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

Towards the development of a strategy for water pollution prevention and control in the Barada River Basin, Greater Damascus area

March 2009
Prepared by Studies and Integration Consulting

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SIXTH FRAMEWORK PROGRAMME

PREFACE

In rapidly developing countries, urbanization, industrial growth and the change of economic development patterns is often significantly impacting on the water environment, threatening local ecosystems and compromising sustainability in current and future water use. Efforts to address the issue mostly concentrate on building the infrastructure required for addressing demand growth and increasing pollution loads. However, soft-path approaches based on an appropriate combination of regulatory and economic instruments are also important, as they can more easily enable the adoption of environmentally friendly practices, by encouraging users towards water saving and pollution prevention. Furthermore, the need for developing the required capacity for the integration of interrelated aspects of sectoral policies and the improvement of the coordination of water management operations among different authorities is gradually leading to the reform of the water sector. Such reforms usually include the establishment of dedicated institutes for training and education on environmental issues and of different bodies and departments, solely aimed at developing and implementing policy decisions in an integrated and holistic way.

This volume of the INECO publishable reports outlines the analysis of the institutional framework and decision-making practices for water management in Syria. It highlights the main water management challenges faced in the country today, and focuses on one water management issue that is currently perceived as extremely significant by water management authorities and citizens: the environmental degradation of the Barada River. Historically, the Barada River has been considered a vital socio-economic resource, sustaining the Ghouta oasis and agricultural activities in the area. The hyper-urbanisation of the greater Damascus area, coupled with the uncontrolled discharge of industrial effluents, has led to the significant degradation of the river and its tributaries, posing a significant threat for all local ecosystems, as well as surface and groundwater bodies.

Responding to this challenge, the INECO project implemented a participatory approach for achieving consensus on water management options for water pollution prevention and control. Emphasis is placed on soft responses, incorporating the application of economic and regulatory instruments to provide appropriate incentives for the development of industrial wastewater treatment facilities, regulating the use of agrochemicals in rural areas, and on issues related to the financial and technical sustainability of water services.

This volume was prepared by Studies and Integration Consulting, and was based on information that was made available through various departments and officers and experts of the Ministry of Irrigation of Syria. Special thanks are extended to Dr. Souliman Ramah, Deputy Minister of Irrigation and Dr. Jamil Fallouh, Water Resources Manager in the Greater Damascus Area, not only for their willingness to provide data and relevant information, but also for their continuous support to the work undertaken. The authors would also like to thank all water management authorities who have provided expertise and support to this effort, and stakeholders who very willingly participated in the workshops, meetings and events organized by the INECO project.

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PART I: WATER MANAGEMENT IN SYRIA: SETTING THE SCENE

GENERAL CONTEXT – COUNTRY OVERVIEW

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

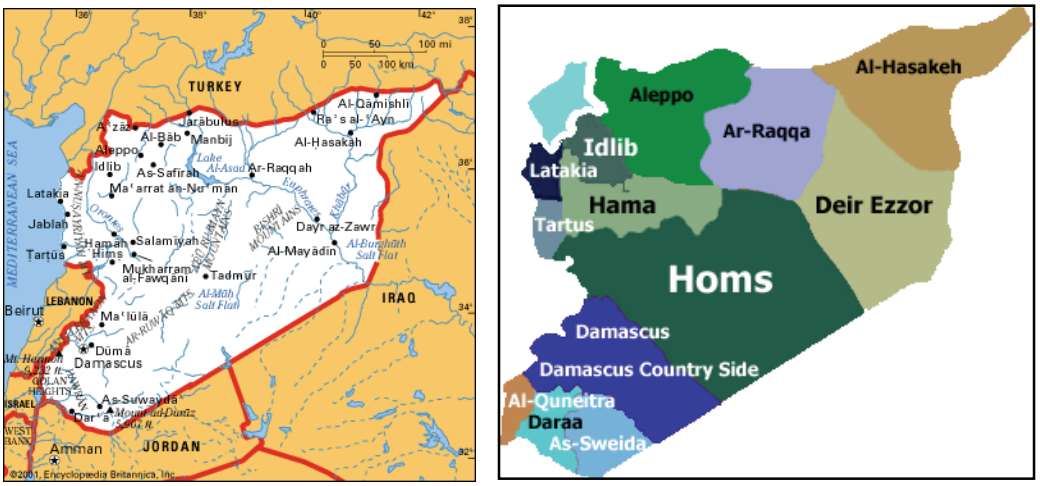

Figure 1: Overview map and governorates of Syria

In terms of morphology, the country can be divided into four regions:

- The coastal region, located 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 19.4 million (2007), 48% of which resides in rural areas. Actual population growth is 2.4%. In 2005, agriculture employed around 17.1% of the total labour force, accounting for nearly 22% of GDP and 60% of the non-oil exports.

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. It further 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 an unbalanced spatial distribution of water resources that does not correspond to the distribution

of population. This exposes available water resources to significant quantitative and qualitative pressures, with water demand exceeding available water resources in some areas.

WATER RESOURCES

Surface water

The country has a relatively dense hydrographical network, when taking into account that approximately 2/3 of its area is dry. It comprises several permanent and temporary rivers and streams that flow for only a few days per year, mostly 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:

- **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.).
- **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 watersheds (e.g. Snoubar, Haweez and Al Hosn).
- **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 of the Tigris, is estimated at 11,515 billion m^3. Surface water resources correspond to 60% of the country's overall water resources, excluding the Tigris share (or 67% if including the Tigris). However, river flow has currently been reduced to the extent that several rivers have become seasonally dry (e.g. the Barada, Khabour, Aawag and most coastal ones). Furthermore, several river beds have been converted to drainage canals of liquid and solid waste. Such is the case of Tartous, where there are 350 waste drainage canals that run into streams, valleys and rivers. Part of this waste flows to the river mouth and is discharged to the sea.

Table 1: Major rivers entering, bordering and leaving Syria

River	Inflow into Syria (km^3/yr)			Outflow from Syria (km^3/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		**37.73**	**27.11**		**31.975**	**9.2**

Groundwater

Several assessments have confirmed the presence of groundwater in most rocky masses of the Syrian territory. These surveys have also revealed that the quantity, quality and depth of these waters depend on geology, i.e. the nature of rocks, their physical quality, their geo-

graphical distribution and location. The aquifers of the country can be categorized into three major groups:

- **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 particularly spread in the coastal areas and the valleys of Aleppo, Hama, Homs, and Upper Jazeera and at the Palmyrian Mountain Range, and lie at relatively large depths of 200 to 250 m on average.
- **Detritus rocks**, which form porous mediums, and contain water of good quality in general. Their water production is lower than that of 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), and intermountain basins and valleys (e.g. Jairoud and Al-Dow).
- **Igneous rocks** which are 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. salinity levels between 150 and 300 mg/l. Water flow in the corresponding wells ranges between 5-15 l/s, varying according to the degree of cleavage and aquifer depth (20-300 m).

In all areas, aquifers have been significantly 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 Damascus valley, such as the Kallaya and the Ras Al-Ein springs) or their flow has been significantly reduced (e.g. the Mzeireeb spring in the Al-Yarmouk basin).

Non-conventional water resources

The total agricultural and industrial discharge has been estimated by the Ministry of Irrigation at 3,526 billion m³ for the period 2003-2004. This volume 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 soil, surface and groundwater resources. 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 2). Furthermore, on an average year, rainfall volumes are sufficient for the cultivation of 3 million ha of rainfed crops (3.3 million ha of non-irrigated land were cultivated in 2003), and for improving the condition of natural pastures.

The water resources of Syria can be distinguished into seven basins: 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 3.

The presented data demonstrate 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 ac-

counts 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 the water available, not including Syria's share of the Tigris river water.

Table 2: Renewable water resources in Syria (billion m³)

	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 2003. Agreement with Turkey is pending.	1250

On average, renewable water resources per capita are equal to 1,000 m³/cap/yr. This rate is continuously 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 1,000 m³/cap/yr to 747 m³/cap/yr, and to 577 m³/cap/yr in dry periods.

WATER EXPLOITATION AND USE

Available water resources in Syria are used for urban and industrial water supply, hydroelectricity production and crop irrigation. Available estimates, presented in Table 3, show that in 2003 the total volume of water used exceeded 16 billion m³.

More than 90% (92.88% according to the Ministry of Agriculture and Agrarian Reform) of available resources is used for the irrigation of approximately 1,350 thousand ha, spread 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). These areas are irrigated through boreholes, surface water, irrigation schemes developed by the Government, and with river and spring waters.

Estimates concerning water availability and use are very hard to obtain due to the lack of reliable data. Groundwater recharge is about 4.2 km³/yr, of which 2 km³ is discharged into rivers. The 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 shared with Jordan may also 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 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.

Table 3: Water balance for an average year in the River Basins of Syria

	Unit	Khabour & Tigris	Euphrates & Aleppo	Orontes	Coastal Basin	Barada & Aawaj	Yarmouk	Badia basin	Total
Basin area in Syria	km^2	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 m^3	788	7105	1110	1557	12	180	163	**10,915**
Ground water	million m^3	1600	771	1607	778	838	267	183	**6044**
Total surface and ground water	million m^3	2388	7876	2717	2335	850	447	346	**16,959**
Degree of organization	million m^3	95	95	85	65	90	85	60	**575**
Available water re-sources	million m^3	2269	7482	2310	1518	765	380	208	**14,932**
Recycling of treated drainage water	million m^2	95	306	325	0	260	72	35	**1120**
Reclaimed agricultural drainage	million m^3	430	575	210	57	89	32	0	**1.402**
Total water resources	million m^3	2794	8363	2872	1575	1123	484	243	**17,454**
Demand on irrigation water	million m^3	4300	5755	2093	566	983	400	68	**14,165**
Demand on drinking water	million m^3	38	322	240	124	270	89	44	**1127**
Demand on water for industry	million m^2	89	86	229	85	76	7	2	**574**
Evaporation	million m^3	132	1.614	148	16	6	31	15	**1962**
Total Demand	million m^3	4559	7777	2710	791	1335	527	129	**17,828**
Water Balance	**million m^3**	**- 1765**	**586**	**162**	**784**	**-212**	**-43**	**114**	**-374**

Overall water balance

Table 3 of page 11 illustrates the average annual water balance of Syrian river basins estimation for 2003, as calculated by the Ministry of Irrigation. The calculation takes into consideration the renewable surface and groundwater resources, as well as non-traditional resources, and water used by the different sectors. It should be noted that renewable water resources and the Syrian portion of shared water are two elements of the balance that need to be recalculated.

GOVERNING WATER – THE INSTITUTIONAL SETTING

INSTITUTIONS & RESPONSIBILITIES

The water sector in Syria is administered by different Ministries and institutions, with a slight overlap in responsibility. These ministries are all represented in the Higher Water Committee, presided by the Deputy Prime Minister for Service Affairs.

There are five ministries (Ministry of Housing & Construction, Ministry of Health, Ministry of Irrigation, Ministry of Local Administration & Environment and Ministry of Agriculture and Agrarian Reform) involved in the monitoring of the quality of ground and surface waters, through their own specialized laboratories and according to their mandates and responsibilities (Table 4).

