INECO

Institutional framework and decision-making practices for water management in Tunisia

Towards the development of a strategy for improved groundwater management

March 2009

Prepared by the Tunis International Center for Environmental Technologies

INECO ("Institutional and Economic Instruments for Sustainable Water Management in the Mediterranean Basin") is a Coordination Action Project supported by the European Commission through the 6th Framework Programme (Contract No: INCO-CT-2006-517673).

SIXTH FRAMEWORK PROGRAMME

PREFACE

Throughout the Mediterranean area, authorities and water users are becoming increasingly aware of the importance of better groundwater resources management. Intense exploitation patterns of past decades have rendered groundwater abstraction uncontrollable by State authorities, mainly due to the extremely large number of private boreholes operating to meet domestic and agricultural needs. The experienced technical and financial constraints call for the implementation of innovative approaches; recent efforts focus on developing community management of groundwater, and implementing an appropriate combination of regulatory and economic instruments to encourage water conservation and the use of alternative water supply sources.

This volume of the INECO publishable reports outlines the analysis of the institutional framework and decision-making practices for water management in Tunisia. It highlights the main water management challenges faced in the country today, and focuses on one water management issue that is considered of primary importance, groundwater overexploitation. The preservation of groundwater resources, which are currently degraded after many years of overexploitation, is strongly linked to agricultural water use, as groundwater is a major water supply source in irrigated agriculture. Furthermore, the wider use of alternative water supply sources, such as treated wastewater for crop irrigation, has become one of the main priorities of the National Water Policy, in an effort to conserve freshwater resources and reallocate these to other water use sectors.

Responding to this challenge, the INECO project implemented a participatory approach towards alternative institutional and economic instruments for better managing groundwater resources at the national level. Emphasis was placed on discussing recommendations for an enabling institutional environment for the collective management of groundwater at the user level. Furthermore, discussed options also concerned appropriate incentives for the use of non-conventional water supply (water reuse) and for enhancing efficiency in irrigation.

This volume was prepared by the Tunis International Center for Environmental Technologies (CITET), and was based on information that was made available through various departments and officers / experts of the different ministries and authorities involved in groundwater management. The authors would like to thank all stakeholders for their willingness to collaborate by providing relevant information, data and expertise, and through their active participation in the INECO process. Special thanks are extended to Mr. Ridha Boulabiar, Director of ONAS (Office National d'Assainissement), for his continuous support and valuable guidance, and to the authorities of the Governorate of Nabeul, which hosted most of the INECO events.

March 2009

Tunis International Center for Environmental Technologies

CONTENTS

PART I: WATER MANAGEMENT IN TUNISIA: SETTING THE SCENE

COUNTRY OVERVIEW

Tunisia, being an arid to semi-arid country, is facing water shortage of increasing severity. Water scarcity problems are expected to intensify, as a result of population growth, rising living standards and accelerated urbanization. These drivers put considerable pressure on available resources and on the agricultural sector, leading to a significant increase in water use and pollution loads.

The escalation of urban water demand has led to an increasing use of freshwater for domestic purposes and to the production of large wastewater volumes. In turn, this has significant impact on the allocation of water for crop irrigation: the agricultural sector is expected to face significant water quantity and quality problems, given that the volume of freshwater that becomes available for crop irrigation is decreasing. Furthermore, there is growing competition over available resources in the vicinity of large urban centres.

In the above perspective, policy makers have been compelled to develop additional resources, and to take measures towards water resource conservation. Currently, the main components of the National Water Resources Management Strategy are gradually shifting towards surface water mobilization, soil and water conservation works, water harvesting, and use of non-conventional water resources, such as reuse of treated wastewater for crop irrigation and aquifer recharge.

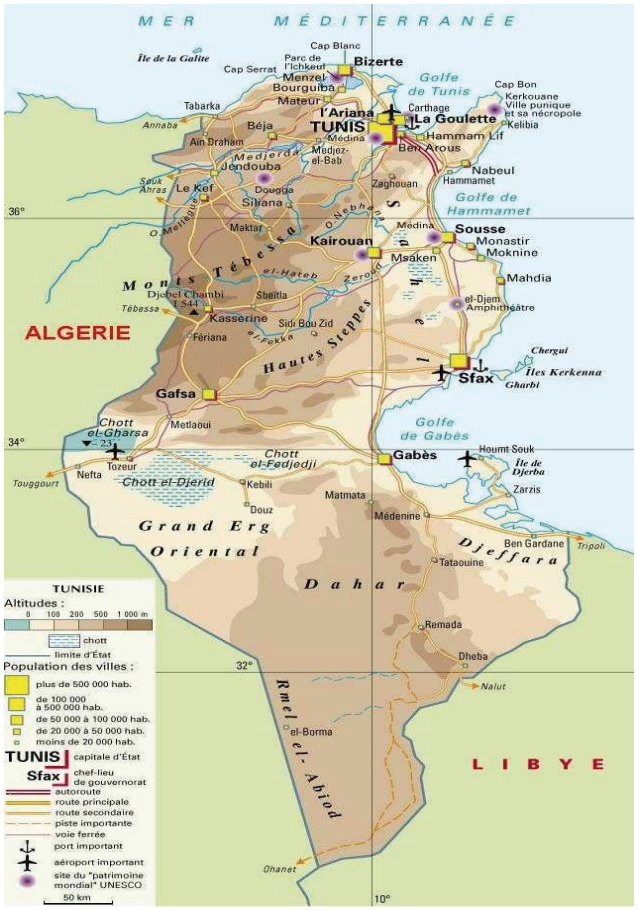

Figure 1: Overview of Tunisia

PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

Climate

Tunisia occupies an area of 163,900 km^2. The average altitude is 700 m, escalating to 1544 m at the Chaambi Mountain, in the central part of the country. In the northern part, along the coastline, the climate is typical Mediterranean, whereas in 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 Saharan dust being frequent during the summer months. The annual evapotranspiration is equal to 1200 mm in the northern part of the country, 1400 mm along the coastline, 1600 mm in the central and escalates to 1800 mm in the southern tip of the country.

Geomorphology and geology

Tunisia presents diversified geomorphological characteristics, due to the influence of climatic conditions, vegetation and human activity. 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 sub-humid climate, most soils are clayey, whereas in the south soils are characterised by different types of accumulations.

Major river basins

The country is divided in 7 River Basin Districts, which include several river basins:

- **Basin 1**, which covers the north-most part of the country;
- **Basin 2**, which comprises the 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 southern limit of Basin 4 and the Sahel up to the north of Chot el Jerid; and
- **Basin 7**, which covers the south-most part of the country, up to the Algerian and Libyan borderlines.

DEMOGRAPHIC & SOCIO-ECONOMIC 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 73.4 years.

Ninety-five percent (95%) of the population is connected to the electricity grid; in rural areas, this percentage decreases to 88%. At the national level, potable water supply is provided to 92.3% of population; in rural areas, the corresponding percentage is equal to 80%. Approximately 76% of households are connected to public water supply networks; this per-

centage drops to only 30% in rural areas. 85.7% of households in urban areas are connected to sewerage systems.

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

- Services: 18,182 million TD;
- Non-manufacturing 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, corresponding to 37,202 million TD in market prices. In the same year, the value of indirect income taxes and subsidies was equal to 4,022 million TD. 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 main agricultural products are cereals (average production of 2 million tons/year), olive oil (250,000 tons), oranges (250,000 tons), dates (100,000 tons) and grapes/wine (500,000 tons). The industrial sector comprises non-manufacturing industry, including mining, energy, electricity and water, construction and public works, and manufacture industry (food industry, construction materials and glass, mechanical and electric products, chemicals and rubber, textiles and leather).

The geographic position of Tunisia, its natural beauty and its 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 approached 40 million. The revenue from tourism activities increased to 2,575 million TD[1].

CURRENT EXPLOITATION AND USE OF WATER RESOURCES

Since the independence of Tunisia in 1956, **the rapid water demand growth** in the domestic, industrial, tourism and especially in the agricultural sector, has urged 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 repeated droughts experienced in the last 15 years.

In this regard, Tunisia has engaged since 1990 in an ambitious program for the exploitation and management of natural and non-conventional water resources. 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. Inter-basin transfer is performed among northern regions, towards the coast and from the western to the eastern part of the country. Transferred water is primarily used for domestic and irrigation purposes. The conveyance network for inter-basin transfer is approximately 30,000 km.

In 1996, total water demand was estimated at 2,620 million m^3 and is expected to follow a continuous growth, following the socio-economic development of the country. On the other hand, the total volume of available resources, comprising both non-conventional and freshwater supply, is rather low, and ranges between 4,000 and 4,600 million m^3. It is estimated

[1] 1TD = 0.8 US$

that in 2010 exploitable resources will be equal to 4,600 million m^3, whereas water demand is projected to 2,689 million m^3. 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 sector. The reuse rate of treated wastewater is equal to 32%. The **most important water use sector** is irrigation, using 80% of the country's available resources. The irrigated area is estimated at 400,000 hectares, whereas irrigation demand is 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 CRDAs and development groups.

Domestic water demand is at present estimated at 350 million m^3/yr. Water supply is provided by SONEDE and regional public services (CRDAs and Development groups in the rural areas). Industrial demand corresponds to approximately 120 million m^3/yr and tourism demand is estimated at 30 million m^3/yr; both are mainly supplied through the public water supply system of 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; a volume of approximately 201 million m^3/yr of wastewater is treated at the 83 plants managed by the operator.

Demand management constitutes an important axis of future water policies for the regulation of the consumption of different water use sectors, and in particularly that of agriculture, which is the largest consumer. In this regard, employed instruments are mainly oriented towards water conservation and rationalization of water use in agriculture. In addition, and in order to assess and monitor water availability 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 and 1,200 measurement points for groundwater quality.

SHARING WATER IN TUNISIA – EMERGING CHALLENGES

Tunisia is likely to face significant disparity between exploitable water resources and water demand in the near future. Such a deficit cannot be met through water conservation or non-conventional water resources (e.g. sea-water desalination and wastewater reuse) alone. Available resources in the country are more and more vulnerable to risks resulting from successive droughts and climate change.

Drought is a periodic and common phenomenon in Tunisia, always taken into account in development strategies and water projects. Due to this proactive approach, the country has managed to overcome drought impacts over the last decade; efforts were directed towards the appropriate management of hydraulic works and the enhancement of soft 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.

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 overexploitation of resources, which impose challenges to decision-making processes for water management. Still, water supply is subject to interruptions, due to the reduction of available supply at the distribution level. These relatively important water shortages can

have negative impacts on public health, the economy and the environment. The risk of water shortage is due either to the inadequacy of infrastructure or to natural phenomena, such as sedimentation in reservoirs or successive droughts.

