agriculture has regional offices responsible for agricultural development. These are also involved in the management of water allocated for crop irrigation.

2.1.4 Other ministries with a role in water management

Other ministries, involved directly or indirectly in water policy formulation and water management operations are:

1. The **Ministry of Industry**, as industrial water requirements are usually supplied through the ONEP infrastructure.
2. The **Ministry of Energy**, as water used for hydroelectricity production is afterwards diverted for irrigation purposes.
3. Other ministerial departments (described also in the chart of Figure 82) which have a role in the control and regulation of water-related issues:
    - Departments of the Ministry of the Interior, responsible for the support of local associations, through the DGRSC, and of the DEA.
    - Departments of the Ministry of Finance for the financial monitoring of water projects and for the financial management of services provided.
    - The Ministry of Economic Affairs, which intervenes in the setting of water tariffs.

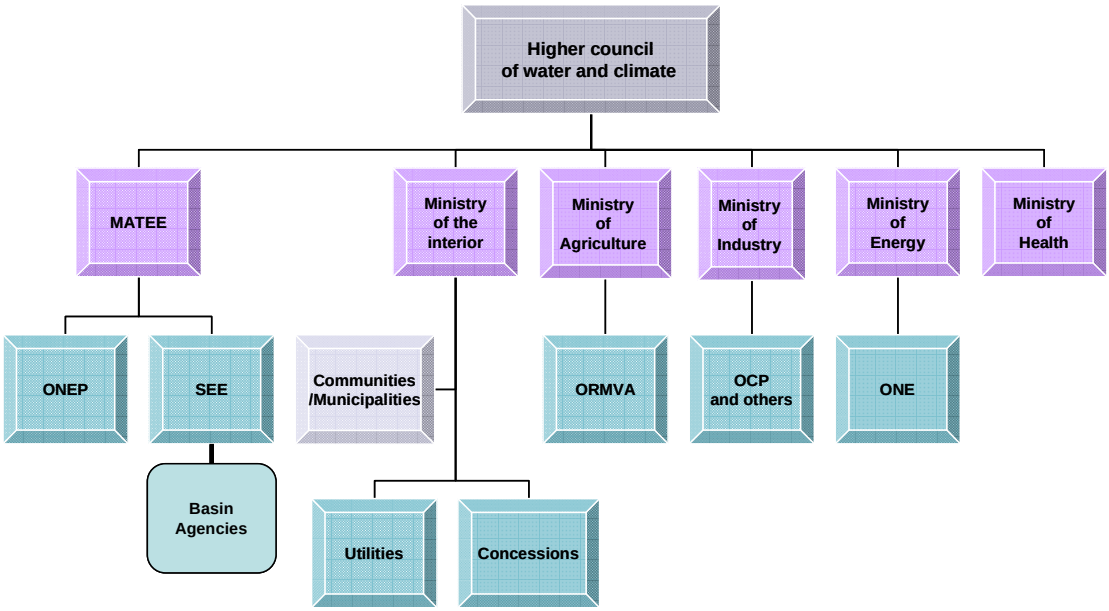


Figure 82: Organisation of the water sector

2.2 Organisation and responsibilities of main actors

2.2.1 Higher Council for water and climate

The Higher Council for Water and Climate was established in 1987, with the aim to formulate the general orientation of the national policy concerning water and climate. Furthermore, it elaborates and formulates an opinion on:

- The national strategy for improving knowledge on climate conditions and the mastering of their effects on the development of water resources;
- The National Water Management Plan;
- Plans for the integrated development of water resources, and in particular the allocation of water among the different sectors and regions of the country or of the same basin, as well as arrangements of assessment, protection and conservation of water resources.

The Council is organized as follows (Figure 83):

- Half of its members are representatives of the state,
- Half is constituted by representatives of socioeconomic sectors
- The secretariat is provided by the MATEE.

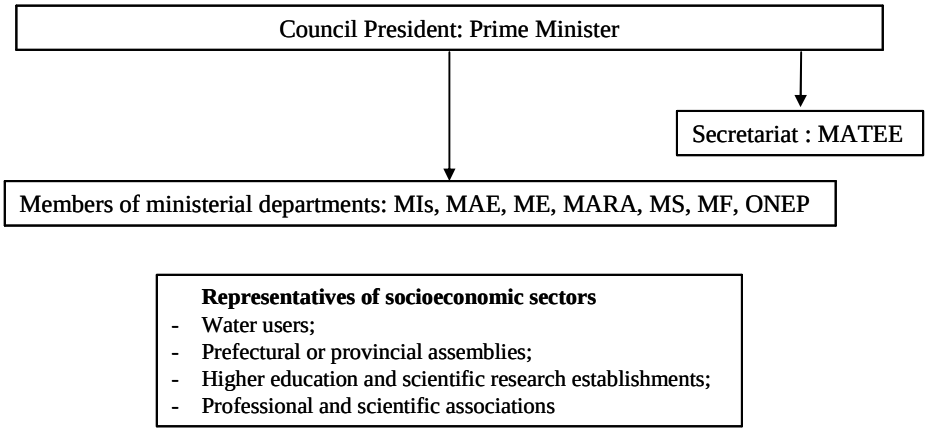


Figure 83: The organization of the Higher Council for Water and Climate

2.2.2 The Ministry of Territorial Planning, of Water and the Environment (MATEE)

The Ministry of Territorial Planning, Water and the Environment was established in November 2002, when the last government was appointed. It comprises 5 departments/divisions:

- The State Secretary responsible for water;
- The Environmental Department;
- The Territorial Management Department;
- ONEP;
- The Hydraulic Basin Agencies.

By regrouping the above, the establishment of the MATEE aimed at adopting an integrated, overall policy and at guaranteeing the prospects for the development of the country.

The ONEP and the Hydraulic Basin Agencies are the main public operators responsible for the implementation of the water policy, and are financially autonomous institutions.