Table 4: Responsibilities of different Ministries for water quality monitoring

Ministry	Responsibility	Types of analysis	Periodicity of control
Housing and construction (MoHC)	Drinking water analyses	Chemical-bacterial parameters, heavy metals, hydrocarbon components	Regular (for chemical and bacterial analysis)
Health (MoH)	Drinking water analyses	Chemical and bacterial parameters	In cases of epidemics
Irrigation (MoI)	Drinking water, river and well water analyses	Chemical-bacterial parameters and heavy metals	On demand and regularly for some rivers
Local administration and environment (MoLE)	Drinking water analyses	Chemical and bacterial parameters, hydrocarbon components	In case of emergency
Agriculture and Agrarian Reform (MoAA)	Soil analyses	Heavy metals	According to research requirements

Additionally, the Directorates for Water Pollution Abatement in river basins, which are under the authority of the Ministry of Irrigation, undertake periodic analyses for monitoring surface and groundwater quality throughout the country for the identification of potential pollution sources of rivers, canals and the surrounding environment. The overall process includes obtaining water samples from rivers and monitored wells in each basin, and the undertaking of physical, chemical, bacterial and biological analyses, including analyses on heavy metals and toxic elements. Results are documented by the Directorate, and copies are sent to all parties involved, which also include explanations on results, the identification of pollution sources and suggestions for their elimination.

Concerning other water management issues and responsibilities, the following are noted:

- 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 issuing 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 modern techniques for water conservation, and the cultivation of less water-intensive crops.
- 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** is responsible for monitoring and controlling water quality, and for developing national standards for the protection of water resources.

Table 5 in page 14 outlines responsibilities in water management, through the illustration of the water resources planning matrix.

Figure 2 presents the organizational chart of the Ministry of Irrigation. The Ministry 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 assessments and surveys, elaboration of water-related legislation and the development of proposals concerning transboundary waters.

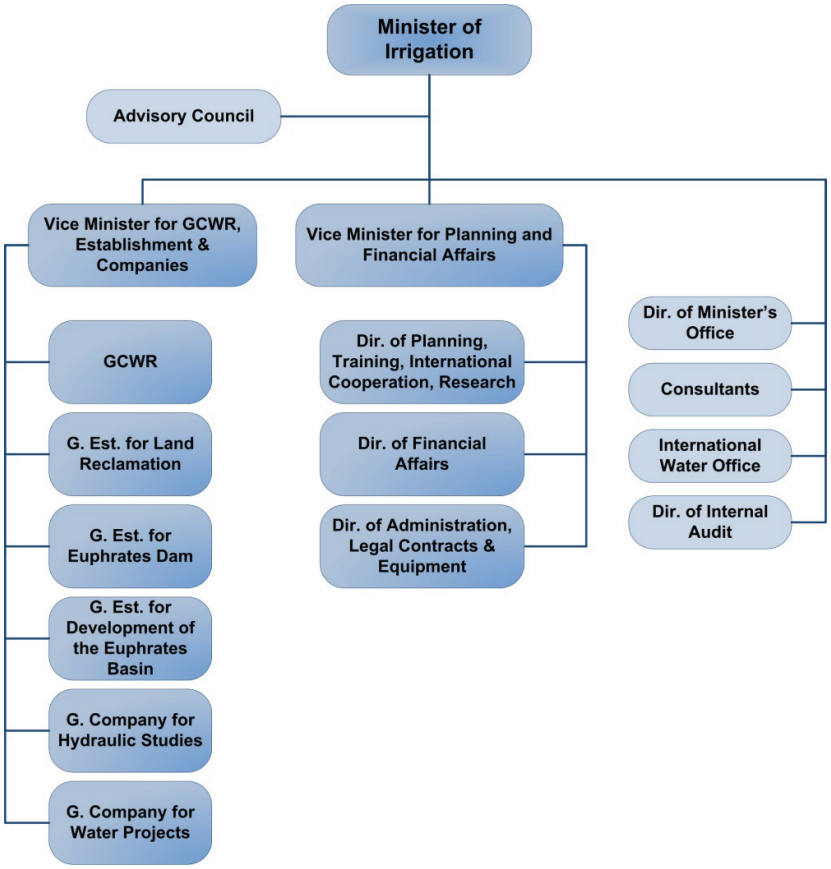

Figure 2: Organisational structure of the Ministry of Irrigation

Table 5: Water resources planning matrix

ACTIVITY	MoI	MoHC	MoH	MoLE	MoAA
Surface waters					
Use	×	×			
Storage	×				
Groundwater recharge	×				
Diversion	×				
Quality monitoring	×	×	×	×	×
Assessment	×	×			
Groundwater					
Use	×	×			
Storage	×				
Recharge	×				
Quality monitoring	×	×	×	×	×
Assessment	×				
Well permits	×				
Irrigation networks					
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	×	×			

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 Reclama-

tion Authority, (c) the General Company for Hydraulic Studies, (d) the General Company for Water Projects, (e) the General Commission for Water Resources (GCWR), and (f) the General Establishment for Land Reclamation. Furthermore, the Ministry of Irrigation is in charge of groundwater monitoring and the issue 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 declining, and the Ministry is exploring alternative options of enhancing the recharge of shallow aquifers.

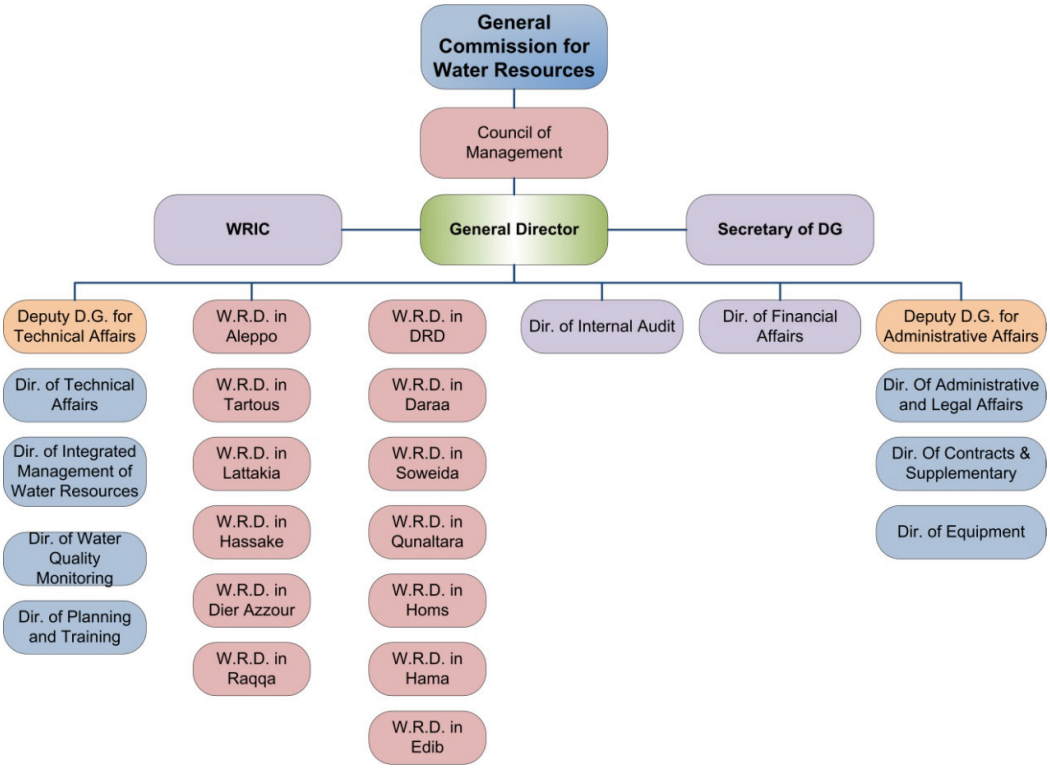

Figure 3: Organizational chart of the General Commission for Water Resources

The General Commission for Water Resources (GCWR) of the Ministry of Irrigation deals with issues concerning integrated water management and with the coordination of the water resources directorates established in the different river basins (Figure 3). Furthermore, the GCWR controls the Water Resources Information Centre (Figure 4).

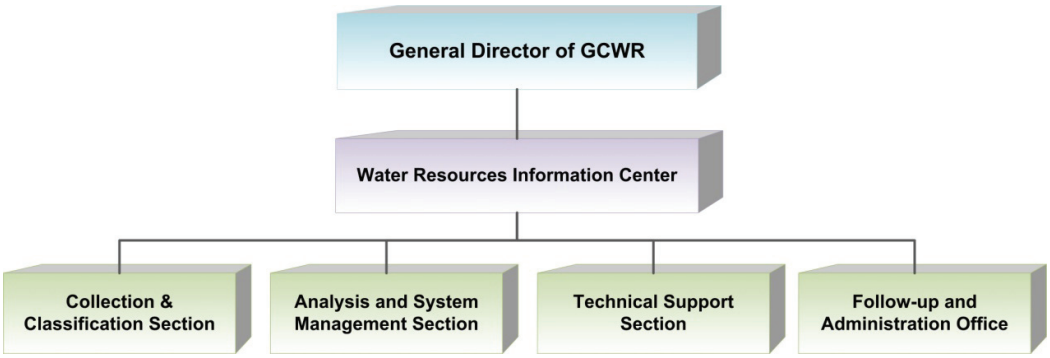

Figure 4: The organization of the Water Resources Information Centre

LEGISLATION

Table 6 outlines the main list of laws and regulations governing the water sector, their focus, content and status of implementation.

Table 6: 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. The 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 the HIWM management and the relevant Ministries. • Providing 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 legal offences). Organisation of water assessments and surveys by the State. Establishment of Water Users Associations.	The most important law for the water sector. It is considered comprehensive, but not fully effected because the Government granted a "grace" period for the industries and the owners of illegal wells and boreholes to comply with the law.
Establishment of the "General Board for Water Resources" Legislative	The General Board for Water Resources (GBWR) is a state board of administrative character, con-	The law defines the following responsibilities for the GBWR: • Management, development and protection of water resources in all river basins of the Syrian Arab Republic. • Supervision of investments and control of	GBRW has prepared many studies and taken many decisions related to its mission. Over-

Reference	Focus	Content	Implementation Status
decree No. 90 for the year 2005 Dated: 29/9/2005	trolled 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 water-related issues and (c) Irrigation management departments which belong to the General Establishment of the Euphrates Dam.	water resources and water infrastructure in all river basins (Euphrates, Orontes, Tigris, Khabour, Barada and Awaj, Yarmouk and semi desert areas). • Formulation of strategies for implementing 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, in 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 procedures and operation of facilities. • Training and education of technical staff within and outside the country, in cooperation with various scientific boards to achieve the targets of the HIWM. • Proposal of relevant legislation needed for the implementation of HIWM tasks, etc.	all, 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 the 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 Company for Water Studies" Law No. 16 1983 Dated: 27/10/1983	The law foresees the establishment of a General Company under the title: "General Company for Water Studies", controlled by the	The company undertakes all assessments, surveys, and studies for irrigation projects, land reclamation schemes, groundwater management, and the management of all relevant infrastructures and of everything required for projects of agricultural and social character. Furthermore, the company undertakes all surveys, assessments and studies for the construction of small and medium-scale dams on	Implemented

Reference	Focus	Content	Implementation Status
	Minister of Irrigation.	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.	

VALUING WATER – WATER PRICING ISSUES

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. Almost nowhere in Syria do farmers pay anything near the supply cost of water, let alone its economic cost (Bazza and Ahmad, 2002; Roth, 2001).

Because water in general, and irrigation water in particular, often requires 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 (Dinar, 1998). Decision makers generally apply some method of water pricing. 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 exponentially increasing populations. This policy considered essential the provision of 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 authorities from farmers, taking into consideration the development cost for an amortization period of 30 years with no interest charged or inflation corrections. 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 7 provides the cost of irrigation development in selected basins. Capital cost payments are funnelled into the autonomous National Debt Fund, within the Ministry of Finance.