Agriculture is the main water consumer; it is expected that the situation will not be reversed until 2030, even if there is limited expansion of irrigated lands. In some regions, where irrigation is an important water use, irrigated agriculture may disappear due to the low availability of water resources and the highly valued alternative land use; these are in fact the main factors influencing the viability of irrigation 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. It is also worth noting that efforts for the rationalization of water use did not have notable effects on urban and rural population consumption.

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

GOVERNING WATER – THE CONTEXT

THE INSTITUTIONAL SETTING

Institutions involved in water management

Most tasks related to water resources management fall under the responsibility of the Ministry of Agriculture and Hydraulic Resources and the directions/institutions under its authority. These comprise the General Direction of Water Resources (DG/RE), the General Direction of Rural Engineering and Water Exploitation (DG/GREE), the General Direction of Dams and Great Hydraulic Works (DG/BGTH), the National Company for Water Exploitation and Distribution (SONEDE), the General Direction of Agricultural land Management and Conservation (DG/ACTA), the Rural Engineering, Water and Forestry National Research Institute (INRGREF), the Regional Departments for Agriculture Development (CRDAs), the National Committee of Water (CNE), the Commission of the Public Hydraulic Estate (CDPH), the institution for the Exploitation of Conveyance Networks of the North (SECADENORD), and the Surveillance Bureau of Hydraulic Resources (BIRH).

Of the above authorities, SONEDE has been established as a national utility for providing potable water all over the country. In this regard, the Utility undertakes projects relevant to the exploitation, maintenance and rehabilitation of facilities and infrastructure for water abstraction, conveyance, treatment and distribution. At present, SONEDE, which employs 7,500 persons and is regionally represented in all 24 governorates, is responsible for:

- The production, treatment and distribution of 317 million m^3/yr of drinking water, through a conveyance network of 30,000 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.

Furthermore, three institutions deal with different aspects of water pollution abatement and control, and operate under the authority of the Ministry of Environment and Sustainable Development:

- The National Sanitation Utility (ONAS) is the major agency dealing with the protection of the water environment and pollution abatement with the mandate to:
    - Eliminate water pollution sources in the areas falling under its jurisdiction, and manage, operate, maintain, rehabilitate and construct all facilities intended for the provision of sewerage and wastewater treatment services in the cities assigned to the utility;
    - Promote the distribution and exploitation of the by-products of wastewater treatment, such as treated wastewater and sludge;
    - Plan and implement sanitation projects;
    - Plan and implement integrated projects related to the treatment of wastewater and stormwater management.
- The National Agency for Environment Protection (ANPE) has been established in order to:
    - Participate in the elaboration of national strategies on pollution abatement and environmental protection;
    - Act for the prevention and mitigation of all forms of pollution and threats to the environment;
    - Take measures towards the rational exploitation of natural resources, within the frame of sustainable development;
    - Approve investment projects for pollution prevention and abatement and environmental protection;
    - Establish regional offices in order to facilitate contact with citizens and industries, and ensure control and monitoring of the state of the environment;
    - Undertake actions for raising awareness and promoting research in the field of pollution abatement and environmental protection.
- Finally, the Tunis International Centre for Environmental Technologies (CITET) undertakes tasks in relation to:
    - Chemical, physical, microbiological analysis of water samples;
    - Promotion of wastewater reuse and improved wastewater treatment technologies;
    - Training and capacity building in the field of water, water pollution and environmental protection.

Table 1 outlines the responsibilities of the most important institutions responsible for water management operations at the national level. At the regional level, the Regional Departments for Agriculture Development (CRDAs), established in each of the 24 Governorates of the country, undertake tasks relevant to the assessment of water resources, the monitoring of water resource use and implementation of irrigation and potable water supply projects, and to the maintenance and updating of the respective regional databases on water resource exploitation, use, water quality, availability and allocation, in line with the requirements of the National Information System of Tunisia.

Table 1: 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 re-charge	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 networks							
Rehabilitation		x					
Modernisation		x					
Reuse							
Drainage water		x					
Wastewater		x				x	
Desalination							
Introduction				x			
Efficient water use				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 implementa-tion		x		x	x	x	x
Operation and Main-tenance of projects		x		x		x	x
Pricing (tariffs)		x		x		x	
Enforcement							
Water data records	x			x			

Additionally, the Groups of Hydraulic Interest (GIHs), also established at the Governorate level, formulate proposals on the common use of water resources, act as consulting bodies

on management and water allocation projects in their area, and monitor owners and end-users associations. With regard to the latter, Agricultural Development Groups have been established at the local level in order to jointly manage water resources, collect the relevant fees from water users and undertake tasks for the appropriate maintenance of water infrastructure and irrigation water distribution networks.

At present, transboundary surface water management policies are implemented by DG RE. 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 coordination mechanism on the Aquifer System of the Sahara. This mechanism aims at establishing a framework for information exchange and cooperation between the 3 countries through: (a) the elaboration of indicators on available water resources and water demand, (b) the definition of water resources management scenarios for the development of the area, (c) the strengthening of cooperation and development of common databases for information exchange, and (c) the development and management of joint monitoring networks for the aquifer system.

Legislation

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 disposal in water bodies, the establishment of protected areas in the vicinity of water supply sources, and the mandatory treatment of wastewater in urban areas. The "Waters Regulation" also defines the responsibilities of the State, Development Groups of public interest and individuals in the construction of infrastructure for flood prevention and control.

The main legislation governing the water sector is outlined in Table 2.

Table 2: Main water laws and regulations

Reference	Focus	Content
Legislative Decree of 24 September 1885	Water Resource Management	Emphasizes on the public hydraulic estate, including only surface and not groundwater resources.
Legislative Decree of 24 May 1920	Water service provision	Provides for the establishment of a special water service, the development of an agricultural and industrial hydraulic fund and for the establishment of a Water Committee.
Legislative Decrees of 5 August 1933, 26 November 1936 and 24 March 1938	Water utilization, conservation and pricing	Regulates the utilization and conservation of the public hydraulic estate and fixes the price for water supply.
Legislative Decrees of 30 July 1963, 11 January 1945 and 17 March 1949	Creation of groups of hydraulic interest	Regulations relevant to the organization of groups/associations of hydraulic interest.
Laws of 11 January 1958, 26 June 1960, 27 May 1963 and 16 February 1971	Water for irrigation	Provides for the creation of public irrigation perimeters and emphasizes the role of the Government in agricultural development
Legislative decrees of 12 March 1964 and Decisions of 19 July 1958 and of 12 March 1964	Water for irrigation	Outlines the role of the farmers in the creation, management and irrigation through privately built water infrastructure and in soil and water conservation.

Reference	Focus	Content
Law no 75-16 of 31 March 1975	Law for water resource mobilization, exploitation and protection	Confirms all regulations cited above and introduces new elements in water resources protection and use. The law is structured in 9 chapters and 160 articles. These are further described below.
Chapter 1 (7 articles)	Water resource management	Defines all components of the public hydraulic estate, which is administered by the Ministry of Agriculture and Water Resources.
Chapter 2 (13 articles)	Water mobilization and conservation	Defines perimeters for management and water use, operations needed for obtaining authorizations from the administration. Regulates the establishment of protection zones for aquifers, and identifies the actors in charge of water conservation and protection of the public hydraulic estate.
Chapter 3 (18 articles)	Water exploitation	Describes the replacement of private water ownership rights by rights of use and describes all actions required to obtain such rights. The chapter focuses mainly on water springs and streams.
Chapter 4 (12 articles)	Water exploitation	Emphasizes on the identification of special zones in the public hydraulic estate and regulates their exploitation, which is subject to pre-authorization from the administration.
Chapter 5 (34 articles)	Water exploitation	Defines regulations and responsibilities for hydraulic works and concessions required for the exploitation of the public hydraulic estate.
Chapter 6 (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; measures should be introduced in order to ensure the preservation of water resources both in terms of quantity and quality.
Chapter 7 (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 quality 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 (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

Reference	Focus	Content
		autonomy (before the introduction of the relevant provisions, financial management was controlled by the Government).
Chapter 9 (5 articles)	Water law application	Determines jurisdictions and penalties for the breach of the statutory provisions of the water law (code) and the decrees for its execution.

It should be noted that 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.

Furthermore, and with regard to authorizations for water abstraction, the regional services of DG ACTA grant permits to pump water 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 two thirds (2/3) of the lake reserve capacity. In case of collective use, the water price is determined by the management committee or by the development group.

FINANCIAL FRAMEWORK

Governmental authorities involved in the financing of the investments in the water sector comprise the Ministry of Finance, the Ministry of Agriculture and Water Resources, the Ministry of Environment and Sustainable Development, the Ministry of Public Health, the Ministry of Scientific Research, and the 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$. These funds were made available through bilateral and multilateral cooperation programmes. Loans and donations for different projects related to water resources exploitation, land and water conservation, sanitation, potable water production and agricultural water management were offered 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, the French Development Agency, the German Bank (KFW), the German Cooperation Agency (GTZ), the 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 the maintenance of works for land improvement and water distribution by land-owners. Farmers finance the excavation of wells and boreholes on their own and are sometimes subsidised by the State, provided that a permit has been granted and the project has been approved by the competent authorities.

VALUING WATER – WATER PRICING ISSUES

There is wide recognition of the fact that water is a social and economic good and that its exploitation should be justified by the economic output of water use. However, it is also considered that priorities imposed by socio-economic considerations, such as supply of potable water and irrigation of crops of strategic importance, should be respected. In this regard, **tariff regulation** and **water pricing** is an important issue in the country.

Concerning irrigation, water was granted to farmers free of charge until 1970, 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 financial 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 the operation and maintenance costs, whereas costs related to the renewal of equipment and important repairs in infrastructure are mostly State-funded. The aim of this policy is to try to secure a minimum level of financial sustainability, while at the same time ensuring that better services are provided to farmers. In 1996, the recovery of operation and maintenance costs reached a global equilibrium at the national level, due to an increase in irrigation water tariffs, since 1991. However, the overall recovery of operation, maintenance and renewal costs did not exceed 60%. Furthermore, the collection of fees from consumers is at times inadequate, resulting to lack of financial resources for the Agricultural Development Groups.

Table 3: Comparison between regional water cost and tariffs (year 1996, values in TD/m³)

Region	Cost	Tariff	Recovery (%)
Northern	0.079	0.073	92
Sahel	0.161	0.090	56
Central	0.088	0.054	61
Southern	0.036	0.024	67
National Average	**0.079**	**0.069**	**87**

Future irrigation water pricing policies are expected to lead to increased efficiency of agricultural activities in irrigation perimeters and orient farmers towards the application of water conservation measures.