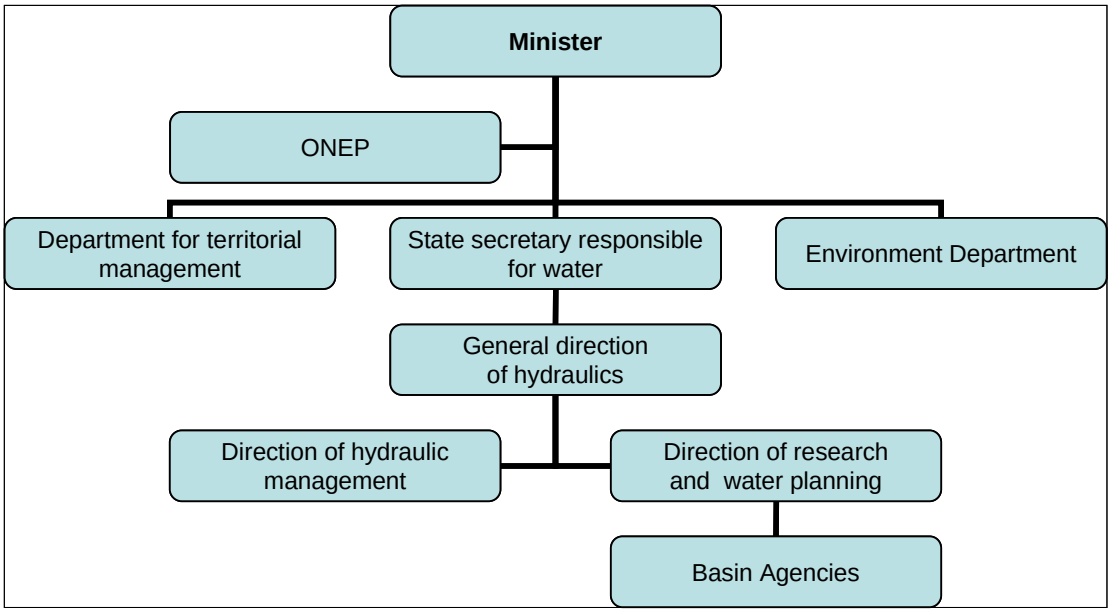


Figure 84: The organization of the MATEE

2.2.3 The Hydraulic Basin Agencies

The key actors in regional water management are Hydraulic Basin Agencies, which, as stated above, are financially autonomous institutions. The 1st (pilot) agency, established in 1999, was the one of the Oum Er Rbia Basin. Six more were established in 2002: Moulouyas, Sebou, Loukoss, BouRegreg, Tensift and Souss-Massa. The mandates of the Hydraulic Basin Agencies are:

- Maintaining the public hydraulic infrastructure and organizing its use and exploitation.
- Promoting the economic value of water.
- Providing financial and technical assistance for water management operations.
- Developing the Integrated Water Resources Management Plan and ensuring its implementation.
- Issuing permits and authorization for the use of the public hydraulic infrastructure.
- Providing the necessary support for preventing water pollution.
- Performing studies and assessments on water quantity and quality issues.
- Proposing and implementing regulation measures.
- Maintaining the inventory of water rights, concessions and permits for water abstraction.

The responsibilities of the Basin Agencies are to:

- Develop water resources through:
  - Water resource planning and management,
  - Assessment of water resources,
  - Exploitation of water resources,
  - Monitoring of the quantity and quality of water resources,
  - Control of the water resource utilization;
- Protect water resources and national heritage by:
  - Safeguarding the public hydraulic domain,
  - Preventing and managing the exceptional situation,
  - Operating, maintaining and exploiting hydraulic works;
- Provide services towards third parties by:
  - Providing technical assistance and receiving benefits from services delivered,
  - Developing partnerships;
  - Providing financial assistance.

2.2.4 The National drinking water office (ONEP)

The ONEP is the most important actor in the production and distribution of drinking water, as it is responsible for approximately 80% of the total water supply and 25% of the distributed volumes. Established in April 3rd 1972, the responsibilities of ONEP include:

- Planning and management of drinking water supply in the Kingdom.
- Assessing, implementing and managing drinking water abstractions throughout the country, with the exception of non-delimited agricultural areas, which are not subject to an agricultural development plan.

- Managing water services in cities where this service cannot be provided by the municipal authorities.
- Providing technical assistance on issues related to monitoring of the quality of water consumed upon request of the public institution concerned.
- Controlling, in collaboration with relevant authorities, the pollution of water intended for human consumption.
- Providing, upon the request of individuals, technical assistance on the assessment, implementation and management of water abstraction and distribution systems.
- Undertaking relevant assessments, in collaboration with the Ministry of Public Health and other Ministries involved in projects.

In the context of implementing a strategy for the development of sewerage services, the State adopted Law n° 31-00 (Dahir n° 1–00–266 of September 1st, 2000). Through this Law, the ONEP has been designated responsible for the management of sewerage services in communities and municipalities, following a relevant decision issued by the respective local Community Council. The Law had been preceded by similar decrees which transferred the provision of sewerage services from communities and municipalities to local, public water utilities (Regies).

2.2.5 The Ministry of the Interior – Water Utilities and Concessions

Water Utilities (Regies)

At present there are 13 water utilities, established in the large cities following the relevant decisions of the Local Municipal Councils. Their aim is to ensure the distribution of potable water, and potentially sewage collection and treatment. Often, and in order to assure an adequate recovery of costs, these utilities are also responsible for electricity distribution. In the Oum Er Rbia Basin, the only "regie" is the one of **Beni Mellal**.

Concessions

Approximately 35% of the total population and 50% of water needs are serviced through concession contracts. The main companies involved are:

- LYDEC, which is responsible for water supply and sewerage services in the city of Casablanca since 1997. The population supplied is approximately equal to 4 million.
- REDAL, which is responsible for water supply and sewerage services in cities of Rabat and Sale since 1999, supplying approximately 2 million inhabitants.
- AMENDIS, which is responsible for water supply and sewerage services since 2001 in cities of Tangiers and Tetouan.

2.2.6 The Ministry of Agriculture - Regional offices for agricultural development (ORMVAs)

The ORMVAS (Offices régionaux de mise en valeur agricole) were first established in the 1960s with the aim of decentralizing irrigation water management. At present, the 9 ORMVAs have the mandate of promoting agricultural activities in the large irrigated perimeters of the country. In this regard, several laws and decrees have been implemented for specifying their status of financially autonomous public institutions, under the control of the Ministry of Agriculture. Their main responsibilities are to:

1. Assess agricultural development schemes in the irrigated perimeters, within the framework of the large hydraulic infrastructure management.
2. Monitor and provide assistance to the exploitation of irrigated perimeters, by scheduling irrigation, undertaking experiments in agricultural production, monitoring the implementation of the irrigation schedule, monitoring soil quality and drainage, maintaining irrigation networks, and collect the corresponding water charges.
3. Organising agricultural production.

With regard to the civil society, additional parties with a role in water management are:

- The usual farmer associations, which have water rights and manage interdependently the hydraulic infrastructure.
- Farmer associations, commonly established in irrigated perimeters for promoting the involvement of water users in the management of water distribution networks
- The associations of users of agricultural land, which aim at facilitating the participation of end-users, implementing water distribution networks and manage and maintain hydraulic works.