Table 7: 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 an amount 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. There are often errors in the preparation of lists of users at the Governorate level by the Ministry of Irrigation, as well as underestimation of the number of farmers, which are compounded by other inefficiencies in the billing and collection processes (World Bank, 2001).

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 mobilized resources only. Secondly, easily mobilizable resources have already been exploited and the development of new resources would be possible only at a very high cost.

CONCLUDING REMARKS - KEY WATER MANAGEMENT ISSUES FACED AT THE NATIONAL LEVEL

The water sector of Syria needs to face up to different challenges, mostly stemming from the weak linkage between water planning and management and societal needs, and the large environmental 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, can be summarized in but are not limited to the issues outlined below.

There is **lack of knowledge** and assessment of 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 lack of data and information is considered a major impediment in achieving comprehensive management and balanced investment in the exploitation of water resources. Furthermore, throughout the country, there is lack of efficient systems for monitoring the quantity and quality of water resources. This re-

sults in the insufficiency of data necessary for formulating policies to prevent the overexploitation and pollution of water resources.

There is **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. Problems also stem from:

- The multiplicity of authorities and some overlaps in responsibility;
- The lack of communication and data exchange among decision-makers, engineers, and water management specialists and professionals;
- 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 only recently drawn under the supervision of the Association of Engineers.

Applied economic tools and incentives are ineffective in reducing water demand and in providing funds for increasing water supply and efficiency in water use, while reducing water waste. It should however be noted that such goals cannot be achieved by the water sector alone, in isolation from general policy directions adopted by the State and without taking into account other important political and social considerations.

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 these practices are manifested in the:

- Drop in groundwater levels (indicating 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 problem is encountered 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 Badeia to the west of Palmyra, Damsarkho, Hamidieh, the Akkar valley at the Syrian coast and other areas.

Finally, it can be argued that the present policy has failed in developing and providing opportunities for the **building of the capacity** required for supporting improved and effective water management. There is lack of high-level expertise, equipment, supplies, laboratories, raw materials, spare parts and financial transparency. These difficulties constitute problems by themselves, and result in the exacerbation of several of the aforementioned issues.

PART II: THE INECO SYRIA CASE STUDY:
WATER POLLUTION PREVENTION AND CONTROL IN THE BARADA RIVER BASIN

BACKGROUND AND MOTIVATION

On a national level, the water sector of Syria is faced with different challenges: the increase in water demand, especially in rapidly developing urban areas, the limited water availability and lack of hydraulic infrastructure, and the degradation of water bodies as a result of over-exploitation and/or pollution are compromising environmental sustainability and indirectly affect economic development. Furthermore, the lack of integration among sectoral policies, overlaps in responsibility and lack of technical and institutional capacity impede the effective implementation of water management policies.

Problems associated with the environmental degradation of water courses are particularly acute in the vicinity of metropolitan areas. Industrial development and urbanization pressures require the expansion of the infrastructure base and the strict enforcement of environmental legislation. At the same time, the need to sustain and enhance economic growth necessitates the development of incentive-based policies, so as to assist the modernization of small and medium enterprises.

In the above context, the INECO Project fostered a constructive dialogue process on alternative institutional and economic instruments for mitigating water pollution in the Barada River Basin, the area where the capital of Syria, Damascus, is located. Historically, the Barada River has been considered a vital socio-economic resource, sustaining the oasis of the "Ghouta" and agricultural activities in the area. The hyper-urbanisation of the greater Damascus area, coupled with the uncontrolled discharge of industrial effluents and the reduction of the river flow, has led to the significant degradation of the river and its tributaries, posing a significant threat to the local ecosystem and traditional activities.

THE CASE OF THE BARADA RIVER BASIN

REGION OVERVIEW

The Barada Basin is located in the southwest part of Syria, and stretches from the western mountainous part 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 5).

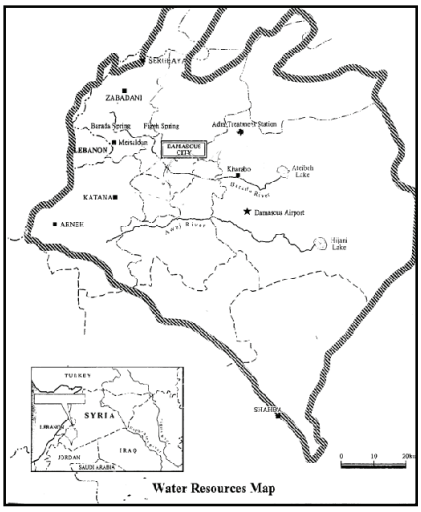

Figure 5: Location of the Barada Basin

The Basin extends over an area of 8,630 km², and can be divided into two distinct regions (Figure 6): (a) the mountainous area in the northwestern mountain range, which occupies an area of 3,500 km² approximately, and includes the East Lebanese Mountains, and (b) the plain comprising the Ghouta oasis and surrounding areas, which extends over an area of approximately 5,100 km² and has an altitude ranging between 595 m to 700 m above sea level. The Barada Basin includes the prefectures of Damascus and parts of the Rural Damascus, Darra and Sweida prefectures (70%, 11% and 19% respectively).

Figure 6: Mountains and plains in the Barada River Basin

The **climate** varies, as a result of the altitude difference, from desert climate in the plains to mild wet in areas with altitudes exceeding 2,000 m. Accordingly, the spatial distribution of rainfall 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), diminishing to 90 mm/yr in the plains (Ateibeh and Hijane Lakes). Annual evaporation in the mountainous region is between 300-350 mm and 90-100 mm in the plain, but reaches the value of 380 mm/yr in dry years. Prevailing winds are northwesterly in the north-western part of the basin and south-western in the southeastern region.

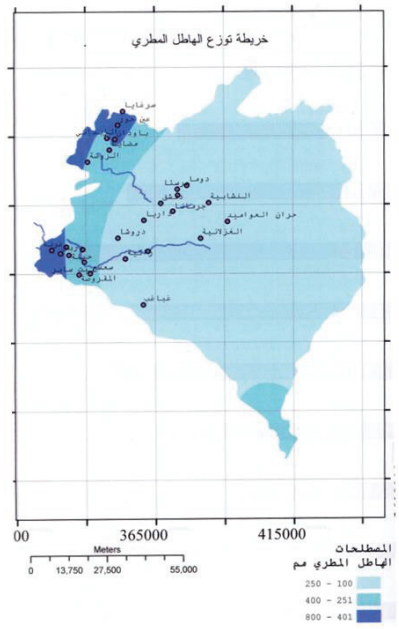

Figure 7: Rainfall distribution in the Barada Basin

The total **population** of the basin is more than 4.5 million inhabitants, accounting for approximately 30% of the total population of Syria. The annual population growth rate varies between 1.68% in the city of Damascus and 4.48% in other, rapidly developing zones of the Basin.

POLLUTION AND ENVIRONMENTAL DEGRADATION OF WATER BODIES

As the area where Damascus, , the capital of Syria, is located, the Barada Basin concentrates human activities exerting significant pressures that contribute to a great proportion of the serious environmental degradation occurring 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 the acute water pollution issues faced in the area.

The Barada Spring Lake, Northern Damascus, before the summer of 2007

At present, and with the exception of Damascus city and few suburban areas, all the settlements of the Basin discharge their wastewater onto land or in the two main rivers. The disposal of significant volumes of solid waste contributes to contamination, transforming river beds to waste banks. Furthermore, and with the exception of some large, rather new, factories, nearly all of the wastewater generated from industrial activities is discharged without prior treatment to the Barada River. It is estimated that the BOD resulting from industrial effluents only is 12.5 ton/d. Added to this, there is significant disposal of toxic chemical products, primarily from lead industries and battery manufactories, which also contributes to severe soil pollution. Although groundwater contamination from industrial activities has not yet been confirmed, it is quite probable as aquifers are recharged by river water.

A polluted stream in the region

Historically, the Barada River has been a vital water resource, as it sustained the 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 cultural heritage. Additional pressures to the river's ecosystem concern the significant decrease of rainfall in the area and the diversion of water from the Barada and the Feige springs, as the lat-

ter is currently used for drinking water supply. All these factors affecting the river's dilution and self-purification capacity combined with the significant pollution loads have led to severe, and possibly irreversible, environmental damage.

Barada spring lake in February 2008.
Many boreholes have been drilled by the State around the spring to supply water to Damascus

LOCAL AND NATIONAL INITIATIVES FOR WATER POLLUTION MITIGATION

In view of the exacerbation of water problems, the Syrian Government has launched several important projects for improving water quality. New legislation obliges tanning manufactories to move from the river vicinity to the new industrial area of Adra (in northern Damascus), where a large wastewater treatment plant has been built; however, the plant cannot process industrial wastewater and manufactories still need to develop their own pretreatment facilities.

The new wastewater treatment plant of Adra

The Ministry of Housing and Construction, in collaboration with Governorates and Municipalities, has initiated a programme for the construction of wastewater treatment plants in

the rural areas, in order to ensure that all domestic wastewater is treated before being discharged to the river. The programme, which is supported by international donors, comprises the construction of 30 wastewater treatment plants in several areas of the Basin.

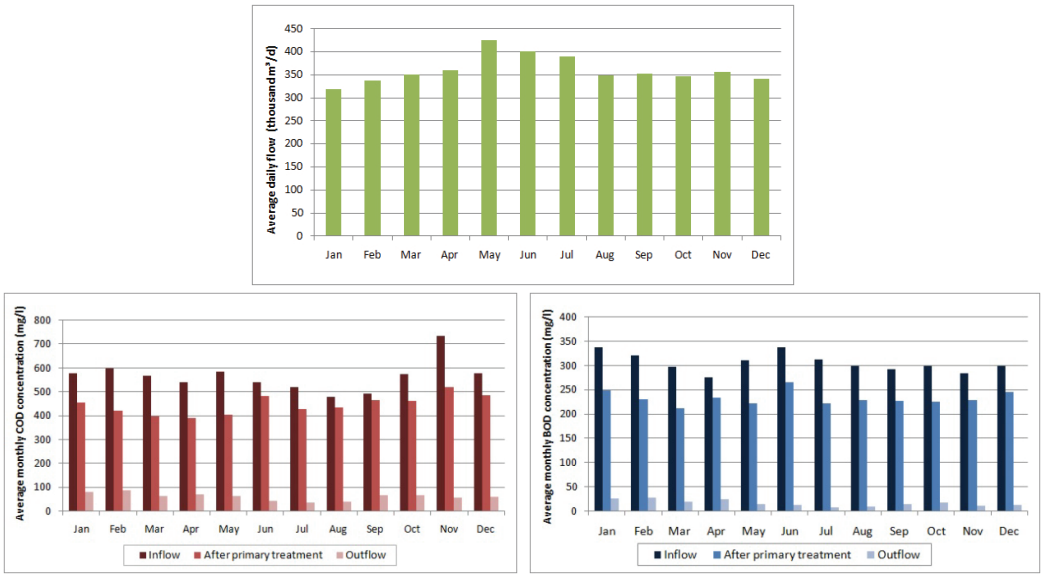

Figure 8: Flow, COD and BOD concentrations in the Adra wastewater treatment plant (2006)

Additionally, and in order to address knowledge and information gaps, the State, with the support of the Japan International Cooperation Agency (JICA), has undertaken a new initiative for monitoring water resources in the region, as well as surface and groundwater quality, particularly focusing on the rivers of the Barada Basin.