In the domestic sector, water pricing was uniform for all users before 1968. After the establishment of SONEDE, a distinction was made between households, tourist facilities and the sugar, textile and steel industrial sectors. This approach prevailed until 1974, when an Increasing Block Tariff (IBT) pricing system was established, distinguishing between consumption blocks and use types.

The IBT system applied for potable water use is based on quarterly consumption, and the water bill also includes a charge for wastewater collection and treatment. The first (social) block (which corresponds to minimum water consumption) is limited to 20 m³. The second block corresponds to quarterly consumption between 0 and 75 m³ whereas the third block is between 0 and 150 m³. For a quarterly consumption over 150 m³ the price per cubic meter is 6 times higher than the one of the first block, in the 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.

It is considered that future pricing systems should maintain the concepts of social equity and access to basic water services. At the same time they should not hinder economic development or compromise the financial sustainability of water services. The application of appropriate pricing policies may be beneficial in the exploitation of water in the agricultural, industrial and tourism sectors.

Furthermore, there is recognition of the emerging need for the reorganisation of SONEDE and ONAS in order to ensure their financial autonomy, allowing also the privatisation of (some of) their responsibilities. Such a reorganisation could also entail the establishment of Hydraulic Basin Agencies.

CONCLUDING REMARKS

Tunisia, as well as other Southern Mediterranean countries, faces challenges stemming from the increasing disparity between water supply and demand, periodic droughts and their impact on major water uses, and degradation of freshwater resources in terms of quantity and quality.

On the technical side, one of the major problems encountered is the reduction of surface water storage due to siltation, which decreases the dams' useful lifetime and limits their capacity. The situation is aggravated by the arid climate and torrential rains, as well as the low vegetation density. Excessive application of chemicals, fertilizers and pesticides in agriculture results in water quality deterioration and pollution of groundwater resources by phosphates and nitrates. Furthermore, 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 scarcity.

As a result of the current socio-economic development patterns and the intensive exploitation of resources, many improvements should be made in the current water-related legislation, which focuses on the exploitation of resources, rather than on demand regulation. The open economy from one side and the scarcity of the resources on the other are bound to enhance competition over water use. This could eventually lead to the establishment of water markets, allowing for the exploitation of water by uses of high value, thus inducing a shift towards a more economically efficient water allocation. In this context, governance reforms would be oriented towards the decentralisation of water management operations and participation of water users in decision-making, ways of enabling resource conservation and environmental protection, and the active pursuit of integrated water management, taking also into account the objectives and limitations of other development policies.

PART II: THE INECO TUNISIA CASE STUDY:
DETERIORATION OF AVAILABLE GROUNDWATER RESOURCES IN TUNISIA

BACKGROUND AND MOTIVATION

In spite of the considerable effort made in Tunisia for water mobilization, which played a dominant role in controlling water resources and attenuating the socio-economic impacts of droughts, farmers continue to overexploit phreatic water tables. The average rate of exploitation is 106%, a fact that has resulted in the gradual depletion of productive aquifers and water tables, and to increased salinity levels in coastal aquifers.

In the above context, the INECO project committed to foster constructive dialogue on alternative institutional and economic instruments for better managing groundwater resources at the national level. Given the inherently uncontrollable nature of groundwater abstractions, due to the existence of numerous private boreholes, the emphasis is placed on creating an appropriate institutional environment for enabling the shared management of groundwater at the user level. Additional considerations concern the wider introduction of non-conventional water resources and the improvement of efficiency in irrigation water use. The aim is two-fold: first to promote water conservation, and second to alleviate the increasing conflict among competing water use sectors over the allocation of freshwater resources.

GROUNDWATER MANAGEMENT IN TUNISIA

FACTS AND FIGURES

In 2000, the annual renewable groundwater resources of Tunisia were estimated at 740 million m³. Their rate of exploitation through equipped wells and boreholes is estimated at 106% (i.e. 780 million m³). Groundwater exploitation schemes were mainly developed during the last 20 years, as in 1980 the total exploited volume was equal to only 395 million m³ (97% growth).

Table 4: Available and exploited groundwater resources in Tunisia (Data for the year 2000)

Region	Available Resources (million m³)	Exploitation (million m³)	Rate of exploitation (%)
Northern	386	405	105
Central	236	262	111
Southern	118	113	97
Total	**740**	**780**	**106**

Phreatic, shallow water tables are those most often exploited, as they are within easy reach through large-diameter wells and boreholes. The number of surface wells has escalated from 60,415 in 1980 to 128,400 in 2000, recording a total growth of 113% (5.6% per year). The number of equipped (with motor-pumps, windmills, solar cells etc.) wells escalated from 23,061 in 1980 to 86,965 in 2000 (total growth of 380%, 19% per year). All these abstractions have been authorized by the Ministry of Agriculture and Hydraulic Resources.

The total number of water tables in the country is estimated at 273, of which 71 are exploited at a rate of 146%. The renewable resources of these aquifers are estimated at 385 million m³, and represent more than 52% of the total renewable resources. It is expected that at this rhythm of exploitation, these aquifers will face significant risks resulting from pollution and overexploitation. The largest use of groundwater (350 million m³, i.e. 45%) is observed in the north-east region of the country.

Table 5: Distribution of phreatic water table exploitation through equipped wells per region

Region	Number of equipped surface wells	Rate %	Exploited resources (million m³/yr)	Rate of exploitation (%)
Northern	39315	45	405	52
Central	35378	40	262	33
Southern	12272	15	113	15
Total	**86965**	-	**780**	-

With regard to salinity levels, the following have been observed:

- 12 water tables with a salinity of less than 1.5 g/l and potential yield of 22.5 million m³/yr, representing 3% of the country's water resources;
- 47 water tables with salinity of less than 3 g/l and potential yield of 98.5 million m³/yr (13% of the country's resources);
- 92 water tables with salinity ranging between 3 to 5 g/l, potential yield of 300 million m³/yr, corresponding to 40% of renewable resources;
- 122 water tables with salinity exceeding 5 g/l, potential yield of 318 million m³/yr, representing 43% of renewable resources.

THE GOVERNING DIMENSION

Institutions and actors involved in groundwater management

The governmental authority mostly involved in groundwater exploitation is the **Ministry of Agriculture and Hydraulic Resources**, which undertakes all tasks related to water resource management and exploitation, and controls several institutions responsible of the assessment, monitoring and evaluation of water resources. These include:

- The *General Direction of Water Resources*, which elaborates legislation regarding water resources exploitation and use, collects data and maintains the national Geographical Information Databases on water resources. In addition, the Direction provides expertise and assistance to regional and local authorities for the management of all data related to water resources use and exploitation and management, according to current supply and demand patterns.
- The *General Direction of Rural Engineering and Water Exploitation*, which monitors the institutional aspects regarding the training of associations of collective interest[2] and assesses and implements water management instruments in the agricultural sector. The Direction implements and monitors public irrigation perimeters, and is responsible for the maintenance of infrastructure in these.
- The *General Direction of Dams and Great Hydraulic Works*, generally responsible for the mobilization of surface water resources and thus for the implementation of aquifer recharge and conjunctive use projects, and the construction of dams and small reservoirs in mountainous areas.
- The *General Direction of Agricultural Land Management and Conservation,* also involved in the mobilization of water resources to recharge aquifers through soil and water conservation works and the construction of artificial lakes.

[2] Agricultural Development Groups

- The *Rural Engineering, Water and Forestry National Institute*, responsible for promoting the adoption of improved irrigation techniques, water saving and conservation and water reuse, and for artificial aquifer recharge projects using treated wastewater.
- The *Regional Departments for Agriculture Development*, whose mandate is to assess and monitor water resources and use at the governorate level and collect data on water exploitation and use, quality, availability and allocation.
- The *Hydraulic Interest Groups*, which formulate proposals on the joint use of water resources in their area of action, and control water rights owners and end-users.
- The *Agriculture Development Groups,* also responsible for managing water resources and maintaining infrastructure and irrigation supply networks.

Furthermore, through the *National Sanitation Utility*, controlled by the Ministry of Environment and Sustainable Development, 200 hm^3/yr of treated waste water are available. Of this amount, only 30% is currently used as alternative water supply in the agricultural sector.

All the above authorities have implemented policies for the sustainable management, mobilization and exploitation of water resources. These policies, whose primary aim is to preserve the stability of the country's economy by protecting available resources, providing potable water to supply population needs, and safeguarding agricultural production, are summarized below.

Policies in place

The Tunisian government was aware of the trends in aquifer depletion and their resulting impact; in an effort to offer alternative supply sources and thus reduce groundwater use to sustainable limits, the State initiated policies aimed at the reuse of treated wastewater in irrigated agriculture.

At present, a total volume of about 57 million m^3 of treated effluent (approximately 30% of the total produced volume) is used for the irrigation of 12,000 ha of agricultural land. Irrigated crops include fodder crops and fruit orchards, as well as grapes and olive trees. Treated wastewater is mostly used during the spring and the summer, and in some cases it is the only source of water supply. In other cases, it is to complement groundwater supply.

In addition, in the north-east region of Tunisia, an effort was made to use treated wastewater from secondary treatment for aquifer recharge. However, the project was not fully developed and applications were limited to the experimental stage. Reclaimed water usage is slowly increasing in certain regions, but decreasing in others. Reported reasons include soil and groundwater contamination risks, resulting from the origin of the effluent and the insufficient level of treatment.

Since 1990, Tunisia has adopted a strategy for the introduction of water saving measures, which aims at promoting the adoption of appropriate irrigation techniques by farmers, thus reducing the volume of freshwater allocated to agriculture. The policy offers a subsidy, covering 70% of the cost for irrigation equipment; the remaining 30% can be financed through loans of very low interest rate. The policy has been successful with rich farmers: less groundwater was pumped. However, small and poor farmers did not benefit from the measure, due to lack of awareness and training. As an alternative, desalination has also been applied, but at a very small scale due to high cost.

DISCUSSING WITH LOCAL STAKEHOLDERS – THE APPROACH

The INECO approach towards the development of a participatory process on alternative institutional and economic instruments for addressing water management issues was based on the Objective Oriented Project Pflanning method.

The method, which is similar to the Logical Framework Approach, has been suggested as a tool to support urban participatory decision-making. In INECO, this method has been used to frame discussions with stakeholders, focusing on a water management problem that is commonly perceived as significant (focal) in the region of interest.