Table 74 Responsibilities in water management

AUTHORITY	RESPONSIBILITY
High Council of Water & Climate (CSEC)	Formulation of the general orientation of the National Water Policy
Ministry of Territorial Planning, of Water and the Environment (MATEE)	Definition of the overall integrated policy (Water, Environment, Regional Development)
Secretariat of state for Water	Implementation of the overall policy for water resource management
Hydraulic Basin Agencies	Maintenance and management of the public hydraulic infrastructure at the regional level
National Office for drinking water (ONEP).	- Planning of urban water supply in the Kingdom - Assessment, implementation and management of drinking water abstractions throughout the country, with the exception of non-delimited rural areas, which are not subject to an agricultural development plan - Management of water supply and sewerage services in cities where this service cannot be provided by the local authorities.
Water utilities (cost-plus contract)	Provision of drinking water supply and possibly sewerage collection and treatment services. They are often responsible for electricity distribution as well, in order to ensure an adequate recovery of costs.
Concessionaires	Private operators, for providing water services in large agglomerations.
Regional offices for agricultural enhancement (ORMVA)	Assessment of agricultural development plans for the irrigated perimeters, within the framework of hydraulic works' management, and monitoring and management of the perimeters' infrastructure.
Ministry of Finance	Control of the financing of water-related projects and of the financial management of water services
Ministry of the Economic Affairs	Involvement in the setting of water tariffs and charges for wastewater collection and treatment.

Table 75: Water resources planning matrix

ACTIVITY	CSEC	MATEE	SEE	Hydraulic Basin Agencies	ONEP	Utilities and Concessionnaires	Ministry of Economic Affairs	ORMVAs
Surface waters								
Use				X				
Storage			X	X				
Groundwater recharge				X				
Diversion		X	X					
Quality monitoring				X	X			
Assessment				X				
Groundwater								
Use				X	X			X
Storage				X				
Recharge				X	X			
Quality monitoring				X				
Assessment				X				
Well permits				X				
Irrigation network								
Rehabilitation								X
Modernisation				X				X
Reuse								
Drainage water				X				
Wastewater				X	X	X		
Desalination								
Introduction of technology					X			
Efficient water utilisation								
Domestic				X	X	X		
Industrial				X	X	X		
Agricultural				X				X
Legislation								
Regulation and codes		X						
Standards			X					
Policy setting	X	X						
Water allocation			X	X				
Project financing		X	X	X	X	X		X
Project design			X	X	X	X		X
Project implementation			X	X	X	X		X
Operation and Maintenance				X	X	X		X
Pricing (tariffs)							X	
Enforcement				X	X	X		X
Water data records				X	X	X		X

2.3 Water-related legislation

2.3.1 Law n°10-95 (the Water Law)

Since 1995, the water sector in Morocco is governed by Law n° 10-95. However, the first legal text dealing with water-related issues in Morocco dates back to 1914. After this date, legislation was progressively prepared, following the challenges faced in the management of the public hydraulic domain, which had to be regulated. These regulations involved the urban environment, the industrial and agricultural sectors and other issues. However, they could not respond to the increasing pressures exerted on water resources. They were used for the preparation of the Water Law, which regroups, modernizes, completes and collects all those regulations in a coherent framework, following the principles of IWRM, by decentralizing water management operations and recurring to integrated management and rationalization of water use for meeting the needs of all users concerned.

The Water Law allowed the implementation of recent trends in water management through the establishment of Hydraulic Basin Agencies in 1999. The mission of the Basin Agencies is to evaluate, plan and manage water resources in the respective Hydraulic Basin. As they have access to their own financial sources (revenues from water charges, loans, subsidies, grants), the Basin Agencies can grant loans, assistance and subsidies to all institutions and individuals for the management and protection of water resources. In brief, through the introduction of the polluter- pays and the user-pays principles, the new law gives means to finance the rehabilitation of water bodies. The application of those principles is in the process of finalization.

The Water Law defines the geographical setting for the management of water resources: the Hydraulic Basin, which constitutes the unit for the development and implementation of local integrated water management plans, which, in their turn, contribute to the development of the National Water Plan.

2.3.2 The Communal Charter

The Communal Charter assigns to local communities and municipalities the responsibility of providing public water services, such as drinking water distribution, electricity distribution, sanitation, transport, sewage collection and treatment, waste management etc. It is subject to regular updating and refinement, so as to ensure its adaptation to the evolution of the political and socio-economic context.

The new Community Charter, issued on October 3rd 2002, entered in force in 2003, after the official announcement of local election results. The main modifications concerning water management concerned the prerogatives of the President of the Community Council for employing the help of the civil police force, notably on issues which have a direct impact on the provision of drinking water supply and sanitation services.

2.3.3 The transfer of sewerage services to the ONEP and to water utilities

Law n° 31-00 (Dahir n° 1–00–266 of September 1st, 2000) was adopted within the context of implementing the strategy for the development of sewerage services. Through this Law, the ONEP has been designated responsible for the management of sewerage services in communities and municipalities, upon the relevant decision of the Local Community Council.

The Law was preceded by similar decrees, allocating the provision of sewerage service from to local utilities.

2.3.4 Other important laws on technical aspects for water resource protection

Other important laws and regulations, particularly dealing with environmental and water resource protection are:

- **Law n° 11 - 03 on the protection and the enhancement of the environment in Morocco.**
  Its principles and regulations aim at:
  - Protecting the environment from all pollution sources, and preventing environmental degradation independently of its origin.
  - Ameliorate living conditions.
  - Define the technical and financial legislative framework for environmental protection.
  - Implement a specific accountability framework for ensuring the mitigation of environmental damage and the compensation of victims.
- **Law n° 12 - 03 on Environmental Impact Assessments**
  The law defines its application framework and defines the content of environmental impact assessments and the responsibilities of regional committees.
- **Decree of October 17, 2002 on water reuse for irrigation purposes**
  The decree defines the conditions for reusing reclaimed wastewater for crop and landscape irrigation, by describing conditions for the irrigation of:
  - Agricultural products consumed raw
  - Cereal production
  - Garden and sport field irrigation
  - Orchard irrigation.

  The standards set concern the wastewater treatment process, and concentrations which should not be exceeded for each type, and the quality standards for irrigation water which may be mixed with treated wastewater.

Further legislation on direct and indirect discharge standards is in the stage of elaboration.

2.4 Financial framework

2.4.1 Financing of drinking water and treatment services

The financing of water supply and sewerage services in Morocco is performed through the following mechanisms:

- Cost recovery through the set water charges and tariffs,
- Loans, subsidies, grants, etc.