ASSESSMENT OF WATER POLLUTION ISSUES IN THE BARADA RIVER BASIN

The pollution of the Barada River is demonstrated by the high concentrations of phosphates, bacteria, BOD, COD, dissolved solids, ammonia, heavy metals, and suspended solids in both surface and groundwater. This section presents an in-depth analysis of the problem, on the basis of data collected by the Syria INECO team for identifying the primary causes to the issue. It further elaborates on secondary causes, relating to the institutional ("governing") and economic ("valuing") dimensions of the problem, with the aim to pinpoint issues that need to be resolved for the effective implementation of sustainable solutions.

POLLUTION FROM SEWAGE WATER

All the areas of the Damascus metropolitan area included in city zoning planning are connected to the sewerage network, with the overall percentage of connected households reaching 73.8%. Sewage is treated in the newly built wastewater treatment plant of Adra (capacity of 485,000 m^3/d). However, operational problems in the plant are frequent, as industrial wastewater is often discharged to the public sewerage network without proper treatment.

The situation, however, is not the same in the rural areas surrounding Damascus. The discharge of untreated sewage onto land and in water bodies has led to the deterioration of the aquatic ecosystems of the river, its lakes (Barada Spring and Otybeh), and of groundwater bodies. In addition to increased health risks, this results in direct or indirect economic

losses and a drop of real estate values and necessitates future investment for developing alternative water supplies, safe for human consumption. Sewage contamination further reduces the recreational value of surface water bodies.

In fact, measured BOD concentrations have exceeded the allowed limits in most of the tributaries of the Barada River. Especially in the downstream part of the Basin, the measured BOD concentration in one of the river tributaries in early 2006 was 130 mg/l, whilst the maximum allowed concentration according to the British standards for river water quality is 25 mg/l.

A drainage pipe discharges wastewater in the river, 1200 m from the Barada Spring, Zabadani Area, February 2008

POLLUTION FROM AGRICULTURAL ACTIVITIES

The uninformed and excessive use of nitrogen fertilizers, the irrigation of crops with untreated sewage water and the discharge of sewage onto land is leading to extensive soil degradation. The impact of agricultural activities is also manifested by the considerable increase in the concentrations of nitrates and ammonium ions in several wells in the Damascus surrounding areas. Notably, in 2006 the authorities were forced to stop the implementation of a plan for the drilling of more than 200 boreholes for potable water supply in several regions of the Ghouta, as nitrate concentrations were found in the range of 100-200 mg/l (the limit for potable water use is 40 mg/l). Similarly, ammonium concentrations in the Barada river water have increased, also due to the decline in river flow. In one of the Barada tributaries, the measured concentration in early 2006 exceeded 13 mg/l, while the maximum allowed limit according to the British standards for river waters is only 3 mg/l.

POLLUTION FROM INDUSTRIAL EFFLUENTS

One of the main causes of water pollution in the Barada Basin is the direct discharge of industrial wastewater (with or without pretreatment) into natural waters. The uncontrolled discharge of industrial wastewater occurs on a large scale. The fertilizer and food processing industries contribute to the pollution load, but the impact from smaller and medium-sized industries, such as tanneries, can be even larger. Table 8 summarizes the sources of contamination associated with industrial activities in the River Basin. Furthermore, the Annex to

this document includes a comprehensive listing of the Syrian standards for the discharge of wastewater, depending on the type of the recipient water body.

In fact, there is clear evidence that water in the downstream part of the Basin is being heavily polluted from tanning activities. The results of analyses from samples taken from the Barada and the Al Daeiani rivers (one of the Barada tributaries) revealed high concentrations of hexavalent chromium. The corresponding concentration reached 1.18 mg/l in March 2006, as a result of tanneries discharging wastewater into the river without prior treatment.

The industrial units of the area are generally not connected to the public water or wastewater network. They often depend on private boreholes for water supply and sometimes have their own wastewater treatment plant to ensure adequate treatment of effluents. However, the dominant practice is for industries to illegally discharge wastewater to the sewerage network without prior treatment.

Presently, a modern industrial zone is under construction near Damascus, where industries will be sited according to a proper classification of activities, and common treatment facilities will be provided, according to the type of industrial processes. The overall strategic goal is to gradually relocate all manufactories to the zone, in an effort to control industrial pollution and ensure proper treatment and disposal of industrial waste.

Table 8: Sources of contamination from industrial activities in the Barada River Basin

Sources of contamination	Result	Indicators
– Disposal of liquid industrial waste in the sewerage network without proper treatment – Disposal of industrial waste in water reserves, valleys and groundwater wells – Disposal of solid industrial waste in the vicinity of surface and groundwater bodies – Ineffective administration of fuel tanks and stations, vehicle rewind and washing workshops, garages, illegal disposal of oils and lubricants in the sewerage network	Water contaminated with chemicals and organic material flows towards water reserves and groundwater contamination due to seepage	High concentrations of: chlorides, TDS, heavy metals-hydrocarbon compounds

EFFECTS AND HEALTH IMPACTS

As presented above, the analysis of measurements from monitoring stations shows that there is significant deterioration of both aquatic ecosystems and groundwater quality. Details of monthly measurements from monitoring stations during 2006-early 2008 are provided in the Annex of this report.

The effects of water pollution involve the deterioration of water quality in both ground and surface water, which leads to considerable environmental damage and inhibits their use for industrial, agricultural and potable water supply. Furthermore, surface waters are becoming more and more polluted, affecting ecosystems and reducing the economic and recreational values of the waters and the surrounding environment. The increased nutrient levels, as well as decreased oxygenation, impact seriously on local ecosystems. As a result, in some cases there is need for implementing expensive pre-treatment to guarantee the safety of potable and industrial water supply. Finally, the uncontrolled discharge of toxic compounds, mostly from lead factories and battery manufacturing units is also causing soil pollution problems in the region.

Additional effects involve significant health risks (e.g. through bathing in polluted water or through the consumption of agricultural products irrigated with polluted water), the higher costs required for producing safe drinking and industrial water, the loss of income from fisheries and aquaculture, the loss of valuable biodiversity, and the drop in real estate values, as a result of the deteriorating surrounding environment, especially at the city outskirts. Furthermore, the agricultural sector is negatively affected from the use of untreated water for irrigation purposes.

Table 9 lists the types of food- and water-borne diseases at the national level. It should be noted that there is an extremely high rate of infantile diarrhoea, with fatalities ranging up to 10% in areas that are not connected to the public water supply system.

According to the outcomes of a private survey, based on the 3-year records of cancer incidents admitted in the Bayroni hospital (2004-2006), the highest percentage of cancer patients in the Barada River Basin has been admitted from Duma city, located in the area surrounding Damascus. Furthermore, Mr. Asaad al-Dakhil, chemist and Director of the FAO laboratory in the Directorate of Water Resources for Damascus and surrounding areas indicates that: *"Assessments have proven that there are high concentrations of ammonia, nitrates and heavy metals in the wells and groundwater of the Damascus surrounding areas, which causes serious diseases, and especially cancers"*. He further adds that *"hundreds of these wells are used for drinking water or for irrigation; the result is the same, because contaminants can be consumed directly, through drinking water, or indirectly through vegetables and fruits, irrigated with polluted water. The Adra treatment plant can treat domestic wastewater, but cannot remove heavy metals, as it does not include a stage for chemical treatment"*. It should be noted that Mr. Dakhil was a member of the Committee which analysed water and vegetation in the Duma and Harasta cities in late 2004. On the basis of the survey findings, the Committee decided to destroy all the agricultural crops that had been planted that year.

Table 9: Outbreaks of water and food borne diseases in Syria (Source: Strategy and National Environmental Action Plan, 2003)

Year	Typhoid	Summer type diarrhea	Acute diarrhea in children under 5 years
2000	5101	Non-existent	45,290
2001	5781	Non-existent	34,629

THE INSTITUTIONAL ("GOVERNING") DIMENSION OF THE PROBLEM

As mentioned in Part I of this report, water management falls primarily under the authority of the Ministry of Irrigation. The Ministry is responsible for developing water resources and for guaranteeing the availability of water of suitable quality to all water use sectors. Priority is of course given to domestic water supply. In this framework, the responsibility of issuing permits for domestic and industrial discharge has also been allocated to the Ministry of Irrigation. However, other Ministries are involved in the different functions:

- The Ministry of Local Administration and the Environment, through the corresponding Governorate authorities, issues licenses for discharge in the sewerage system.
- Within the Ministry of Housing and Construction, the Drinking Water Directorate is responsible for planning, designing and constructing municipal drinking water treatment plants and distribution systems. The Sewerage Management Directorate

is responsible for the development of sewage collection systems in urban areas and municipal wastewater treatment plants. Once the facilities have been developed, responsibility for operation and maintenance is allocated to regional and local authorities.

- The Ministry of Industry (MoI) is responsible for all industrial activities, public and private, in the country.

According to the existing legislation, in the event of non-compliance with discharge regulations, the Ministry of Irrigation is the authority responsible for taking appropriate action. At present, actual enforcement is almost non-existent, due to a lack of funds, as well as broader economic and employment considerations. On the other hand, the staff of the Ministry of Local Administration and Environment (MoLAE) is being trained to enforce Environmental Impact Assessment (EIA) requirements; however, there is no legal basis for enforcement, as the pertinent legislation is still lacking.

For any new industrial facility, the MoI requests from the manufacturer to provide an EIA study before issuing the corresponding license. The role of the MoI is to inform the MoLAE of the Environmental Impact Assessment, which then provides the corresponding approval. Old industrial facilities need to comply with the provisions of the Environmental Law No 50, which demands the installation of wastewater treatment facilities. However, the law has not been applied so far, as the Government has granted a grace period to facilitate compliance to the legislation.

Overall, and with regard to decision-making, it can be argued that the strong centralization of water management responsibilities results in reduced flexibility of local water authorities. Furthermore, there is a slight overlap in responsibilities, which requires the implementation of coordination and data and information exchange mechanisms. It can be argued that the current lack of an integrated environmental management approach, specifically targeting the industrial sector, is an important cause to the problem. There is no joint strategy or action plan also entailing coordination of the efforts of the different ministries and institutions involved. This is partly due to bureaucracy, but also results from the lack of expertise and experience in dealing with such issues.

THE ECONOMIC ("VALUING") DIMENSION OF THE PROBLEM

The exacerbation of water pollution problems faced in the Barada River Basin also has an economic dimension. In this context, this section of the report summarizes issues related to current water pricing practices and the recovery of water service costs, focusing particularly on sewage collection and treatment. Considerations regarding the financial sustainability of water services and private sector involvement are also briefly outlined.

Water pricing incentives and recovery of water service costs

In an effort to decrease water consumption by providing additional economic incentives, the Government, through the Ministry of Housing and Construction, issued a Decree reforming water tariffs (Decree Nr. 1028 of 27/09/2007). Details are presented in Table 10.

Sewerage charges are applied only in the city of Damascus; a share of 15-20% of the customers' water bill is allocated to cover part of the sewage collection and treatment costs. It has been estimated that presently the corresponding cost for sewage treatment is about 5 S.P./m^3. According to data received from personal communication, wastewater treatment

costs were lower than 5 S.P./m³ when the energy required for the operation of the Adra wastewater treatment plant was provided by Metan Gaz. Other factors that have increased wastewater treatment costs are related to the presence of industrial effluents, which necessitated the development of additional units to treat wastewater containing used oils.