The followed approach was divided in three stages (Figure 2):

1. The first stage, **Problem Analysis**, involved the identification of stakeholders, the mapping of their key problems, constraints and opportunities, and the definition of a key water management issue in the region of interest. Furthermore, this stage included the identification and analysis of cause and effect relationships between threats and root causes of the issue at hand;
2. Next, the **Analysis of objectives**, concerned the development of policy objectives from the identified problems, and the identification means-to-end relationships;
3. The final stage, **Option analysis**, concerned the identification of different options that can contribute to the achievement of the agreed objectives. Options were subsequently evaluated in two stages by stakeholders to formulate the most suitable strategy for problem mitigation.

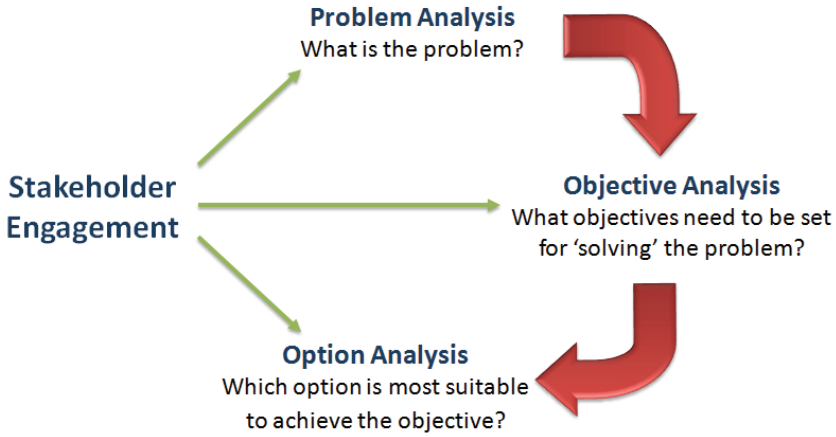

Figure 2: The framework for public participation and engagement in INECO

The overall process was articulated through individual (preparatory or consultation) meetings with key stakeholders (decision and policy makers, representatives of key water users), workshops and public meetings open to stakeholders and all citizens concerned, discussion fora, and dedicated surveys. Emphasis was given to the openness of the process; special care was given to inform stakeholders of all outcomes and replies of other parties, whereas all information collected was made accessible to the public through the distribution and web uploading of material.

The following paragraphs describe the overall implementation of this approach towards deriving regional policy recommendations for sustainable groundwater management in Tunisia.

PROBLEM ANALYSIS

The first stage of the developed process concerned the identification of key stakeholders, with a role or interest in groundwater management, including:

- Authorities involved in the management of water resources at the national level (ministries) and at the local level (Governorates, water authorities, and municipalities);
- Representatives of important users, such as farmer associations, agricultural development groups, hotel owners' associations;
- Professionals dealing with various issues related to groundwater exploitation and management, artificial aquifer recharge and use of treated wastewater for crop irrigation.

The first workshop, open to all parties, was held on May 8th 2007, in Nabeul, 60 km from Tunis. The workshop brought together 46 participants, including 15 decision-makers, 13 technicians, 5 farmers, 12 representatives of Agricultural Development Groups (GDAs), and 1 Media representative. Its main objective was to foster discussion and exchange of opinions and views on the focal water management problem of aquifer depletion.

Photos from the 1st INECO Stakeholder Workshop, Nabeul, May 8th 2007

The discussion focused mostly on the use of groundwater in the agricultural sector; in this context, issues discussed included the introduction of new methods and equipment for water saving, wastewater treatment and reuse for crop irrigation, research and assessment of the status of water tables, and requirements for additional infrastructure development. Emphasis was also given to legislative and water policy issues and the "Valuing" and "Sharing" dimensions of the problem. Concerning water governance, it was further noted that the management of water resources in irrigated agriculture (organisational and institutional measures, technical tools) and the participatory management of water tables (through GDAs) are two important aspects which need further analysis. In this regard, issues that need to be embedded in policy implementation also comprise the development of comprehensible management rules, reinforcing the capacity and the role of GDAs.

Following from this, first event, a second workshop for "Building a common vision for managing groundwater resources in Tunisia" was held in Nabeul on December 6th 2007. Its primary aim was to further discuss the problem with the local stakeholders, through the development of a "Problem Tree", qualitatively describing the causes and effects of the problem. The event also offered the opportunity for a first exchange of views on policy objectives and potential options, which are further discussed in the following paragraph. Through a dedicated questionnaire, stakeholders were also able to express their views on the significance of the problem, its effects and primary causes.

During the workshop, stakeholders were asked to validate a preliminary "Problem Tree", drawn by CITET on the basis of the outcomes of the previous workshop. The results of this validation exercise, aimed at reaching consensus on the dimensions and underlying causes of the problem, are presented in Figure 3.

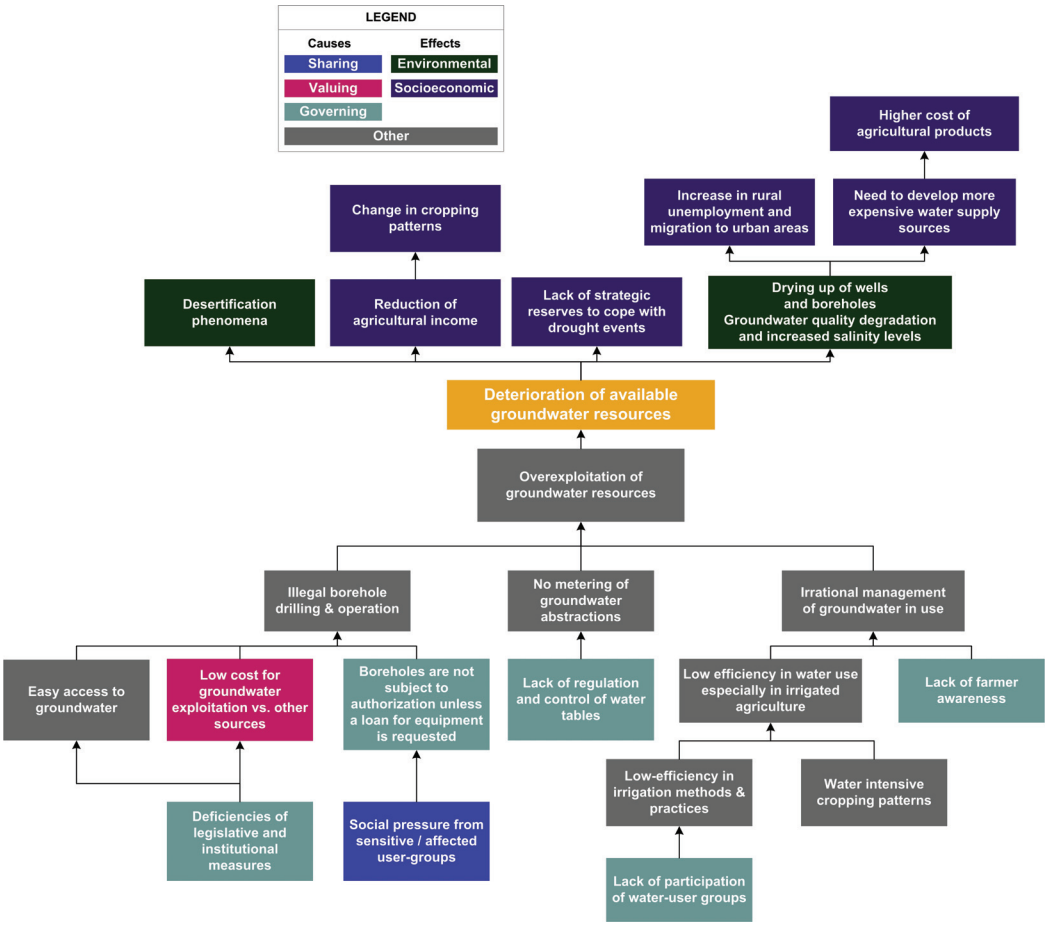

Figure 3: Problem tree analysis of the causes and effects of the deterioration of available groundwater resources in Tunisia

According to the qualitative "Problem tree" analysis, groundwater depletion is on the one hand caused by limited recharge and on the other by the overexploitation (abstractions exceeding natural replenishment) of aquifers. Overexploitation can be attributed to the operation of illegal boreholes, mostly drilled by farmers for irrigation purposes and to the lack of control over the operation of private boreholes. Abstractions are not metered, mostly due to social and political pressures by the affected user groups.

Furthermore, the low efficiency in irrigation water use, resulting from the limited application of water saving techniques, the adoption of water intensive cropping patterns and the limited technical capacity of farmers exacerbates the problem. Incentives in using alternative non-conventional resources (treated wastewater) are considered inadequate, and the application of water reuse remains limited. Main reasons include the low quality of treated effluents, adopted standards, climate, soil types, choice of crops, land-use patterns, and especially farmers' unwillingness to accept and pay for treated wastewater and public perception issues.

Photos from the INECO Tunisia Stakeholder Workshop "Building a common vision for managing groundwater resources in Tunisia", Nabeul, December 6th 2007

Aquifer recharge is still at the experimental stage, and results seem to be encouraging. However, outside the public irrigation schemes, awareness campaigns to promote water reuse and water conservation have not yet managed to adequately address the concerns of end-users, and application remains limited in spite of the governmental subsidies offered. In the long run, it is expected that aquifer overexploitation will have negative impacts on the environment, on agricultural income and on the development of rural areas. The main comments concerning the "Problem tree" that stemmed from the workshop were the following:

- The increasing water demand, coupled with the degradation of groundwater bodies both in terms of quantity and quality, constitute major challenges at all levels of decision-making and policy implementation.
- Overexploitation of groundwater is also partly due to the easy access to the resource, as abstractions are free of charge and uncontrolled.
- Wasteful water use in irrigated agriculture stems mostly from: (a) lack of technical capacity of farmers, (b) weak valorisation of water in irrigated agriculture, (c) limited demand for surface water, and (d) limited farmer awareness on improved irrigation practices.
- Institutional and legislative measures have proven inadequate to address the issue. It is therefore considered that there is need for pursuing enhanced involvement of end-users in the formulation of water management policies.
- Effective solutions to the problem could sustain an increase of cultivated areas, mitigate water shortage and loss of agricultural income, and contribute to addressing desertification problems, already experienced in some parts of the country.

In addition to the above, replies to the dedicated workshop questionnaire were also a helpful tool to reveal key objectives that need to be pursued for reversing current trends, and in identifying possible options for problem mitigation.