With regard to **drinking water provision**, the recovery of costs is effected through:

- A water supply (or royalties) charge, calculated according to water consumption.
- A contribution to the 1st implementation (PPE - Participation au Premier Etablissement) , aimed at recovering the corresponding investment costs;
- A fixed charge to cover connection costs;

- A fixed charge for the recovery of surveys and assessments;
- A pollution charge, for which the pertinent legislation is under approval.

Water supply charges in urban areas vary among regions and comprise two parts: a fixed charge, and a volumetric charge, which depends on the volume of water consumed. The maximum rates are those of Casablanca, whereas the minimum are those of Meknès.

The water bill depends on the type of use:

- For residential users, the water tariff follows the Increasing Block Rate structure, dividing water consumption into four blocks:
  - 1st block: 0-6 m³ - rate lower than cost;
  - 2nd block: 7 to 20 m³ - rate equal to cost;
  - 3rd block: 21 to 40 m³ - rate higher than cost;
  - 4th block: >40 m³ - rate much higher than cost.
- Preferential tariff, for boundary-marked fountains, where the price is uniform and equal to 2.18 DH/m³.
- For industrial users, the price is also uniform, and equal to 2.23 DH/m³.

In rural areas, the water is generally delivered to the user through an intermediary at prices ranging between 7 and 12 DH/m³. This intermediary buys water from the ONEP at the reduced price of 2.18 DH/m³.

Charges for sewage collection and treatment comprise two parts: a fixed and a variable charge. The fixed charge varies according to the type of use:

- For residential users, it ranges between 36.00 and 55.68DH;
- For commercial establishments it ranges between 144.00 and 242.04 DH ;
- For public buildings, administration offices etc., it ranges between 72.00 and 121,44 DH.

The variable charge is estimated according to the volume of water consumed, and also follows an increasing 3-block rate structure:

- 1st block: 0-6 m³/month;
- 2nd block: 7-20 m³/month;
- 3rd block: >20 m³/month

It should be noted that water billing is performed on a monthly basis in both the case of municipal water utilities and private operators. However, with the exception of big clients, the ONEP implements quarterly invoicing.

Furthermore, a tax concerning the implementation of the 1st establishment (PPE) is also implemented. This tax aims at the recovery, by household and building owners, of the cost required for extending the public sewerage network. This objective is evident by the formula for the calculation of the PPE, which depends on the type of the building, making a distinction between apartment blocks and individual houses. Connection charges depend on the pipe diameter and on the façade, whereas charges for assessments and survey depend on the size of the project, and can exceed even 10% of the project costs.

In spite of the above, water tariffs cannot ensure alone an adequate recovery of costs, due to the limited ability-to-pay of the users. This is particularly true in the small villages and cities, where costs are higher. In this case, the contribution of local authorities, through subsidies

and grants is required. Furthermore, it should be noted that the delays at the investment level contribute adveresly to the overall financial balance.

External sources of financing

The recourse to external financing is becoming more and more important, given the financial mounting of the ONEP investment program. Two types of financing are distinguished:

- Priviledged financing, characterized by interest rates lower than 1%, repayment period of a maximum of 30 years and a 10-year maximum grant period. This type of financing is generally reserved for projects of social character (i.e. drinking water for rural areas, sewage treatment schemes).
- Banking-type financing, characterized by an average interest rate of 3%, repayment periods of 15 to 20 years, and a grant period of 5 years. This type of financing is usually reserved for projects in urban areas, and is much faster in obtaining.

Municipal contributions

The financial contribution of municipalities is fixed to cover 30% of the cost of sewage treatment projects and 20% of projects for rural domestic water supply. For the latter projects, the local population also contributes bearing a small share (5%) of the total cost.

State subsidies and grants

State subsidies concern:

- Grants provided for the implementation of rural water supply and sewage treatment projects.
- Subsidies granted to non-eligible municipalities for covering their share of investment costs. They can amount to 30% of the cost of the project.

It should be noted that the annual state subsidy towards ONEP, equal to 300 million DH/yr has been stopped since 1995.

2.4.2 Regulations for drinking water and sewerage collection services

Regulation over the provision of water services aims at encouraging public and private enterprises to provide water services of the suitable quality with least cost. Entities which can assure the implementation of the above principle could be a Ministerial Department or an independent regulating authority. The overall goal is to complete the institutional setting, by establishing an Agency for the water sector, which would encourage integration. Currently, options vary according to the status of the water service provider (public or private).

While the establishment of an independent entity is pending, regulation is performed by the different ministries, according to legal provisions on quality standards, enforcement, hygiene and security, etc.

Private operators

Private operators are monitored by a Committee, which ensures that the operator abides to its contract, and monitors the evolution of tariffs, as well as technical, administrative and financial management. The issues which are not monitored by the Committee are:

- Water pricing, as water tariffs are revised according to previous agreements with the Government.

- Drinking water quality standars, defined by law.
- Water rights.
- Water allocation.

Committees operate under the supervision of the Direction of Regies and conceded services (DRSC), under the control of the Ministry of the Interior.

Public operators (ONEP and Regies)

Similarly to above, committees do not intervene at the definition of prices, which are decided by the Prime Minister, drinking water quality standards and water allocation, which are decided by the MATEE, through the ONEP and by Basin Agencies.

2.4.3 Irrigation water provision

Irrigation water supply sources comprise:

- Surface water, regulated by dams which are financed by the State budget and other foreign sources of financing;
- Groundwater either distributed by the ORMVA or directly pumped by the farmers.

Cost recovery is effected through the setting of a simple volumetric rate (not differentiated according to the overall consumption), which varies according to the region. With regard to groundwater, two water charges are applied:

- The first concerns water delivered by the ORMVAs at the entrance of the farmer's field (parcel), which is generally equal to 0.50 Dh/m³.
- The second concerns water pumped by farmers using their own equipment. In this case, a charge of 0.02 Dh/m³ is paid to the ORMVA.

For surface water, the: tariff varies among basins. In the Oum Er Rbia Basin, the price is equal to 0.24 Dh/m³.

The low tariff for groundwater pumped in the field (0.02 Dh/m³) results in the irrational use of water by agricultural users and to the over-exploitation of groundwater resources.

Finally, it should be noted that:

- Water losses in parcels are extremely high (more than 60% of the water is lost in the irrigation networks.
- Water-intensive crops, such as bananas, melon etc., are still being cultivated, even in areas under water stress;
- Cost recovery is low, and does not exceed 30%.

3. Identification of focal problems in water management

3.1 Constraints facing the water sector

3.1.1 Natural constraints

The Hydraulic Basin of the Oum Er Rbia is faced with various natural constraints, mostly concerning the sustainability and availability of water in terms of both quantity and quality. Water availability is subject to the large variation of precipitation in both space and time. This is due to several factors, such as the location of the region, and the overall climatic conditions. It should be noted that in the drought episodes, commonly repeated after 1980, the reduction in the volume of water available was about 15 to 20%.