Table 10: Old and new pricing policy for potable water provision

Use sector/Consumer type	Water consumption (m³)	Tariff (Syrian Pounds/m³)
Old tariff system		
Households	1 to 20	3.0
	20 to 30	4.5
	30 to 60	13.5
	over 60	19
Governmental agencies	-	8.5
Industrial, commercial and tourism establishments	-	22
New tariff system, as of 27/09/2007		
Households	1 to 15	2.5
	16 to 25	7
	26 to 40	15
	41 to 60	22
	over 60	30
Governmental agencies	-	14
Industrial, commercial and tourist establishments	-	30

Currently, the costs for industrial wastewater treatment are not recovered. The decreasing ability of the industry to pay the wastewater fees and poor law enforcement play an important role. Fines for exceeding discharge standards are not enforced. Generally speaking, it can be supported that the industrial sector is motivated to discharge wastewater in the public sewerage system, as this entails lower costs, even with the new water tariff.

In the agricultural sector, the structure of the water tariff collected from farmers covers only a share of the cost for irrigation water distribution networks, in addition to the costs of network operation and maintenance. The tariff is fixed at 3500 SP/hectare, and is not differentiated according to the type of crop irrigated. This means that the tariff for irrigating fruit trees, for example, is similar to the one imposed for cotton, sugar beets or other, water intensive crops, a scheme that does not provide any incentive for water conservation.

Overall, it can be summarized that the current system for cost recovery is insufficient. The economic burden is expected to increase in the near future, because of sewerage network expansion and the operation of new wastewater treatment plants.

Public financing and private sector involvement

Similarly to many other sectors in Syria, water services are perceived as a public good and are thus heavily subsidized. Water service providers and authorities are required to transfer all revenue raised by water tariffs to the Ministry of Finance. Funds can then be borrowed back with a low interest rate of 1.7%. This practice does not encourage efficient operation and management.

All required investment is financed by the State budget. Governmental or private companies carry out individual water works (e.g. laying out of new pipelines, construction of wastewater treatment plants) on the basis of contracts signed with the Central Government. Several infrastructure projects have been carried out with financial support from international donors and agencies.

Presently, there is no investment from the private sector in wastewater projects; some efforts have been pursued by individuals to purchase treated wastewater from local authorities, in order to subsequently use it for the irrigation of their agricultural fields. However, the practice is not foreseen by the law, as the relevant legislation concerning wastewater reuse is lacking.

DISCUSSING WITH LOCAL STAKEHOLDERS – THE APPROACH

The INECO approach towards the development of a participatory process for discussing alternative institutional and economic instruments to address water management issues was based on the Objective Oriented Project Planning 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 9):

1. The first stage, **Problem Analysis**, involved the identification of stakeholders and the mapping of their key problems, constraints and opportunities, and the definition of the 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 of 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 by stakeholders to formulate the most suitable strategy for problem mitigation.

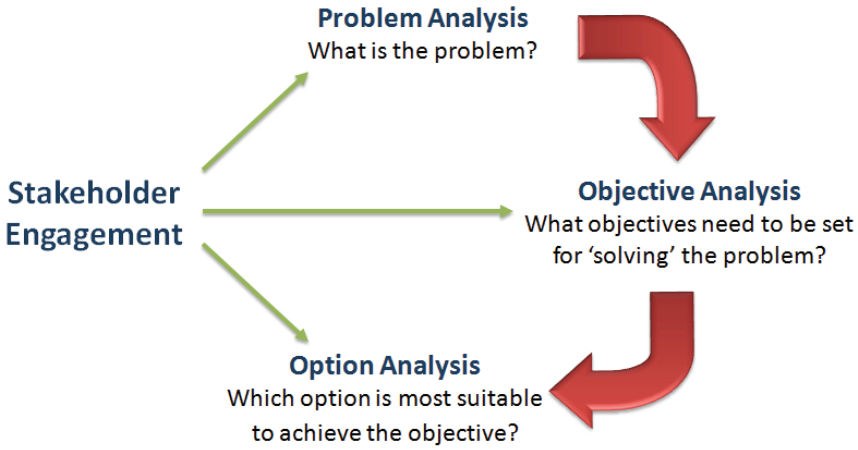

Figure 9: The framework for public participation and engagement in INECO

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, surveys, discussion fora, and dedicated questionnaires. 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 for deriving regional policy recommendations for mitigating the water pollution issues faced in the Barada River Basin.

PROBLEM ANALYSIS

The first stage of the developed process concerned the identification of key stakeholders, with a role or concern over the pollution of the Barada River, these being:

- Authorities involved in the management of water resources and industrial activities at the national level (ministries) and at the local level (Governorates, water authorities, and municipalities);
- Representatives of industrial associations and major industries of the area;
- NGOs and associations particularly concerned with the continuous degradation of the Barada River, the surrounding areas and the Ghouta oasis.

Furthermore, and with the effort to build an informed participatory approach, meetings and interviews were held with municipal authorities and farmers of the Barada River Basin, in order to collect individual views and suggestions from all end-users and local authorities.

Photos from the INECO Syria Stakeholder Workshop "Building a common vision for mitigating water pollution in the Barada River Basin", Damascus, September 10th 2007

The first workshop, open to all parties, was held on September 10th 2007, at the Sheraton Maaret Seydnaya Hotel, near Damascus. The event gathered 54 participants, including representatives of public authorities and ministries dealing with various issues related to water pollution abatement, and NGOs and water users' associations. Its primary aim was to discuss the problem with the local stakeholders, through the development of a "Problem Tree" describing the causes and effects of the problem in a qualitative way. 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 able to express their opinion on the significance of the problem, its effects and primary causes and desired course of action.

Following from the detailed mapping of causes and effects of water pollution in the Barada River Basin, described in the previous section, stakeholders were asked to validate a preliminary "Problem Tree", drawn for the purposes of the workshop. The results of this validation exercise, aimed primarily at the exchange of views and experience, are presented in Figure 11 (Page 37). According to the qualitative "problem tree" analysis, efforts undertaken to address the problem have thus far remained incomplete due to: (a) the inadequate enforcement 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 of discharges. The current agricultural practices, which include excessive application of fertilizers and pesticides, overexploitation of water resources and inefficient irrigation methods have also contributed to the exacerbation of water pollution in the area.

On a first level, causes to the problem comprise the discharge of untreated sewage and industrial effluents. Illegal connections to networks and arbitrary disposal of sewage onto lands in the vicinity of populated areas, resulting also from the lack of infrastructure, are rather common. With regard to industrial wastewater, the pertinent legislation imposes pretreatment prior to discharge to the sewerage network. However, sometimes industrial wastewaters are mixed with municipal wastewater, without the required pretreatment. The current agricultural practices, which often involve the uninformed and uncontrolled excessive application of fertilizers, contribute to the exacerbation of the problem. Nitrate and ammonia ion concentrations in some wells in the Damascus countryside have exceeded the standards for drinking water quality. Furthermore, irrigation with untreated sewage water, and discharge to the agricultural land of the Ghouta add to the problem.

Overall, the current water pricing system can be considered inefficient, as sewage collection and wastewater treatment costs are not fully charged to the users. Furthermore, costs for industrial wastewater treatment are not recovered, whereas fines for exceeding the current discharge standards are not applied. Presently, the decreasing ability of industry to pay wastewater fees, the poor management and maintenance of industrial wastewater treatment plants, the lack of systematic, periodical monitoring and poor law enforcement play an important role. The limited financial resources and capacity of water and wastewater service providers, resulting also from poor cost recovery, inhibit the expansion of existing sanitation programmes and wastewater treatment infrastructure and the implementation of new ones. Additionally, erosion of existing sewerage systems, also resulting from poor maintenance, is often reported.

Replies to the dedicated questionnaire were also helpful in revealing the perceptions of stakeholders as to the significance of causes and effects to the problem and possible options for problem mitigation. The most significant results of the survey were the following:

- Although water shortage is considered the primary water management problem (approx. 70% of replies), water pollution is also considered significant (48% of replies).
- The majority of participants (87%) believed that the pollution of the Barada River is a very important issue, which needs to be immediately addressed. Increased health risks are considered the most significant effect, linked also to the pollution of groundwater bodies.

- The following are considered the main causes of river pollution: a) inadequate domestic wastewater collection and treatment (41%), and b) discharge of industrial effluents without prior treatment (33%).
- Industry was considered the sector where policies should focus (48%), followed by municipal wastewater collection and treatment (26%). Agriculture was thought of as far less important (6%).

Four main instruments were discussed for mitigating industrial pollution and were ranked by workshop participants, using a scale ranging from 1 (least effective) to 5 (most effective). Ranking results are presented in Figure 10, below.

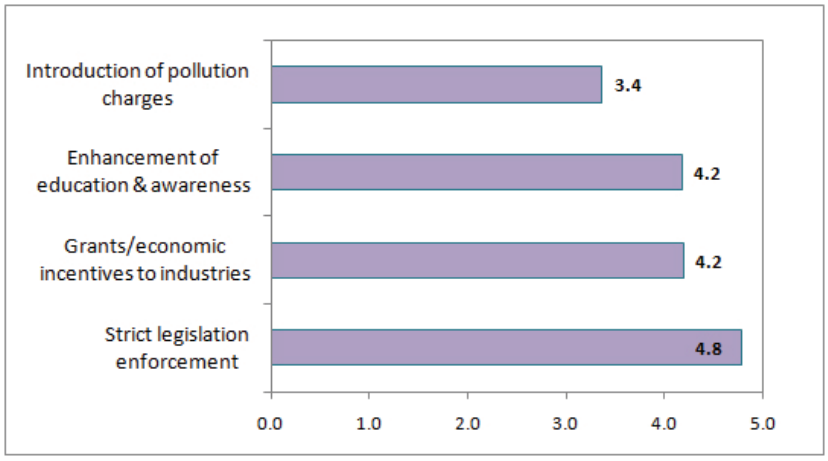

Figure 10: Ranking of options for industrial pollution prevention and control (Outcome of the Syria Stakeholder Workshop Survey)

The main arguments and issues raised by the workshop participants can be summarized in the following:

- The application of the law for both private and public sector establishments is a very crucial issue. The Environmental Law is still not fully applied because there are many implementation difficulties for public establishments due to the lack of political will.
- It is very important to harmonize and integrate the different sectoral policies.
- The implementation of any economic instrument should be based on a participatory approach, involving all the responsible bodies in order to identify and agree upon solutions.
- It is necessary to rethink the overall concept of water policies, especially with regard to food security, water security and the increasing costs for developing new water supply schemes.
- Solutions to problems are already known. Decisions are now necessary, and their application should originate from decision-makers at the high political levels, and not from experts. All ministerial departments should be involved, in order to create a very specific, targeted and clear water policy, which should then be presented to the high-level decision makers for implementation.

Suggestions, comments and issues raised formed the basis for the discussion on policy objectives and potential options, described in the following sections.