The most significant results of the survey were the following:

- The majority of respondents agreed that the sector where action is needed immediately is agriculture (82% of replies). Overexploitation to meet increasing tourism demand is not perceived as significant (18% of replies).
- The most significant underlying causes to groundwater degradation are: (a) the lack of joint agreement and planning for groundwater extractions, and (b) the lack of awareness on efficient water use practices. Additional causes perceived as important are the limited enforcement of legislation on abstraction limits and the inefficient mobilisation of water users and the general public towards water conservation.

- All respondents perceive that public participation is key for the successful implementation of policies. Effective methods could entail: (a) advisory committees, including experts and representatives of water users, and (b) public hearings and meetings for fostering the exchange of view on policy development and planned projects.

During the workshop, seven (7) main policy approaches and instruments were discussed. These were further ranked by the respondents of the survey, using a scale ranging from 1 (least effective) to 5 (most effective). Ranking results are presented in Figure 4, below, which underlines the pertinence of economic instruments in addressing the issue at hand.

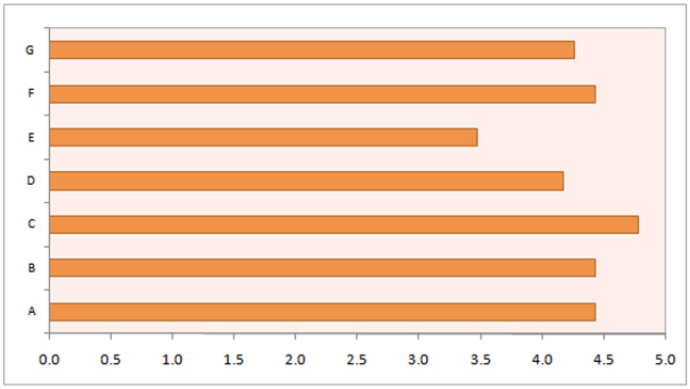

Figure 4: Ranking of instruments/approaches for achieving more sustainable management of groundwater resources

The outcomes of this "Problem Analysis" stage were subsequently used for the definition of policy objectives and the formulation of proposals on instruments that could be applied to achieve these.

DEFINING POLICY OBJECTIVES

Firstly, the results of the previous stage ("Problem Analysis") were used to draw the "Objective Tree" of Figure 5.

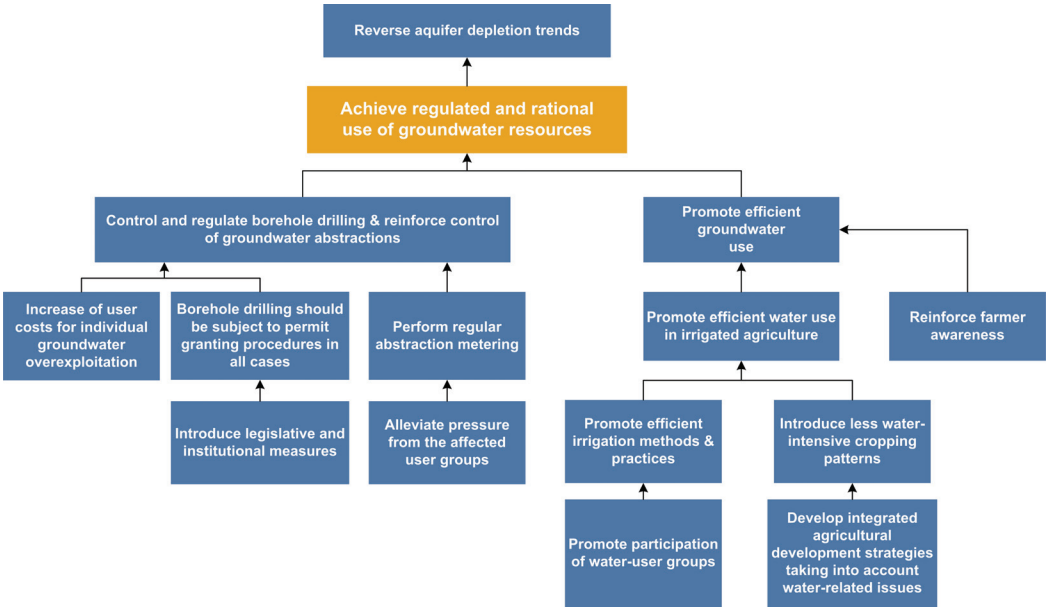

Figure 5: Objectives for addressing groundwater degradation in Tunisia

Subsequently, this "tree" was further elaborated to define a set of key policy objectives, towards the main goal of **"Achieving regulated and rational use of groundwater resources"**, incorporating the views and goals of all stakeholders.

Two main policy objectives were defined through this process: (a) the control and regulation of groundwater abstractions, including licensing and operation of new boreholes; and (b) the rationalized use of groundwater in irrigated agriculture.

Furthermore, and as all the consulted parties supported (a) the introduction of new water supply sources, such as treated wastewater, as means for substituting freshwater use for crop irrigation, (b) the participative management of water tables, suggested options were also oriented towards the promotion of reuse in irrigated agriculture and the reinforcement of end-user participation in decision-making.

IDENTIFICATION AND ANALYSIS OF OPTIONS FOR MITIGATING GROUNDWATER OVEREXPLOITATION

The work towards deriving policy recommendations focused on the suggestion of alternative (institutional and economic) options to achieve the aforementioned objectives. These suggestions, subject to evaluation, were used to formulate a roadmap for the development of strategies suitable for achieving the wider goal. To facilitate discussions with local stakeholders, and in accordance with the objectives defined above, potential policy instruments were grouped into four (4) main categories, as follows:

- Options to directly control groundwater abstractions (enhancement of command-and-control regulatory approaches);
- Options to enhance efficiency in irrigation water allocation and use, leading to reduction in the use of freshwater resources, groundwater included;
- Options for increasing the use of alternative water supply sources for crop irrigation, such as treated wastewater;
- Options to strengthen the socio-economic and institutional environment (enhance coordination and integration of policies and among institutions involved, develop community management and enhance public involvement).

The following paragraphs present in more detail the suggested options. The analysis also outlines barriers that have inhibited the (effective) implementation of potential responses, as well as associated issues that need to be considered and evaluated to achieve sustainable solutions to the problem at hand. Identified issues pertain to the three main functions: (a) water service provision (Operational function); (b) River Basin level/Aquifer management (Organizational function); (c) National water policy and law (Constitutional function).

REGULATION AND CONTROL OF GROUNDWATER ABSTRACTIONS

A list of options suggested for achieving regulation and control of groundwater abstractions is presented in Figure 6. Currently, the monitoring of groundwater abstractions, both public and private, is undertaken by the CRDAs. Authorisations for borehole drilling and the corresponding permits are provided by the CRDA if drilling depth is less than 50 m. Otherwise, the drilling permit should be issued by the Ministry of Agriculture. No limits for borehole drilling are imposed, unless there is clear evidence that the water table has been overexploited. An inventory of groundwater abstraction points has already been developed at the regional level.

However, and as mentioned above, there is clear evidence that the enforcement of the corresponding penalties and fines in case of overabstraction from existing boreholes is rather slack, mostly due to social reasons. Furthermore, easy access to groundwater leads to the drilling of illegal boreholes, which cannot be readily controlled by the relevant authorities. It therefore becomes evident that regulation and control can only be achieved indirectly by applying a mixture of:

- Economic instruments, aimed at discouraging groundwater use;
- Institutional reforms, shifting responsibilities to communities and empowering them to collectively manage their (groundwater) supply, especially outside irrigated perimeters where alternative supply is not available.

Economic instruments can entail the reform of irrigation water pricing policies with the aim to increase the costs entailed in groundwater exploitation. This can be effected either through the introduction of abstraction charges, internalising (part of) resource costs associated with overexploitation, or by increasing the corresponding financial costs, e.g. through an increase of energy prices for groundwater pumping. As these reforms could prove difficult to implement, the objective could also be pursued through surface water pricing policies, where of course surface water supply is available. In any case, the relevant charges should not be significantly lowered, so as to discourage water waste, and any reform needs to be complemented with other policies, aimed at improving efficiency in irrigation water allocation and use.

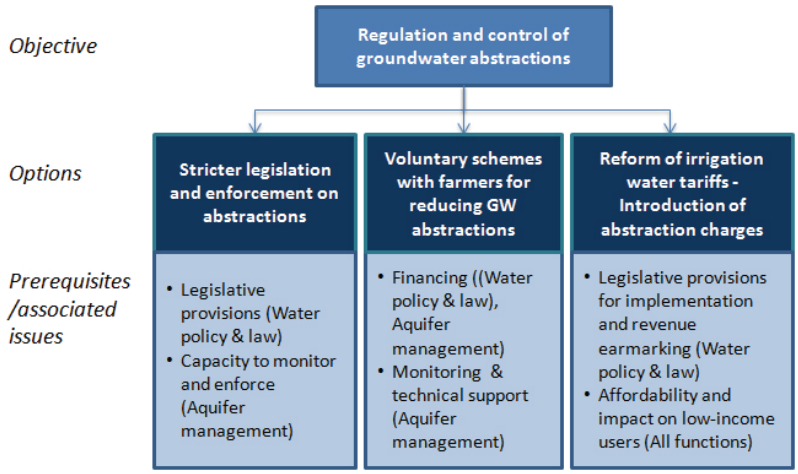

Figure 6: Suggested options – Regulation and control of groundwater abstractions

Voluntary schemes with farmers to reduce groundwater abstractions in areas facing overexploitation problems can also be a promising option. These can involve compensation payments for the loss of agricultural income, and could also be applied as a contingency measure in drought, when there is increasing need for conserving strategic water reserves.

IMPROVEMENT OF EFFICIENCY IN IRRIGATION WATER USE

The Government of Tunisia, within the framework of an overall strategy for promoting water saving, is taking specific measures to enhance efficiency in irrigation water allocation and use, in the form of financial assistance to those who apply improved irrigation methods. Currently, modern irrigation techniques are applied in 70% of public irrigation schemes, and there is a significant effort for reinforcing awareness and training through appropriate campaigns and initiatives. As prices of cereals experienced a continuous increase, there could be

shift to less water-intensive crops (e.g. rainfed wheat), if this would be combined with subsidies and tax incentives.