Furthermore, the Oum Er Rbia Basin is situated between two other Basins of significant socio-economic importance, which experience significant water management issues:

- The Tensift Basin, where Marrakech is located, experiences a widening gap between supply and demand;
- The Bouregreg Basin where Casablanca and Rabat are located, cannot depend on its own water resources, and where inter-basin transfers had to be implemented. It should be noted that the Atlantic zone, with 7 million inhabitants is the most dynamic region of the country in socio-economic terms.

In order to address the above issues, the State undertook several actions, such as:

- Regulation of water flow;
- Development of an extensive irrigation network;
- Inter-basin transfers to reinforce water supply in large cities;
- Engagement in a National Debate on water-related issues.

The above actions are further detailed in the following paragraphs.

Regulation of water flow

As mentioned above, surface water resources in the Oum Er Rbia Basin are estimated at 3,604 million m³/yr, varying between the maximum of 8,300 million m³/yr and the minimum value of 1,300 million m³/yr. The State's plans for dam construction in the Basin was started in 1929, reinforced during the 1950s and accelerated thereafter.

Flow variability was regulated through the construction of 15 dams, with a total storage capacity of 5.22 billion m³, and storing, on average 3.6 billion m³. The three larger dams are:

- The Al Massira dam, constructed in 1979, with a capacity of 2.76 billion m³;
- The Bin El Ouidane dam, constructed in 1954, with a capacity of 1.25 billion m³
- The El Hasanli dam, constructed in 2001, with a capacity of 740 million m³ of which 473 are regulated.

At present, dam construction can be considered economically viable for only a few sites.

Development of an extensive irrigation network

The total area irrigated by the Great Hydraulic Works is approximately 309,000 ha, and corresponds to 70% of the irrigable area of the basin. This area forms part of 5 Irrigation Perimeters:

- **Beni Amir**: The perimeter, with an area of 35,000 ha is supplied from the Kasba Tadla dam, and from groundwater (irrigation of 6,000 ha). The total water demand is approximately equal to 390 million m³/yr.
- **Beni Moussa**, with an area of 69,500 ha and an estimated water demand of 740 million m³/yr. The perimeter is supplied almost exlusively by the Bin El Ouidane dam (710 million m³/yr). Groundwater contributes to the supply of 30 million m³/yr for irrigation purposes.
- **Doukkala**, a perimeter of 61,000 ha, irrigated from the Al Massira Dam, through the dam of Imfout. The total water demand is approximately equal to 550 million m³/yr.
- **Tessaout amont**, with a total area of 30,000 ha. The perimeter is supplied from water regulated by the Moulay Youssef Dam (210 million m³/yr) and from irrigation returh flows (40 million m³/yr on average).
- **Tessaout aval**, with a total area of 48,500 ha, where a network of séguias was constructed and supplied from the Tessaout River (oued). The area equipped for irrigation is 5,000 ha and is irrigated from the Lakhdar-Tessaout system.

Inter-basin transfers to reinforce water supply in large cities

Water from the Oum Er Rbia Basin is used for meeting water needs in the regions of Marrakech and Casablanca, and, during exceptional droughts, for the city of Tangier. More specifically:

- A volume of 305 million m³/yr is transferred form the Oum Er Rbia Basin to the region of Marrakech. Of this amount, 260 million m³ are used for irrigation purposes and 45 million m³ for meeting urban water needs.
- The annual supply provided by the Basin for meeting water needs in the Casablanca City is equal to 120 million m³.
- Drinking water was transported in 1995, through tankers, to the city of Tangiers, which experienced serious problems as a result of the 1993-94 drought. During 4 months, water was transferred from the city of El Jadida to the harbour of Tangier, providing 30.000 m³/d (3.6 million m³ in total).

Engagement in a National Debate on water-related issues

The National Debate on water-related issues was officially launched by the Prime Minister in November 2006. The debate will continue through the publication of Regional Proceedings in 2007, and aims at raising awareness among water users on the need for conserving and protecting water resources.

3.1.2 Technical issues

In spite of all the aforementioned efforts, there are still technical issues that need to be resolved. The most important ones are:

- The overexploitation of groundwater resources, due to overpumping but also to reduction in precipitation,
- Water quality deterioration,
- Inefficiency in water use,
- Protection from floods.

These problems are further aggravated by water governance and the current perceptions of consumers towards water use.

Groundwater overpumping

Groundwater overexploitation has resulted in an alarming decrease in water table levels, especially in the plains of Abda and Doukkala.

In certain areas, extracted volumes are doubled every 15 years, as a result of well construction and borehole drilling for irrigation purposes. The situation is further aggravated by the current practice of pumping from deep water tables, which are considered strategic reserves, to be used only under exceptional circumstances. At present, the decrease of water table levels is observed throughout the basin, and reaches alarming values, which often exceed 2 m/yr.

Furthermore, the coastal aquifer, located between Azemour and Safi, and used for the irrigation of high-valued crops, faces the risk of sea intrusion. A survey is currently in progress, with the aim to assess the situation and study the impact of elevated chloride levels on the socio-economic environment.

Similarly to other Mediterranean countries, climate change impacts on the water resources of Morocco. The pertinent assessments, undertaken by the Environmental Department of MATEE, have estimated a reduction of precipitation of the order of 15% during the last few years.

Alarming water quality deterioration

Approximately half of water resources of the Oum Er Rbia basin are being polluted by the discharge of industrial and domestic wastewater, by nitrates and pesticides and by sea-water intrusion. Water quality deterioration is further aggravated by the delay in implementing sewage treatment schemes and the enforcement of the relevant legislation on pollution prevention and punitive actions.

The water resources of the basin are extremely vulnerable to pollution, due to both natural reasons and to human pressures. The basin faces pollution issues similar to those of the entire country, and due to all types of human activity (from the domestic, industrial and agricultural sectors). In total, pollution is estimated to approximately 2,000,000 equiv. inhab./yr.