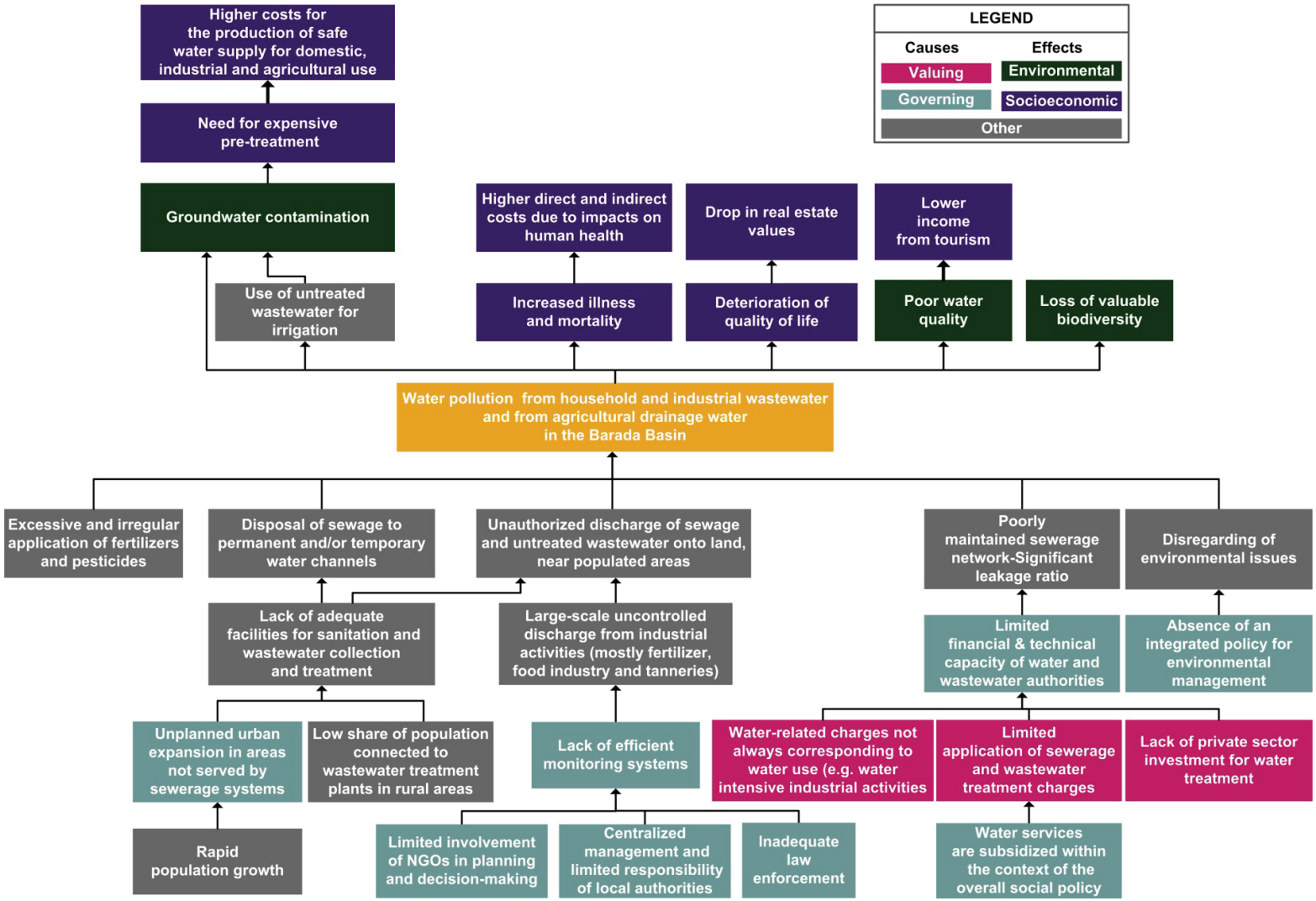

Figure 11: Problem tree analysis for water pollution in the Barada River Basin

DEFINING POLICY OBJECTIVES

Subsequent, individual consultation and discussion sessions were held with all local stakeholders and actors that participated in the first event, as well as additional groups that expressed their interest to join the process. These meetings were aimed at (a) consolidating the problem analysis of the previous workshop; and (b) identifying key policy objectives which should be pursued for problem mitigation. In this stage, the developed "Problem Tree" was used to identify and develop policy objectives for mitigating the issue at hand. The resulting "Objective Tree", which maps the corresponding means-to-end relationships, is depicted in Figure 12. This "tree" was further elaborated to define a set of key policy objectives, to achieve the main goal of water pollution mitigation and water quality improvement, incorporating the views and goals of all stakeholders participating in the process.

The key policy objectives that need to be achieved according to the Objective Tree of Figure 12 are:

- **Objective A:** Control over the application of fertilizers and pesticides;
- **Objective B:** Elimination of the discharge of untreated sewage onto land and canals, streams and tributaries;
- **Objective C:** Minimization and control of the discharge of untreated wastewater onto land and in the vicinity of populated areas (city and village outskirts);
- **Objective D:** Improvement in the maintenance of the sewerage network;
- **Objective E:** Prioritization and integration of environmental issues in the overall policy framework.

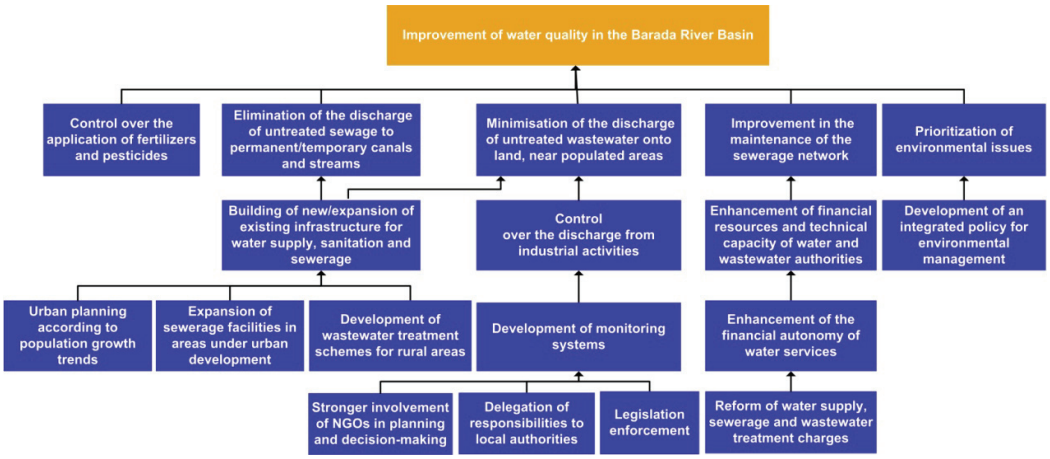

Figure 12: Objectives for addressing water pollution in the Barada River Basin

Furthermore, all stakeholders consulted pointed out that the development and implementation of new tools, like the "polluter-pays" principle and cost recovery schemes should be combined with incentives for adopting environmentally friendly practices and subsidies/grants for improving technology uptake.

In this regard, the options identified and analysed in the following paragraph were formulated in light of the needs to: (a) discourage environmentally damaging behavior, such as the discharge of untreated industrial waste that may impact on water quality and the environment in general, (b) provide additional incentives to industries for conserving/recycling water and treating the wastewater produced, and (c) assist businesses to improve environmen-

tal performance and invest in technologies that favour minimum water use and maximum recycling.

IDENTIFICATION AND ANALYSIS OF OPTIONS FOR WATER POLLUTION MITIGATION

The work towards deriving policy recommendations focused on the identification of alternative (institutional and economic) options to achieve the aforementioned objectives. These suggestions, subject to evaluation were used to develop a roadmap for strategies, suitable for achieving the wider goal, i.e. the improvement of water quality and the environmental protection of the Barada River Basin. To facilitate discussions with local stakeholders, and in accordance with the objectives defined above, potential policy instruments were grouped into four (4) categories, as follows:

(1) Options to control/prevent pollution from industrial effluents;

(2) Options to regulate the use of agrochemicals (fertilizers, pesticides, herbicides);

(3) Options to rehabilitate/enhance existing infrastructure;

(4) Options to strengthen the socio-economic and institutional environment and improve the knowledge base on the problem, particularly through the enhancement of coordination and the integration of policies among institutions involved, and the strengthening of 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).

INDUSTRIAL POLLUTION PREVENTION AND CONTROL

The majority of stakeholders consulted within the framework of INECO have agreed that industrial pollution prevention and control is presently one of the key objectives that need to be pursued. Suggested options that were subsequently discussed with stakeholders are summarized in Figure 13.

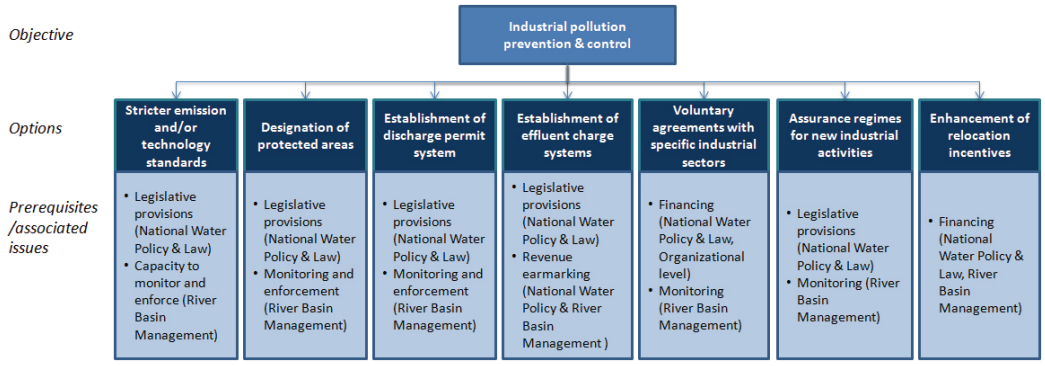

Figure 13: Suggested options – Industrial pollution prevention and control

As mentioned in previous sections of this document, the Government of Syria has initiated a programme for relocating polluting industrial activities in a new area, outside of Damascus. However, the incentives provided are not considered adequate by the users, and there is

delay in the implementation of the programme. Additional motivation, as suggested by industrialists, can be provided through preferential prices for water, electricity and wastewater treatment in the designated industrial zone.

Stricter enforcement of the existing legislation on discharge standards is an option in line with the overall policy directions. On the other hand, it is considered that the introduction of stricter standards (for emissions but also for technologies in specific industrial processes) will impose an additional economic burden to the industrial sector if it is not combined with other (economic) incentives. The designation of additional protected areas along the Barada River, in order to protect vital ecosystems and/or abstraction points can also be favoured.

Although effluent charge systems could be applied, they would require an enhanced knowledge base, as well as significant institutional reforms for the development of the corresponding form of institutional organization at the River Basin level. On the other hand, and as Environmental Impact Assessments are gradually being introduced for new facilities, the development of assurance regimes, targeted at specific, new industrial activities can be a valuable tool providing additional incentives for the adoption of environmentally friendly practices.

The key issue for ensuring the environmental protection of the River and its tributaries, without compromising industrial growth, is the **encouragement** of businesses towards environmental protection. To that end, voluntary agreements with specific (polluting) industrial sectors can provide appropriate incentives on two levels: (a) ensuring compliance with existing legislative provisions and (b) providing further incentives for industries to reduce emissions to levels below the standards. Motivation provided can be in the form of grants, low interest loans or tax rebates, continuous training of personnel on improved practices or through ecolabelling schemes.

REGULATION IN THE USE OF AGROCHEMICALS

The current agricultural practices are not considered major contributors to the degradation in river water quality. However, and taking into account the deterioration of groundwater quality in the rural parts of the basin, this section elaborates on institutional and economic options that could support farmers in rationalizing the application of agrochemicals.