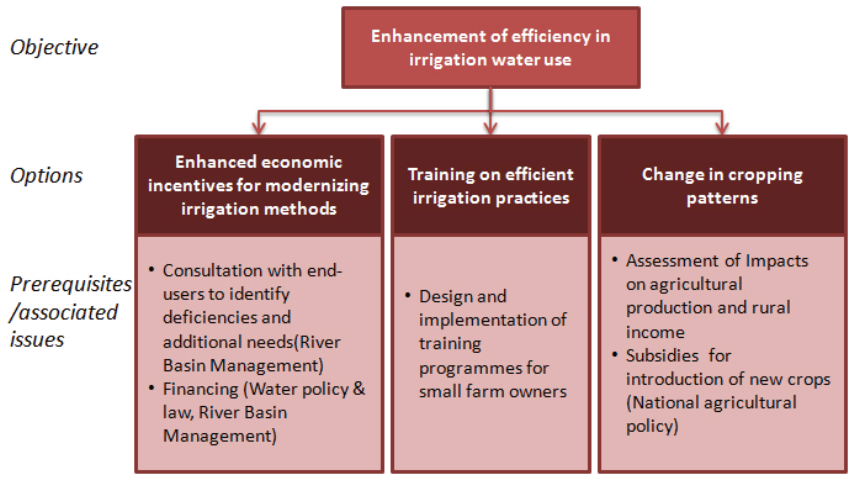

Figure 7: Suggested options – Fostering efficiency improvements in irrigation water use

The results of already undertaken policy measures (encouragement towards water saving and change of cropping patterns, rationalization of water tariffs, efficiency improvements in hydraulic infrastructure) are expected to become evident after 2010, through a decrease in irrigation water consumption. Furthermore, a change in the allocation of available supplies is to be expected, according to economic and social considerations.

ENHANCEMENT OF THE USE OF TREATED WASTEWATER FOR CROP IRRIGATION

Wastewater reuse is considered extremely important in the effort to meet the increasing demand in agriculture, industry and tourism, as projected water needs cannot be satisfied by freshwater resources alone. Estimates based on current urban growth patterns and change in land-use project that a total volume of 480 hm^3 of treated wastewater will become available in 2030. This volume represents 10% of the total mobilized resources and can allow the irrigation of 100,000 ha. However, reuse can only be possible and beneficial if:

- Specific standards are set for effluent quality, depending on the type of crop irrigated.
- Funds are provided for: (a) the development of conveyance networks from wastewater treatment plants, located near urban centres, to irrigation perimeters, (b) separate distribution networks at the perimeter level, and (c) facilities for interseasonal storage. The significant capital investment for infrastructure development cannot be recovered from the users, as this would render the use of other, cheaper, water supply sources (namely groundwater) preferable.
- Training of farmers and extensive awareness campaigning to improve acceptability of treated wastewater use by farmers and the general public.

Currently, the artificial recharge of overexploited water tables with treated wastewater has not been extensively developed. Experiments and assessments prove that if this measure is to be practiced, the quality of treated wastewater should be improved through tertiary treatment, to eliminate all risks of contamination and further quality deterioration of available groundwater supplies.

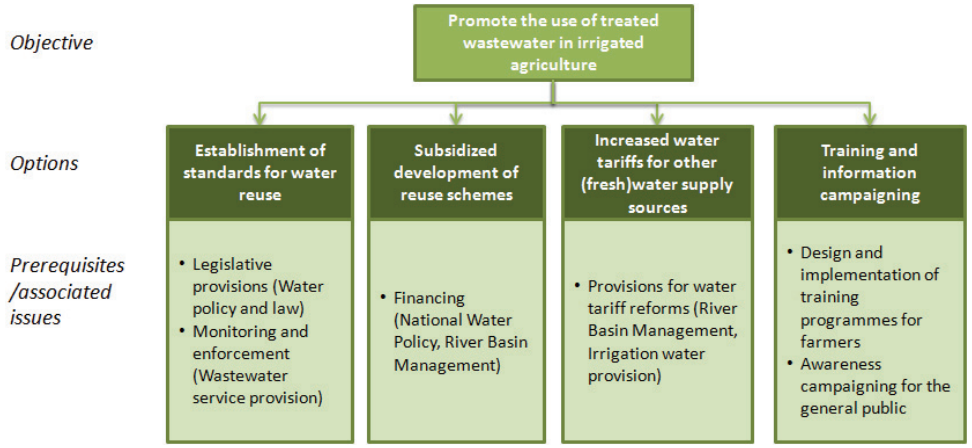

Figure 8: Suggested options – Promoting the use of treated wastewater in agriculture

STRENGTHENING THE OVERALL SOCIO-ECONOMIC AND INSTITUTIONAL ENVIRONMENT

The encouragement of community-based groundwater management is an option that is seriously considered both at the regional and national level. Efforts are being undertaken to promote the sharing of responsibilities and the participation of all users through the Agricultural Development Groups.

The real involvement of users in the decision-making process and in the day-to-day management, rehabilitation and maintenance of hydraulic infrastructures requires a long and resource-intensive process for building human and technical capacity. In this regard, there is need for:

- Enhancing awareness and education;
- Providing further encouragement for the establishment of Agricultural Development Groups through the appropriate legislative reforms.
- Foreseeing the development of mechanisms for wider coordination and cooperation among the institutions involved.

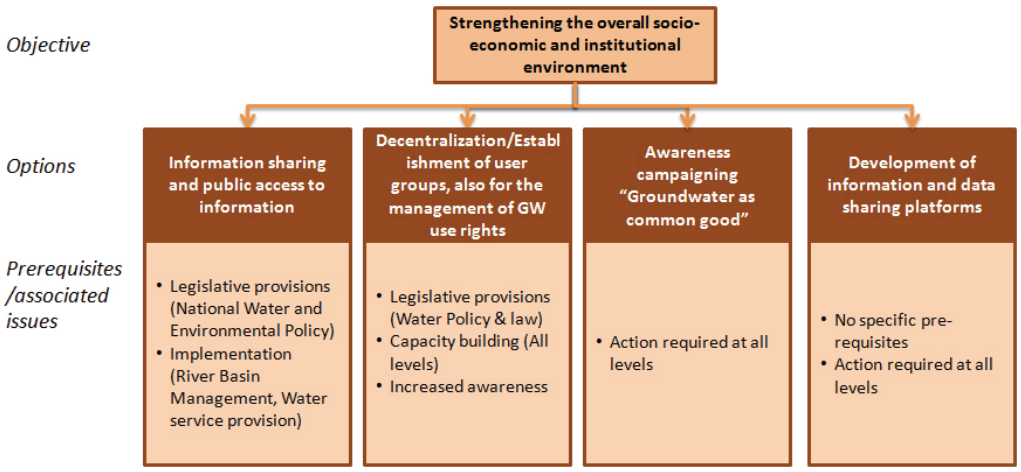

Figure 9: Suggested options – Strengthening the overall socio-economic and institutional environment

OPTION EVALUATION

PRIORITIZATION OF SUGGESTED INSTRUMENTS

The first step towards the evaluation of suggested responses was their prioritization by local stakeholders, on the basis of a set of predefined criteria, common to all the INECO Case Studies. The step was implemented from February to June 2008, and involved the distribution and completion of a survey for ranking ten (10) broad categories of instruments. The survey was aimed at evaluating the feasibility and applicability of suggested responses, taking into account the local and the national water management context, current conditions and priorities, and future challenges facing the water sector.

For facilitating the process, CITET organized 2 meetings in the Agricultural Department (CRDA) of Nabeul to explain the objectives of the questionnaire, made available in local language. In total, 64 stakeholders (technicians, farmers, hotel owners, agriculture development groups and citizens) participated in the two events and responded to the questionnaire. The outcomes concerning the screening of approaches are summarized in the spider chart of Figure 10.

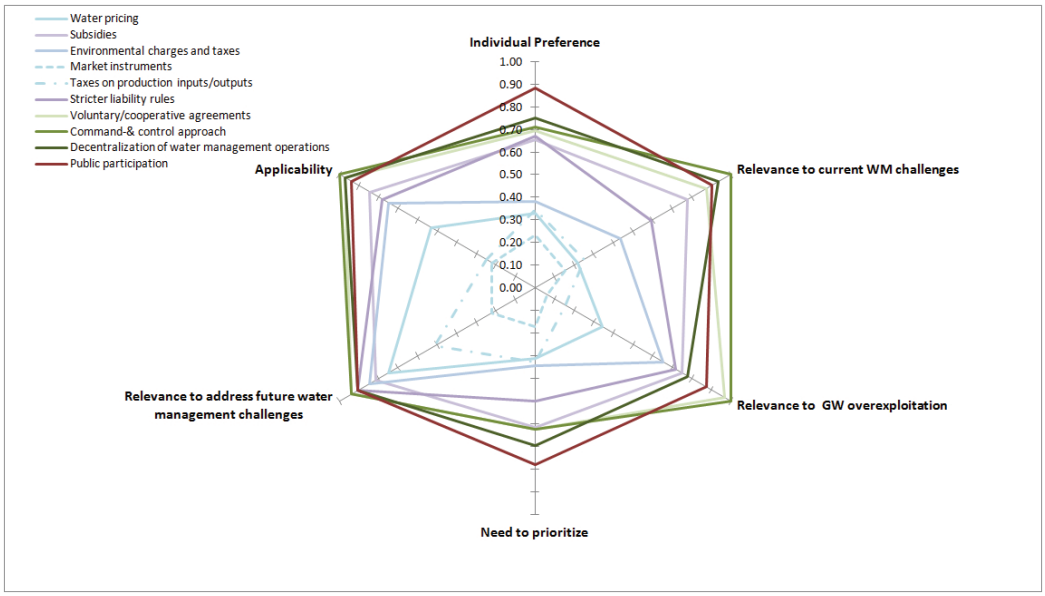

Figure 10: Prioritization of instruments for addressing current and future water management challenges

A key outcome was that answers from different stakeholder groups converged with regard to the solutions of the problem under discussion. Instruments and approaches that seemed to be most relevant and applicable comprise public participation in combination with decentralization of irrigation management and enhancement of regulatory approaches (stricter liability rules and command-and-control policy approaches). Voluntary schemes are also considered pertinent and applicable, given the current institutional framework. Stakeholders expect that their combination with stricter enforcement of the pertinent legislation could provide the basis for effective policies to address both current and future water management challenges.

Water pricing, as well as measures that would impose additional economic burden on water users are not favoured when compared to other soft approaches; it can be thus be argued that socio-economic considerations and broader agricultural policy goals are reflected both

in the perceptions of the different water user groups, and of secondary stakeholders dealing with everyday water management issues.