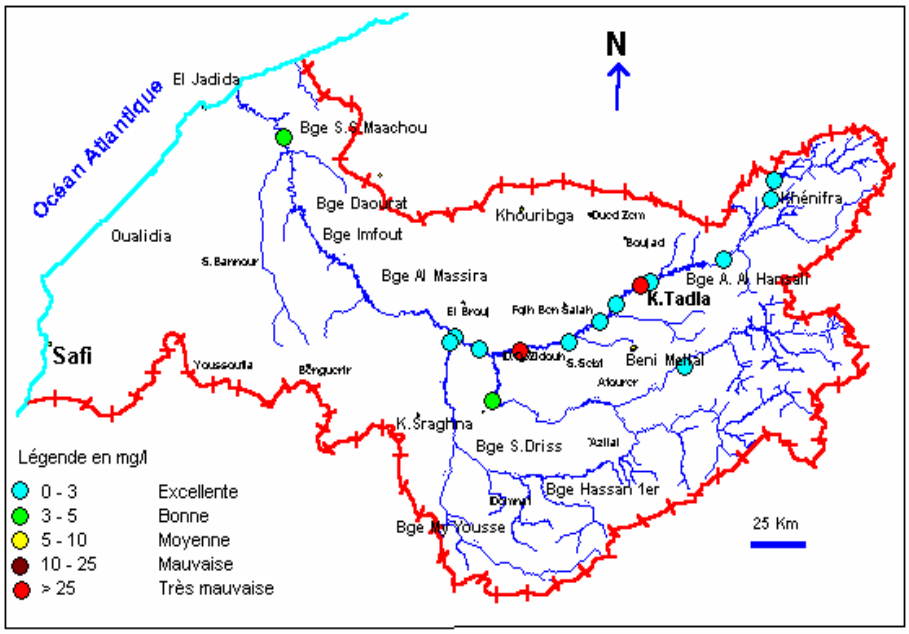


Figure 85: Water quality in terms of BOD_5 in the Oum Er Rbia Basin (1999-2000)

In the area under the authority of the Oum Er Rbia Hydraulic Basin Agency, **domestic pollution** originates from a total number of 70 urban cities and centres. At present, the total annual volume of collected sewage water is approximately 40 million m³/yr. The total annual pollution load generated by these areas is estimated at 21,500 tons of BOD and 42,000 tons of COD.

At present there are 16 sewage treatment plants, of which only 6 are operating (Khouribga, Beni Mellal, Boujâad, Boujniba, Hattane and Ben Guérir). Unfortunately, the Oum Er Rbia River constitutes the main discharge point from all inhabited areas in its vicinity. It is therefore necessary to prioritize the implementation of treatment plants for those regions within the framework of the corresponding National Plan.

The main **industrial pollution** sources are located in the areas of Beni Amir and Beni Moussa. Especially canneries and oil industries have a significant contribution to the increase of nitrate and organic matter concentrations. The annual volume of industrial discharge is estimated to approximately 16 million m³, whereas the annual organic pollution loads generated by the agro-food industries, which are the main source of pollution, are estimated at 11,000 tons of BOD and 21,500 tons of COD.

It should be noted that pollution generated from those industries is practically of the same magnitude as the one of the domestic sector, and represents 65% of the total COD load, which is difficultly biodegradable.

Therefore, industries should at least foresee a pre-treatment stage, which will allow a reduction of at least 40% of organic pollution, by adopting simple technologies such as lagoons, which can contribute to a significant pollution reduction.

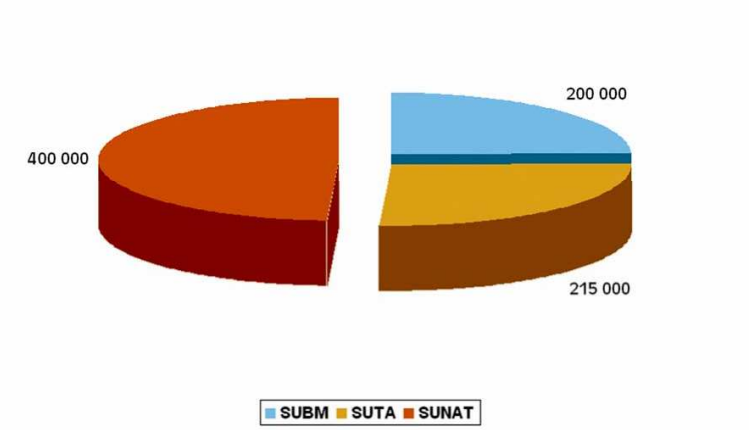


Figure 86: Pollution generated from the sugar industries (in equiv. inhab.)

Agriculture contributes to groundwater pollution due to the application, at times excessive, of manure, fertilizers and pesticides. In the area controlled by the Oum Er Rbia Agency, the quantity of nitrogen leaching towards aquifers or streamed towards water courses is estimated at 10% of the quantities applied. Therefore, approximately 3,500 tons of nitrates, originating from manure application reach the Tadla aquifer as a result of leaching. Furthermore, the pollution originating from pesticides is estimated at 2.2 tons/yr.

The aforementioned uses impact negatively on the quality of both surface and groundwater. Various campaigns led by the Oum Er Rbia Agency, and the establishment of a monitoring

network for water quality have allowed the evaluation of the current water quality status in the basin.

Groundwater quality experiences a continuous degradation. Over the past 15 years, the measured nitrates' concentrations have escalated to alarming levels, reaching values higher than 50 mg/l in the majority of stations sampled. Since the 1980s, the problem of nitrates has become particularly acute in the Tadla plain, where concentrations exceed the acceptable norm of 50 mg/l (Figure 87). At present, more than 60% of the water table surface area (80,000 ha) is polluted, and if no action is taken, the entire aquifer will shortly become contaminated in the short term. For accessing and addressing the issue, the Agency has established a monitoring programme in Tadla, where measurements are performed twice per year, through a network of 92 sampling points. According to those measurements, over the past 10 years nitrate concentrations increase at a yearly average rate of 5 mg/l.