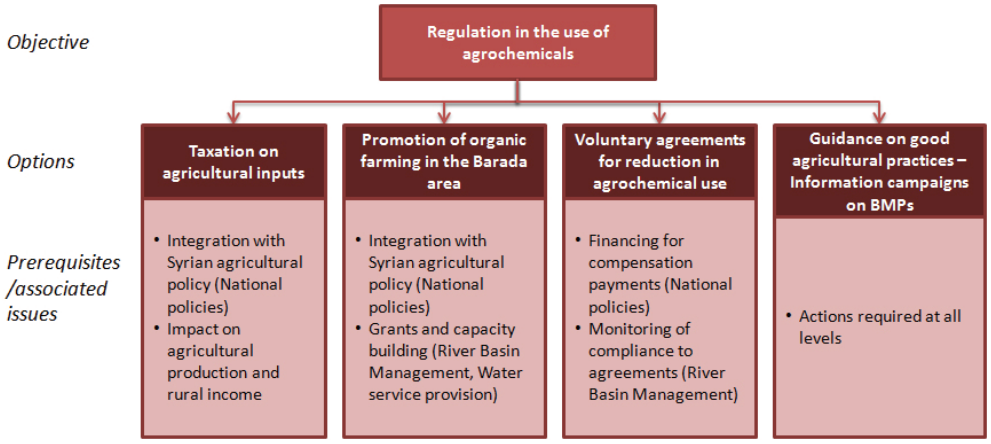

Figure 14: Suggested options – Regulation in the use of agrochemicals

All suggested options should be further examined in relation to the goals of the national agricultural policy and analysed as to their impact on agricultural production and rural employment. Indirect taxation on agricultural inputs (fertilizers, pesticides and herbicides) is

unlikely to produce concrete results, as it would require strong regulatory capacity to ensure that the increased production cost is not transferred to the final consumer. However, encouragement can primarily be provided through information campaigning, awareness raising and training of farmers in rural areas on best management practices in agriculture, also emphasizing on the increased health risks that the excessive application of agrochemicals can entail. Such initiatives can be further elaborated to promote organic farming in the River Basin, through targeted subsidies.

Finally, even with regard to agricultural pollution, the establishment of voluntary or cooperative agreements between farmers and water management authorities can be a promising instrument. This would require raising the financial resources necessary for payments compensating the loss of agricultural production resulting from restrictions in the application of agrochemicals. On the other hand, compensation payments can be lower than the increasing cost for producing safe drinking water (samples from wells in the area reveal very high nitrate concentrations and therefore alternative water supply sources should be developed).

INFRASTRUCTURE DEVELOPMENT AND REHABILITATION

As mentioned above, the Syrian Government has recently implemented a reform of water tariffs with two primary aims:

- Reinforcing the incentive function of tariffs, by applying considerably higher rates for increased household consumption;
- Assuring that new charges are affordable and guaranteeing access to water services for the poor (the rate charged for the first, "social" block is lower than the one previously applied).

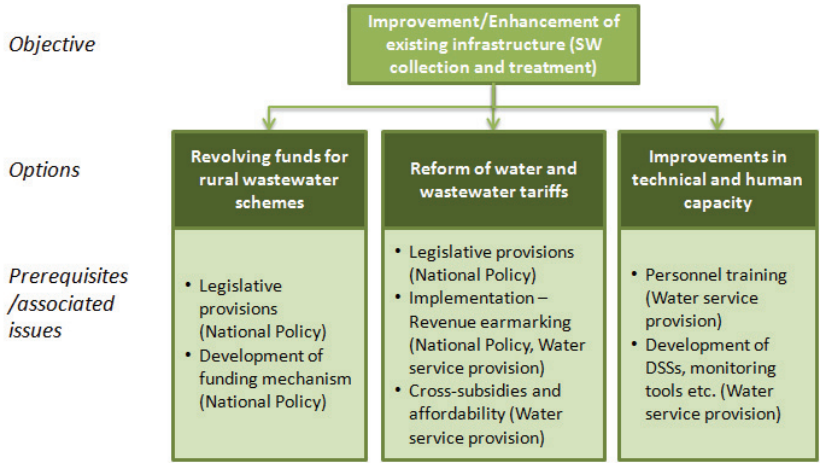

Figure 15: Suggested options - Infrastructure development and rehabilitation

It is obvious that capital costs for infrastructure development cannot be adequately recovered through current pricing schemes, as this would result in a significant increase of water tariffs and sewerage charges, unaffordable by some social groups. However, water tariffs should at least recover operation and maintenance costs, in order to secure the technical sustainability of the system. Currently, rural wastewater treatment schemes are funded by the State, with support from international donors. The flexibility and the transparency of the system could probably be enhanced through the establishment of a "revolving fund" for the development of such systems.

STRENGTHENING THE SOCIO-ECONOMIC AND INSTITUTIONAL ENVIRONMENT

As pointed above, the multiplicity of authorities and actors involved in urban planning and the issuing of permits for industrial activities is a significant impediment for the development and effective implementation of coordinated policies for water pollution prevention and control. Given the intensity of the problem, there is need to pursue concerted management and integration of functions among all Ministries involved. This can be achieved through:

- The establishment of one authority responsible for the implementation of all policies in the Barada River Basin, or through
- The establishment of Inter-ministerial committee, for the better coordination of actions among authorities.

Similarly, there is need to enhance the knowledge base on water quality and quantity issues; it is therefore proposed to develop the corresponding inventories on platforms that are shared by all authorities involved in authorization and monitoring. Along the same lines, regular campaigns targeting specific categories of users (e.g. tanning industry) and the general public need to be implemented in order to raise awareness on (a) pollution prevention, and (b) the need to pursue the protection of the river through governmental policies but also through citizen initiatives. Finally, there is need to develop and empower Water User Associations, in order to support the enhanced involvement of water users in the decision-making process.

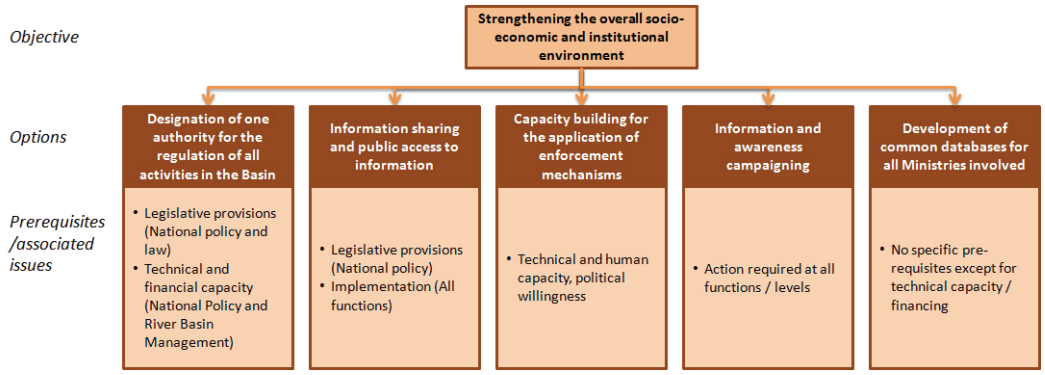

Figure 16: Suggested options – Strengthening the overall socio-economic and institutional environment

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 included 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 economic and institutional instruments, taking into account the local and the national water management context, current conditions and priorities, and future challenges. A total of 26 responses were received from key stakeholders and user groups. Prior to the distribution of the surveys, several consultation meetings were held and continuous contact was pursued to answer queries and provide expert support. The outcomes are summarized in the spider chart of Figure 17.

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 strict legislation enforcement in combination with financial encouragement through subsidies and other forms of financial aid. Instead of indirect taxes, there is preference for voluntary agreements, and possibly for introduction of environmental charges and taxes.

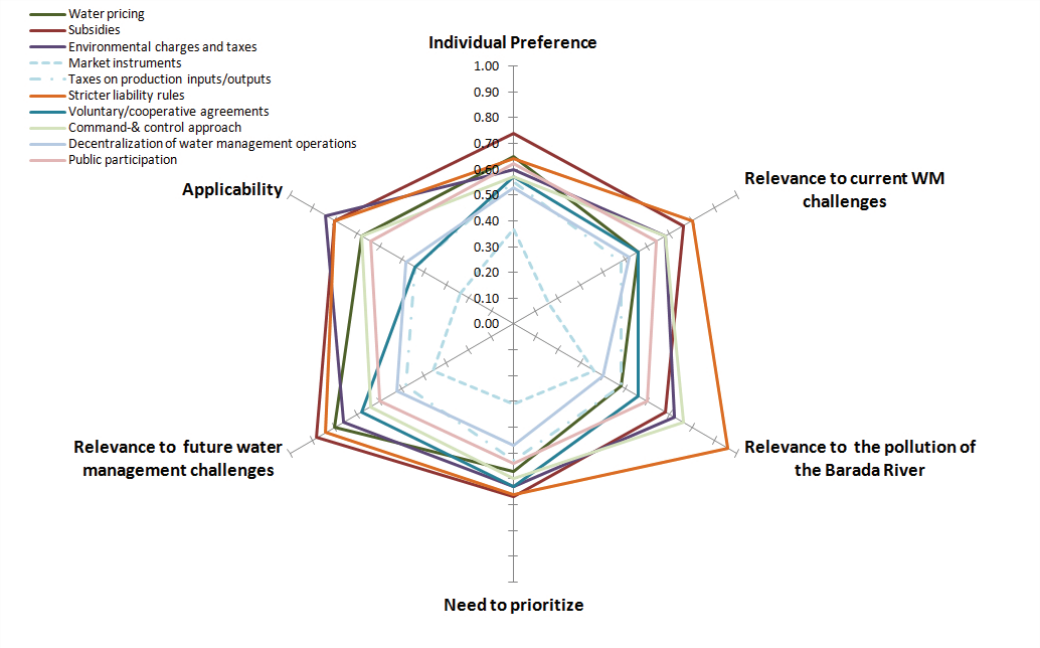

Figure 17: Prioritization of instruments for addressing current and future water management challenges

With regard to the currently applied (or potentially applicable) instruments, opinions and suggestions can be summarized in the following:

- The 'polluter pays' principle needs to be implemented, possibly in combination with incentives for environmentally friendly practices.
- Subsidies are required to create additional incentives for the relocation of industries, and for encouraging businesses to invest in water-efficient equipment, reduce water usage and improve water quality.
- There is need to support technology transfer in the agricultural sector, through education and training. Specific measures should be taken to support small and medium-scale farmers.
- A more effective water pricing system would enable authorities to recover costs relating to water supply provision; however clear distinction needs to be made between industrial, agricultural and residential water use. An institutional and legislative reform would be required to provide more liberty to water and wastewater authorities in establishing water tariffs.
- Costs relating to borehole and well licensing need to be flexible, and adapted to the state of the exploited groundwater body.

Strict legislation enforcement is considered the most effective way of addressing the problem; however, distinctions between the public and the private sector need to be eliminated, so as to enhance transparency in the system.

FURTHER CONSIDERATIONS TOWARDS OPTION IMPLEMENTATION

The overall process of identifying potential policies for mitigating water pollution in the Barada River Basin was complemented through a last step, aimed at mapping perceptions and sharing views on prerequisites and further considerations for the implementation of proposed approaches.

The step was implemented through individual interviews with decision-makers from the relevant ministries and from the Water Resources Directorate of Damascus. The outcomes are presented in the following paragraphs, which elaborate on issues relating to: (a) instruments for industrial pollution prevention and control, (b) cost recovery and cost sharing issues, particularly focusing on financial costs relating to infrastructure development, operation and maintenance, (c) the overall organization of the water sector and private sector involvement and (d) public participation and stakeholder involvement in decision-making.

Instruments towards industrial pollution prevention and control

Industrial activities dispersed in the Barada River Basin are considered primary contributors to the degradation of the river. Although a number of policies are currently being pursued by the Ministry of Irrigation (relocation of industrial facilities, enhanced monitoring and strict enforcement of legislation), soft measures towards industrial pollution prevention would likely significantly improve the effectiveness of current policies. In this regard, specific questions were used to map stakeholder perceptions on alternative ways of encouraging the industrial sector towards environmental compliance and cleaner production practices. Responses are portrayed in Figure 18.