FURTHER CONSIDERATIONS TOWARDS OPTION IMPLEMENTATION

The overall process of evaluating potential policies for mitigating groundwater overexploitation was complemented through a last step, aimed at: (a) mapping perceptions and sharing views on prerequisites and (b) elaborating on further considerations for the implementation of proposed approaches. This step ran from November 2008 up to mid January 2009. Overall 70 stakeholders from different bodies and organizations (public, NGOs, Universities specializing in water-related issues, research centres, CRDAs, the ONAS, the INGREF, etc.) were contacted. Thirty-six (36) persons responded by completing the survey, representing all major secondary stakeholders and affected user groups. The outcomes of the survey were further discussed with the CRDA of the Nabeul Governorate and representatives of ONAS on 21/01/2009.

The main results are summarised in the following paragraphs and pertain to the analysis of issues relating to: (a) water conservation in irrigated agriculture, (b) ways of incentivizing water saving and changing demand patterns, (c) means for regulating groundwater abstractions, (d) cost recovery and cost sharing, and (e) ways of enabling public participation and involvement in decision-making.

Water conservation in irrigated agriculture

The overexploitation of groundwater is interlinked with its use for crop irrigation, especially in areas where no alternative supply is available. As such, ways of promoting water conservation in the agricultural sector are of primary importance. The main issues of concern that were examined in the last evaluation step were related to:

- Increase of efficiency in water use;
- Adaptation of crop choices to water availability;
- Promotion of a more efficient way of sharing water among the different water users; and
- Guaranteeing that all adopted responses will remain socially equitable in order not to damage subsistence agriculture.

Responses received are summarized in Figure 11.

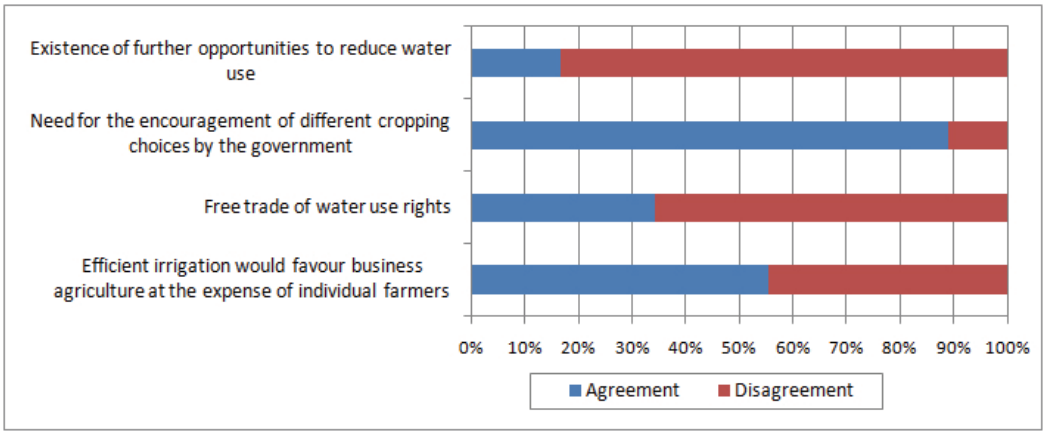

Figure 11: Stakeholder views on ways to conserve water in irrigated agriculture

Surprisingly, the consulted stakeholders believe that margins to reduce water use in irrigated agriculture are limited; however, almost 90% of respondents underline that different cropping choices need to be encouraged. Along the same line, 63% of stakeholders perceive that water use rights should not be traded among farmers, commonly sharing the perception that this could eventually favour business agriculture at the expense of subsistence farming. In this regard, it becomes evident that stakeholders emphasize on the role of the State in the development of water and agricultural policies, outlining the need for integrating approaches for sustaining the agricultural sector, while at the same time preventing further degradation of water resources.

Incentives for water saving

Although it seems to be generally believed that margins to reduce water use in agriculture are limited, particularly with regard to crop choices, further investigation was undertaken as to ways of providing additional incentives for the adoption of improved water use practices. These could entail: (a) the enhanced application of volumetric charges, (b) the development of financing mechanisms to provide aid to those who decide to invest in new technologies and (c) the introduction of mandatory technology standards for new irrigation projects, if these are to be developed in the near future.

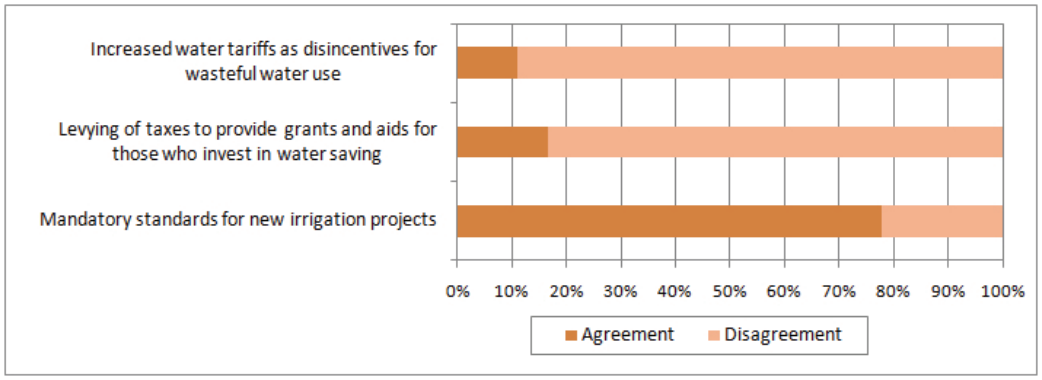

Figure 12: Stakeholder views on mechanisms to provide incentives for water saving

As evident from the results of Figure 12, the increase of water tariffs and the levying of taxes, as means to raise revenue for supporting technology shifts, receive limited acceptance from the majority of stakeholders; it is thus obvious that there is much concern over the affordability of water-related charges, as well as strong belief that all efficiency improvements should be financed through other sources of funding (e.g. general budget).

Phasing out of low-value water use in stressed areas

In view of the increasing water stress experienced in some areas, the lack of alternative supply, and the growing competition over water resources and land use, specific uses might have to be phased out or relocated to other regions, where the stress on the resource side is still limited.

In this context, water stress mitigation at local level could be effected by offering the appropriate incentives to water users. This could entail compensation for abandoning low-value uses and shifting to other occupations, or raising water charges so that low value uses would not be economically viable.

The responses of stakeholders to these two alternatives are presented in Figure 13. Half of respondents indicate that the offer of compensation would be a suitable incentive. On the other hand, responses with regard to the setting of water charges portray significant opposition against free market operations. In general, it is believed that efficient water allocation policies to support a shift towards economic efficiency would require a strong social component, so that the interests and resources already invested in water uses that can no longer be easily sustained would not be compromised.

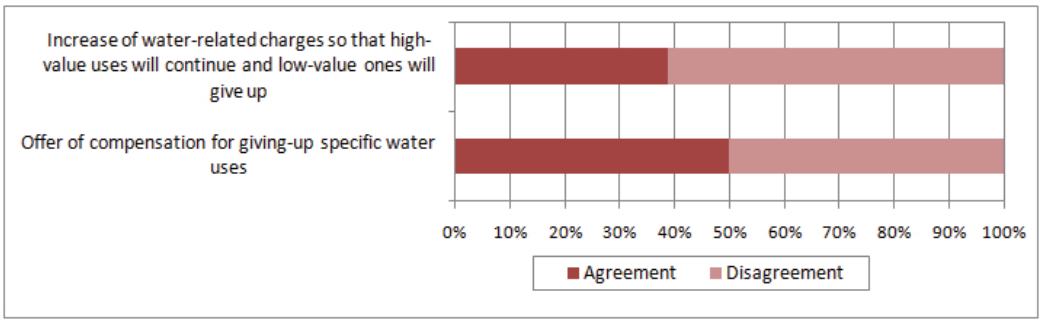

Figure 13: Stakeholder views on potential scenarios for limiting water use in case of water stress exacerbation

Regulation of groundwater abstractions

The effective implementation of command-and-control regulatory approaches for individual groundwater abstractions is being advocated as a priority solution for addressing groundwater overexploitation. Views concerning the stricter enforcement of regulations were analysed, particularly with regard to the:

- Feasibility, applicability and effectiveness of controls over water abstractions, especially in the case of private boreholes and wells;
- Empowerment and political willingness of the State to strictly enforce the pertinent legislation;
- Compensation for environmental damage through the setting of relevant environmental taxes and charges, and ways through which charges could be defined;
- Development of collective schemes for irrigation water supply, so as to prevent individual abstraction, and ways through which the costs for the development of such systems should be recovered.

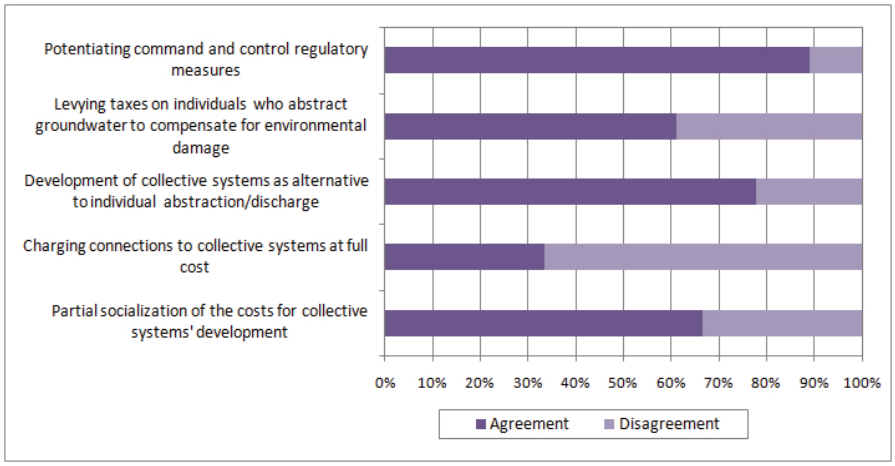

Figure 14: Stakeholder views on approaches to regulating groundwater abstractions

Almost 90% of interviewed stakeholders underline the pertinence of potentiating command-and-control regulatory measures. A similarly significant percentage (72%) believes that the State can successfully enforce the pertinent legislation in an effective and efficient way. Stakeholders are also rather favourable towards the introduction of taxes, addressed to those who incur environmental damage. However, the alternative of developing collective water supply schemes is much more broadly supported. More than half of respondents (67%) perceive that the corresponding costs must be partially socialized in order to maintain acceptability and affordability, considering that additional incentives should be offered to users, so as to replace individual with collective supply.

Cost recovery and cost sharing issues

Development or expansion of existing infrastructure in irrigated agriculture is not considered of primary importance. However, improvement in the recovery of financial costs, as well as the offer of further incentives through water tariffs are considered important both in terms of groundwater conservation and technical sustainability in water service provision.