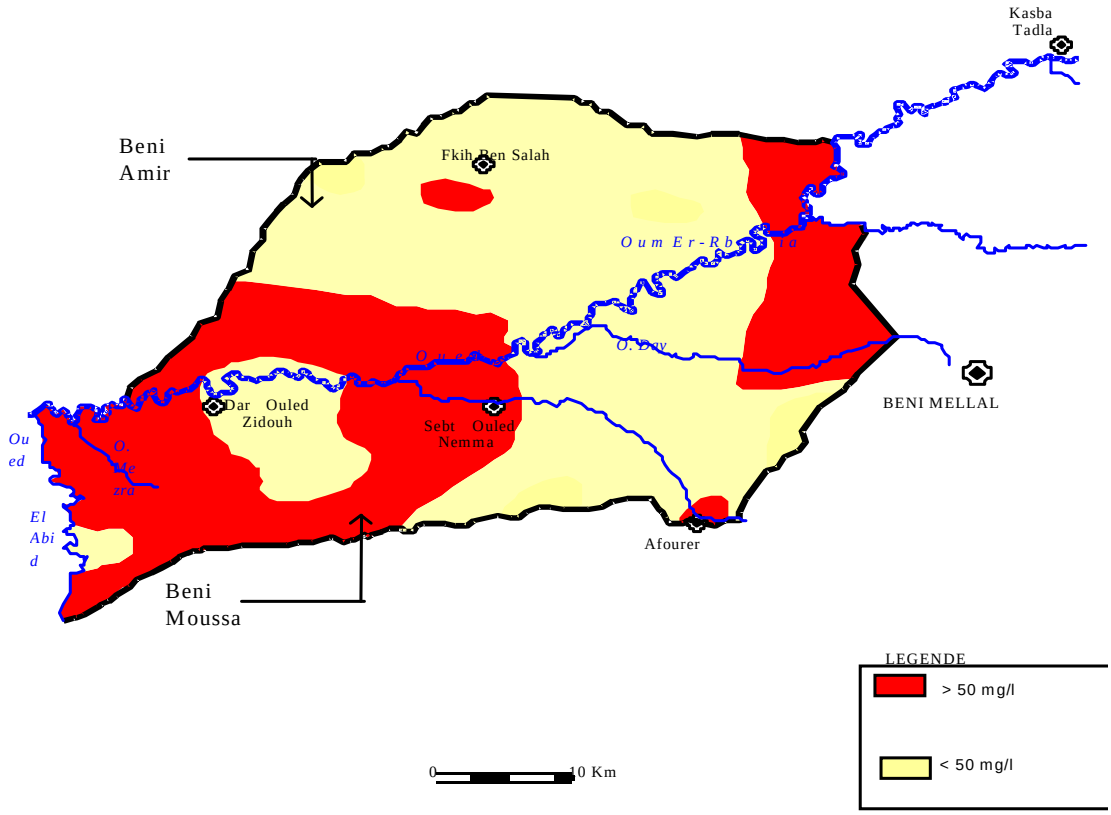


Figure 87: Map of nitrate pollution

The **quality of surface waters** is generally good in the upstream parts of the basin (i.e. upstream of Khénifra) and becomes degraded downstream, as a result of urban and industrial discharges. The section between the downstream Kasba-Tadla and the downstream discharge point of Dar Ouled Zidouh on the Oum Er Rbia River is significantly polluted by the combined discharge of industrial and domestic effluents. This river section experiences an excessive deterioration during the summer months as a result of sugar production activities and other types of industrial wastewater discharged into the river without prior treatment.

Inefficient water use

Water losses in the agricultural sector are extremely important. Losses in irrigation distribution networks are estimated at 20%, whereas losses within the fields (in crop irrigation) are estimated at 50%. The situation is aggravated by the small share of agricultural

land (10%) equipped with advanced irrigation systems. In the domestic sector, distribution losses are approximately equal to 35%.

With regard to **dam siltation**, measures taken have succeeded in ensuring the transportation of sediments in the corresponding watersheds (Table 76). In total, the volume lost in regulation dams (Al Massira, Bin El Ouidane, Moulay Youssef, Hassan the 1st), is currently estimated at 350 million m³. Dam siltation has direct impacts on the regulated volumes, dam performance, dam security, required supplementary works, downstream infrastructure and water quality.

Table 76: Siltation in major dams

Dams	Operation start year	Initial capacity (million m³)	Present capacity (million m³)[31]	Loss of capacity (million m³)	Yearly silting up (million m³)	%
Bin El ouidane	1954	1500	1253	247	5.36	0.35
M. Youssef	1970	197	161	36	1.20	0.59
Hassan 1er	1987	272	245	27	2.08	0.76
Al Massira	1979	2785	2744	41	1.95	0.07
A. El Hansali	2001	740	740			
Total		5494	5143	351	10.59	0.20

Flood protection

Hourly rainfall often reaches levels that can incur floods, which in turn cause problems to the overall economy and the safety of citizens. The dams of the Oum Er Rbia basin can attenuate such effects, in combination of models capable of forecasting precipitation volumes and estimating the volumes that should be released. However, cities such as Settat, Beni Mellal and El Jadida are still vulnerable, mostly due to the uncontrolled urban development especially in floodable areas.

3.1.3 Financial, administrative and institutional constraints

Financial constraints are mostly related to the difficulty of the population to respond to the increased cost of water supply provision. The State finances investments on the construction of dams, irrigation networks in the irrigated perimeters and the upgrade of urban water-related infrastructure. Consumers are charged with all other costs and the overall policy of introducing IBT charges in drinking water supply, ensures that low-income households have access to water services. However, the overall increase of water tariffs is causing some social turbulence, mostly due to the insufficient provision of background information.

Furthermore, the State began, in November 2006, the procedures for mobilizing a fund of 44 billion DH with the aim to reduce by half wastewater treatment problems in the next 15 years.

The overall administrative and institutional setting suffers from the delay in the implementation of the Water Law. This delay is actually preventing a more rational management of water resources, and the application of the polluter-pays principle. Issues slow in implementation are mostly associated with the water charges that will constitute the

[31] Date of last measurement: 2000

financial resources of the Basin Agencies, and that would permit them to provide financial assistance in the development and protection of water resources.

3.1.4 Summary of main water management issues

Table 77 summarizes the main water management problems encountered in the Oum Er Rbia Basin, whereas Table 78 outlines a SWOT analysis for water management in the region.

Table 77: Summary of main water management issues in the Oum Er Rbia Basin

Problem	**Description**
Water shortage and pollution issues	- Widening gap between supply and demand, as a result of supply decrease and escalating demand. At present, water availability per capita does not exceed 600 m^3/cap/yr. - No possibility for additional water supply: More than 90% of exploitable resources have already been exploited. - Increasing water quality deterioration. - Overexploitation of water tables, causing a decrease of piezometric levels. - Considerable delay in the implementation of wastewater treatment projects, due to the lack of financial resources of the operators. - Trend towards the use of unconventional water resources: desalination, wastewater treatment and reuse. - Inefficient performance of irrigation networks
Difficulties in implementing good governance practices	- The multiplicity of intervening parties has not allowed the development of a global, coherent vision for the integration of the development of the water sector. - There are delays in the implementation of Law 10-95 (Water Law). - There is delay in building capacity in the water management sector. - Water prices are low in agriculture. Furthermore, users and customers do not sufficiently respond to water prices set. - The difficulty of the setting up of the tablecloth contract. - There is lack of knowledge and expertise among farmers in efficient water use. Water is used for the irrigation of crops of low value. - There is need to foster change in the behaviour of users towards water.