In this regard, different questions were set forth to user groups and decision-makers in order to map opinions on:

- Ways of allocating costs among different consumer categories (households, industry, tourist sector and agriculture);
- Transparency, fairness and equity of the current tariff system, and ways through which these can be improved;
- Water pricing as a means to achieve recovery of costs for water service provision and the financing of the water system;
- Willingness-to-pay for: (a) improved water services (b) sustaining current water service levels under increasing water stress;
- Potential differentiation of water tariffs according to the type of use, with the aim to generate cross-subsidies among different water user categories.

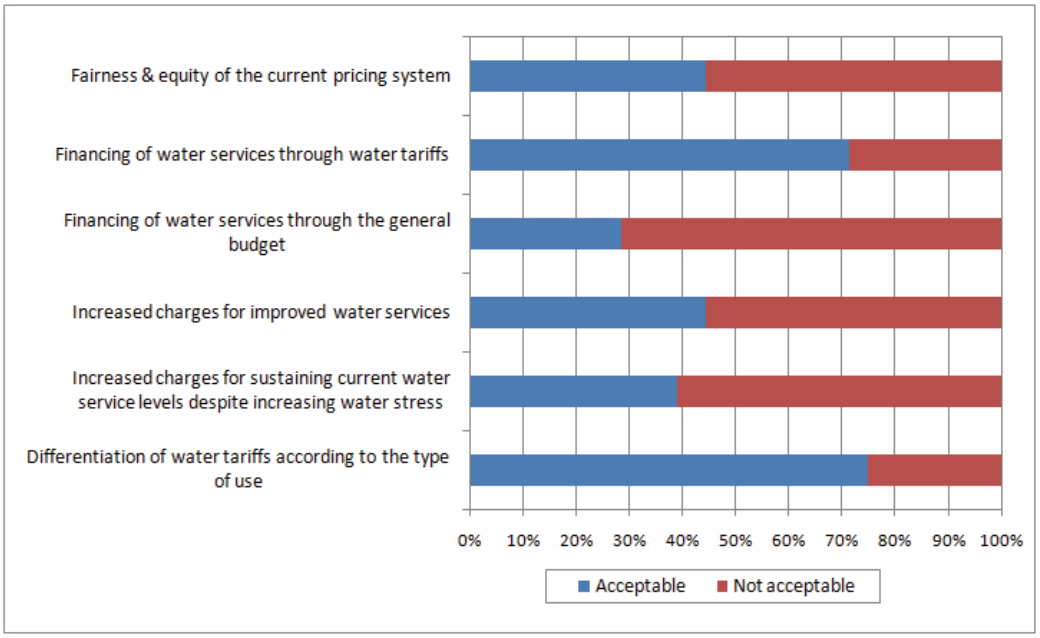

Figure 15: Stakeholder views on cost recovery and cost sharing issues

With regard to cost allocation issues, the majority of stakeholders considered that allocation based on quantities used by the different users would be the equitable way of allocating costs. However, a small share of respondents perceives that water services should be state-supported. Nonetheless, cross-subsidies among different uses are well accepted. It is generally believed that some uses (e.g. tourism or industry) should be charged more than others, taking into account their increased ability to pay. 56% of respondents would not be willing to pay for an improved service; similarly, a raise of water charges to maintain current levels of water services despite water stress is not acceptable by 61% of participating stakeholders.

Concerning the transparency of water-related charges, the majority indicates that the water bill paid is not fair and/or appropriate. Respondents who support this view suggest that water tariffs should incorporate costs relating to water production and development of new projects and infrastructure, that there is need for more explanations and transparency in the calculation of the different components, and that charges should be linked to the volume of water used in an understandable way.

Framework for water management and water service provision

The main directions and goals of national water policy emphasize on the need for demand management and introduction of alternative water supply sources, focusing primarily on irrigated agriculture. A more professional water management, able to foster the implementation of advanced technologies, is supported as means for enhancing the effectiveness of river basin management operations and providing technical support to large consumers and polluters for water saving. The relevant issues considered in the last evaluation step concerned the:

- Evaluation of the existing water service undertakings, in relation to meeting current demands and securing environmental protection;
- Margins for improving effectiveness and efficiency, without considering complex organizational transformations;
- Potential contribution of the private sector, and acceptability of its involvement in the provision of water services.

As portrayed in Figure 16, the current water management framework is evaluated positively by the majority of respondents.

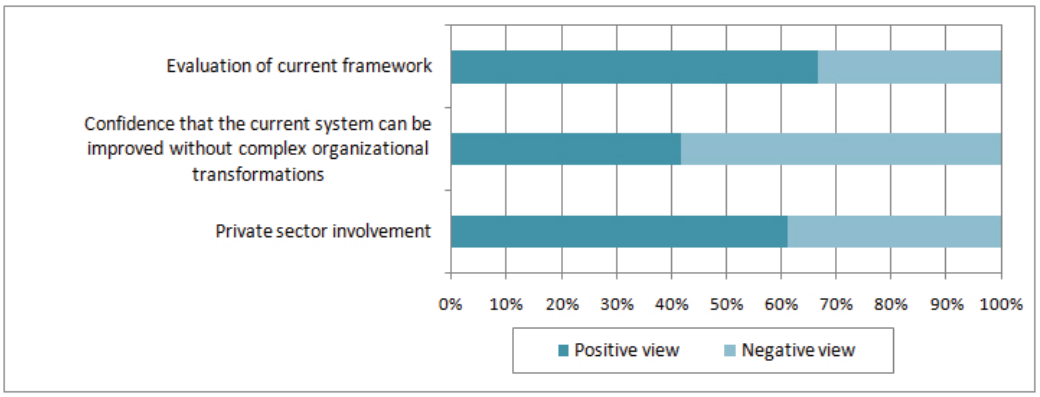

Figure 16: Stakeholder views concerning the framework for water management and provision of water services

Views are diversified on whether there is adequate room for improving the current water service levels, within the context of the current institutional framework, as 58% of respon-

dents argue that this would require broad changes in the way that water services are organized and managed.

The involvement of the private sector is rather well received; given current efforts and initiatives for the re-organization of the two main public water service providers, there is good evidence that the enhanced contribution of the private sector would facilitate capacity building, technology transfer and enhancement of the efficiency of water management operations.

Public involvement and participation

Enhanced involvement of stakeholders and water users, especially farmers, in decision-making is identified as a key priority in the effort for the protection of groundwater bodies and enhancing the efficiency of agricultural practices. Stakeholder perceptions on how user involvement and public participation should be pursued are diverse, based on the common view that current efforts need to be strengthened. Approaches range from enhancing the involvement of the general public and water users, to the strengthening of the role of NGOs for pursuing inclusive processes, and to awareness campaigning and reinforcement of civic responsibility.

Despite the practically unanimous acceptance of the need for public participation, stakeholders do not trust that the outcomes of participatory efforts would be considered by decision-makers and incorporated in water planning (Figure 16). An additional question related to the impartiality of water management decisions leads to the conclusion that 88% of respondents perceives that some stakeholder or user groups are generally given more weight than others in the decision-making process.

Finally, it is considered that any public participation effort should be primarily based on the disclosure of information on significant water management issues; only 14% of respondents, who were in fact decision makers, have sufficient access to relevant data and information.

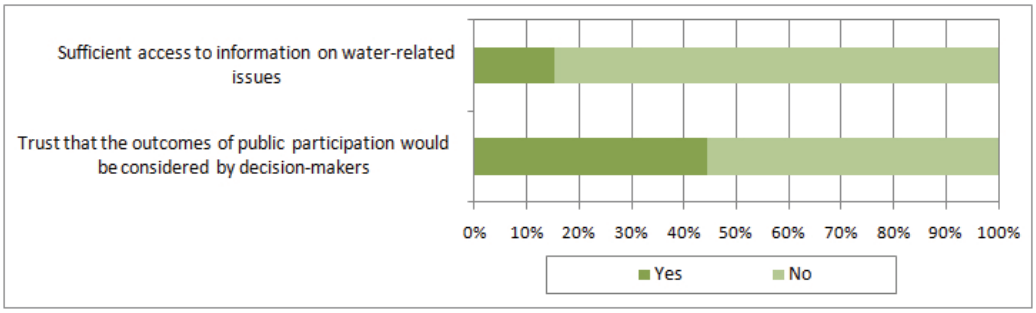

Figure 17: Stakeholder views on major inhibiting factors to public participation

CONCLUDING REMARKS

In response to the observed trends in aquifer depletion, the Tunisian government has initiated efforts towards the mobilisation and safeguarding of water resources; however, population growth, urbanisation, and the expansion of agriculture activities have led to uncontrolled situations. The approach adopted by the INECO project for discussing on the water stress problem, and the steps followed in the elaboration of cause-effect relations and analysis of objectives, have contributed to an in-depth analysis of the issues at hand.

Results from stakeholder consultation and workshops support a set of main options identified by the project, including approaches for regulation and control of groundwater abstrac-

tions, promotion of water reuse, efficiency improvements in irrigation water use and also the strengthening of the overall socio-economic and institutional environment. Answers indicate strong support for measures related to water saving, and particularly towards improving efficiency in irrigation, including the encouragement of different cropping choices by the government, the provision of assistance to large water consumers for water saving, and the adoption of water saving standards for new irrigation areas. Emphasis is also placed on the pricing of water services, supporting the mandatory connection of water users to collective systems that prevent individual abstractions, while charging these connections at partially socialized cost in order to maintain affordability and acceptability. Furthermore, there is some implied support to the generation of cross-subsidies among different water users. The involvement of the private sector in water management and water service provision is viewed favourably and is considered a potential means to enhance the quality of provided water services.

Concerning public involvement and participation, responses indicate that public participation is currently insufficient but very much desired. It is also clearly evident that access to information is considered insufficient by the majority of stakeholders questioned, and that the accessibility and relevance of available information need to be improved. However, there is also strong preference towards the enhancement of command and control regulatory measures, the modernisation of management systems and enhancement of the organisational level.

The participatory process adopted through targeted surveys and stakeholder workshops enabled the open exchange of ideas and solutions among persons who encounter water stress and groundwater management problems on a day-to-day basis; it also offered alternative perspectives of the problem, based on the elaboration of real solutions and options that can be useful, applicable and acceptable for determining suitable strategies for the mitigation of the problems faced. Overall, it is envisaged that the derived recommendations will be able to contribute to the mitigation of the deterioration of groundwater resources, particularly in the Cap-Bon region, provided that authorities commit to the implementation of the necessary changes. Furthermore, public participation and community management of resources need to be encouraged through capacity building initiatives and reforms towards the empowerment of water user associations.