Table 78: SWOT analysis

Strengths	Weaknesses
- The existence of the Water Law defining the Hydraulic Basin as the unit for water management - The establishment, since 1999 in OER of the Hydraulic Basin agency - The existence of efficient operators: ONEP, Municipal Utilities (Regies), ORMVAs, Private companies, etc.	- Communities and municipalities have often been not as efficient in managing water, sewerage and electricity services. They had to resort partly or completely to professionals, who were able to reduce costs and ensure the sustainability and quality of the services provided. - There is difficulty in setting up contracts for the management of water tables. The multiplicity of users makes the implementation of such contracts, managed by the Hydraulic Basin Agency with professional associations, necessary. - There is insufficient level of knowledge and expertise of farmers towards irrigation water use. Farmers should reduce or abandon the irrigation of water-intensive, low-value crops, which are irrigated using groundwater, and apply new techniques for irrigation and pumping, so as to increase agricultural output. - There are still subsidies provided for borehole drilling and pumping by farmers, which foster groundwater overexploitation. - The price signals towards water users are rather weak. The State provides a subsidy of 5 DH/m³ for the cost of mobilizing water resources through dams and for the maintenance of irrigation canals. It will also subsidize wastewater treatment. - There is significant debate over the current strategic planning. Water transfers from the OER should be performed only towards the Tensift basin, and other, external to the basin, water demands should be backed up by the Hydraulic Basin of Sebou. - There is insufficient knowledge on deep water tables and of relevant technology. - The efficiency of drinking water distribution networks is low
Opportunities	**Threats**
- A regional debate is organized by the MATEE in 2007 on water-related issues. - The State has started to financially support with 44 billion DH the implementation of sewage treatment schemes, for reducing by half the relevant pressures within a timeframe of 15 years. - ONEP launched a programme for drinking and irrigation water supply, aimed at addressing the delayes observed. This programme was initiated in 2006, has 2-year horizon, concerns 600,000 inhabitants and will cost approximately 1.2 billion DH. - Farmers are supported through a 60% grant for implementing advanced irrigation systems. - Public authorities are encouraged to merge water supply and sewerage services in regions and to assign their management to operators. The OER Agency is considering this approach. - State Programmes for developing “satellite” cities around large urban centres. - The tertiary sector is under development and will possibly alleviate pressures exerted by agriculture.	- Pollution is increasing as a result of nitrates, pesticides, sewage and industrial wastewater discharge. - Coastal water tables are threatened by sea intrusion - Droughts have significant impacts on water quantity and quality, and flood risks are increasing. - Water is used inefficiently. - There are several polluting industries, which discharge their effluents without prior treatment (e.g. OCP, sugar, dairy etc.) - There is delay in the implementation of Law 10 – 95, particularly with regard to the polluter-pays principle.

3.2 Identification of focal water management problems

According to the analysis presented and the concerns of the Oum Er Rbia Hydraulic Basin Agency, the two most important water management problems encountered are**: inefficient and wasteful water use**, and **water pollution**. Although the background of these two issues has been elaborated in the previous sections, this paragraph briefly outlines the problems' causes and effects, and the associated deficiencies of the institutional and economic setting that have contribute/are contributing towards them.

3.2.1 Inefficient and wasteful water use

Problem Causes

- High losses in distribution networks (40 to 60%).
- Inefficient irrigation methods with high water consumption (sprinkler instead of drip).
- High losses in irrigation canals (20%) and fields (50%).
- Delay in the implementation of a water reuse policy which would permit the use of treated wastewater for crop irrigation.
- Tariffs and recovery systems do not encourage water conservation.

Problem Effects

- Increase of demand leading to the overexploitation of water tables (levels drop at a rate of 1 to 3 m annually)
- Irrational use of untreated wastewater for irrigation purposes
- Increase of polluted water discharges
- Higher investments are required for water regulation, treatment and transfer.

Problem Importance

- Exploitable resources have already been exploited.
- Water stress, incurred from droughts and pollution.
- Preservation of the resource through least cost solutions.
- Deferring the necessary investments for meeting water needs and restoring water quality.

Associated institutional and economic deficiencies

- Delay in the application of the Water Law, especially with regard to the user-pays and polluter-pays principles.
- Low price of water in irrigation
- Cost recovery deficiencies
- Lack of awareness among users, due to insufficient awareness campaigns.

3.2.2 Pollution

Problem causes

- No treatment of domestic wastewater
- Fast urbanization
- Few sewage treatment plants (6 operational plants vs. 70 urban centers)

- Discharge of untreated industrial wastewater (16 million m³/yr) from the food industry
- Manure and pesticides application: 35000t/year of nitrates and 2.2 t/year of pesticide.
- Law rainfall reducing the minimum flow and the dilution capacity of the receiving water courses.

Problem Effects

- Water quality deterioration.
- Limitations in the potential for natural purification
- Deterioration of surface water quality and eutrophication in dams and canals. This, in turn increases dam maintenance costs and treatment costs for drinking water supply.
- Deterioration of groundwater quality, with high concentrations in nitrates and pesticides being observed.
- Contamination of tourist sites.
- Salinisation of water tables.
- Odour nuisances.

Problem Importance

As mostly all resources have been exploited, wastewater treatment should be thought as a solution towards:

- Water saving.
- Reducing wastewater discharge, currently equal to 40 million m³.
- Reusing treated wastewater in the agricultural sector, and therefore reducing pumping from water tables.

Associated institutional and economic deficiencies

- Absence of an integrated water management concept, as since the independence of the country, priority has been given to supplying urban water needs, to the expense of sewage collection and treatment, which only now begins to have the focus.
- Excessive application of manure and pesticides in agriculture
- Low tariffs and ineffective recovery of costs in agriculture, encouraging water waste and pollution.
- No implementation of the pollution charges foreseen.

4 Identification of stakeholders

Table 79 presents the main stakeholders involved in the outlined water management issues of the Oum Er Rbia Hydraulic Basin. Further contact details are provided in the Appendix of the Deliverable.

Table 79: List of stakeholders

Sector	**Organization**
National office of the drinking water (ONEP)	General Direction
	Direction of Khouribga
Regies - Concessions	RADEET
	RADEEJ
	RADEEC
Basin agencies	The Hydraulic Basin Agency of the Oum Er Rbia
	The Hydraulic basin Agency Tensift Marrakech
ORMVA	ORMVA tadla
	ORMVA Doukkala
Wilaya	Wilaya Tadla-Azilal
Entreprises	Suta - sweets refineries of the Tadla s.a.
	COMPLEX MOROCCO PHOSPHORUS III-IV
	SOGEA
Professional associations	FMCI - Moroccan Federation of Advice & Engineering
	AMEPA
	AMEF
	AMEC
Ministries	MATEE
	SEE - Secretariat of state responsible for water