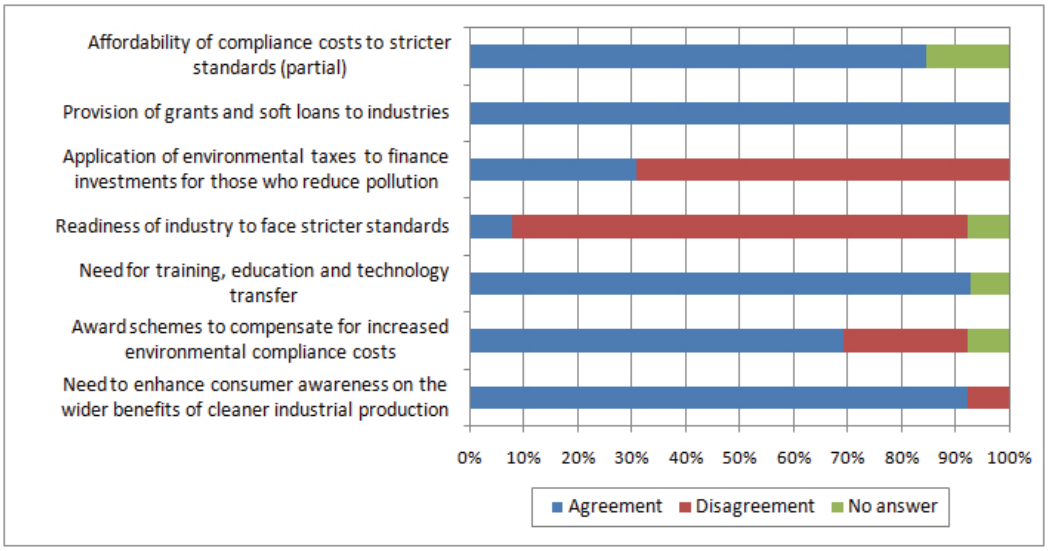

Figure 18: Stakeholder views on alternative approaches to industrial pollution prevention and control

Stakeholder views are diverse with regard to the affordability of compliance costs to stricter emission/technology standards. Overall it is believed that such costs would be affordable for major industries and those that address the local market only, as the competitiveness of the

sector will not be compromised. The case is however different for the majority of small and medium scale enterprises, which would probably not afford advanced wastewater treatment or industrial process change. Along these lines, respondents perceive that the transition of the industrial sector should be helped through grants and soft loans, particularly for those who cannot afford compliance, but with regulation and under specific conditions.

The imposition of dedicated taxes to those who continue to pollute and the use of the generated revenue to finance investment for those who reduce pollution is not accepted by the majority. It is perceived that revenues will not be sufficient to have notable effect. Instead, it is supported that other measures need to be prioritized before such instruments are considered, such as: (a) restoration of water courses and aquifers; (b) strict enforcement of the law; and (c) validation and updating of data on water quality and availability and on pollution sources, as the current significant discrepancies would not allow the accurate assessment of environmental damage.

Additionally, it is also noted that environmental compliance costs would be reflected in the market prices of end-products, negatively affecting small and medium enterprises and favouring large businesses. In this regard, it would be more equitable to oblige all industries to adopt specific practices, so that the competitiveness of similar production units is not compromised further.

The rather widely adopted EU policy of socializing water-related external costs through dedicated taxes and charges collected by special purpose authorities is provisionally accepted by most stakeholders (Figure 19). Some agree with the main principle. However, as public participation processes are not often applied in Syria, it is also believed that the participatory element for defining cost-sharing principles has to be tested on the ground and that education and awareness campaigning is required beforehand. Those who consider the process not applicable stress the fact that measures taken need to be adapted to the Syrian tradition and reality and take into account current economic and social limitations.

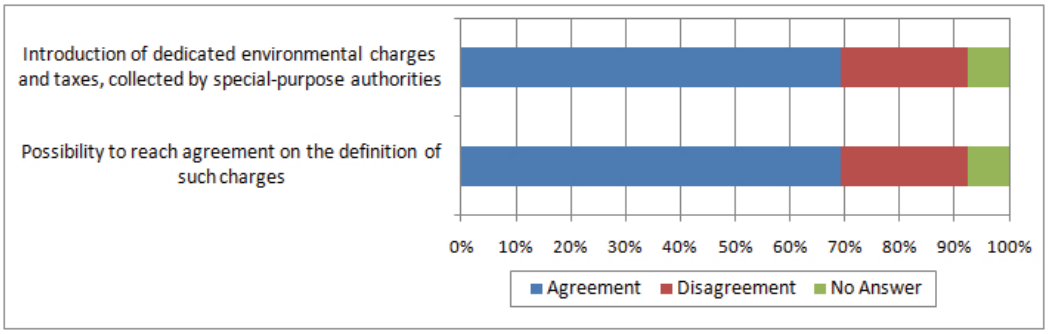

Figure 19: Stakeholder views on environmental taxation

In addition to the economic dimension of the issue, it is widely believed that industry does not have the technical and the managerial capacity required. Technical change (rehabilitation, modernization of equipment, change of processes) also needs to be pursued through development of expertise, implementation of dedicated training programmes, and transfer of know-how from private companies and other countries, more experienced in the field. Ecolabelling and award schemes are also regarded positively, as they would allow signaling efforts towards environmental protection to society, at least in the early stages. Such programmes would however be effective only if combined with intensified efforts to raise societal awareness. Respondents with positive view of such schemes point out the role of mass

media in enhancing public acknowledgement on the wider benefits to the environment and consumer health.

The effective implementation of command-and-control regulatory approaches for individual discharge into water streams or onto land is also advocated as a priority solution for mitigating different causes contributing to the environmental degradation of the Barada river. Stricter enforcement of regulations was examined in light of the:

- Feasibility, applicability and effectiveness of regular control of industrial effluent discharges;
- Empowerment and political willingness of the pertinent authorities to strictly enforce legislation on discharge and technology standards;
- Possibility to develop collective schemes for wastewater treatment for different industrial premises, and ways through which the cost of such schemes should be shared.

Responses from the different stakeholders are depicted in Figure 20.

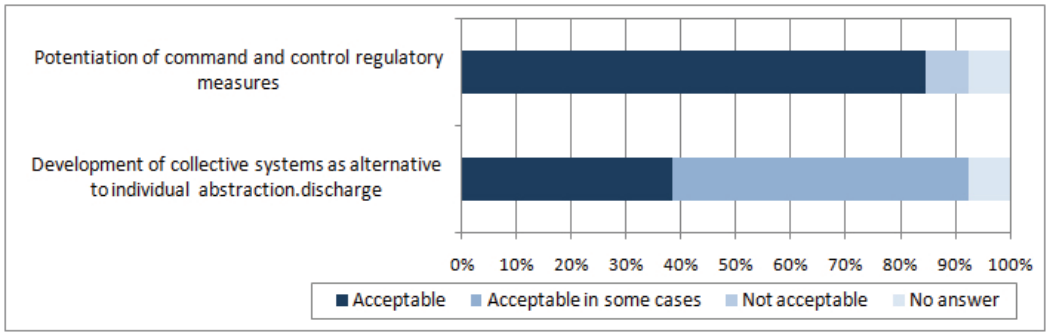

Figure 20: Stakeholder views on alternative approaches to regulating discharge of effluents by individual users

As also noted in previous sections of the report, the regulatory approach is widely accepted. It is generally believed that the State has the means necessary to identify pollution sources and the political willingness to enforce the pertinent legislation on polluters. Other responses however stress the following dimensions:

- The needs of communities and enterprises are not well known. Efforts are thus required to fill data gaps so as to allow more informed decision-making, as well as elaboration and enforcement of regulations;
- Regulation needs to be complemented with wider dissemination of traditional practices for the protection of water sources, so as to raise societal awareness on water-related issues;
- There are often some problems in enforcement, due to the uncontrollable nature of the problem. These should be addressed in an integrated way, by also developing other alternatives.

An alternative way to allow more effective prevention of individual (insufficiently treated) industrial discharge would be the development of collective schemes for wastewater treatment. Such efforts are already under implementation in the industrial city of Adra, and gain support by most of the decision-makers. However, for remotely located industries, other more cost-effective solutions need to be examined, even if these are temporary. It is generally argued that the cost of such systems should be primarily shared between water authorities and users, in order to ensure acceptability of the option and maintain affordability.

Some respondents point out that the level of the recovery of costs needs to be examined on a case-by-case basis, and that private investors in general should be charged at full cost.

The definition of an effective policy incentivizing industrial units to move to designated zones has been an issue of extensive debate, as the State is pursuing the relocation of polluting industries to the Adra industrial zone. Appropriate incentives could entail the offer of compensation or other forms of financial aid. On the other hand, a potential increase of water and pollution charges could be put into practice, so that high-value uses can continue while low-value ones will give up or be further urged to relocate.

With regard to compensation measures, opinions are diverse. Several respondents perceive that the option would need further consideration, and could probably take the form of soft loans, covering part of the relocation costs. Others perceive that financial encouragement is not required. Instead, policies should focus on providing effective support for the adoption of modern technologies and production methods through other means. The offer of additional incentives, by raising water and pollution charges, is rejected as it is perceived as an unfair solution, which will impact negatively on small and medium industries, the core of the Syrian economy.

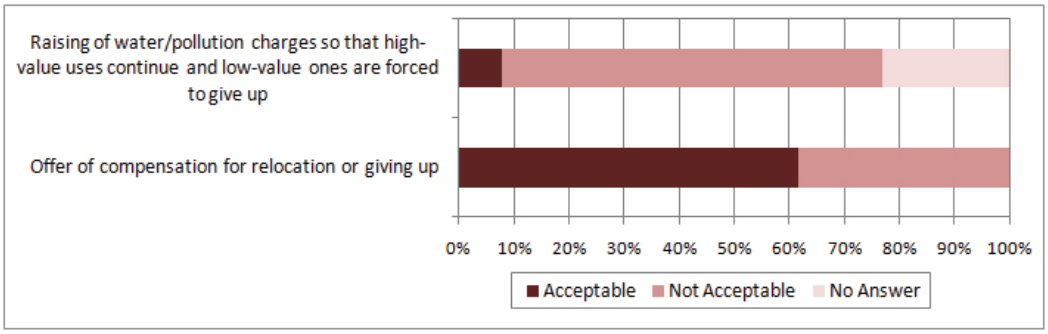

Figure 21: Stakeholder views on alternative approaches towards the relocation and phasing-out of polluting industrial activities

Cost recovery and cost sharing issues

The expansion of infrastructure to serve both the rapidly expanding metropolitan area of Damascus and the rural area surrounding the Barada River is a necessary means for the mitigation of strong environmental pressures exerted in the area (discharge of untreated domestic effluents, abstraction from springs and wells to meet water needs etc.). In this regard, mechanisms for the sharing and recovery of costs relating to infrastructure operation, maintenance and further expansion were further analysed by considering issues relating to:

- Ways of distributing 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 accept an increase of the applied water rates, provided that this would mean improvement in the quality of water services provided;
- Potential differentiation of water tariffs according to the type of use, with the aim to generate cross-subsidies among different water user categories.

Opinions of stakeholders are rather diverse with regard to the way that financial costs should be shared among the different user categories. Several state that these need to be differentiated according to the type of use, with high income uses (tourism and industry) bearing the most significant share of the cost. Others believe that costs need to be allocated proportionally, according to the quantity used and the pollution loads generated.

Full cost recovery through water tariffs is undesirable: significant investment is required for the development of water-related infrastructure, and the full recovery of the corresponding costs through water tariffs would impose significant economic burden on water users. However, the majority of respondents believe that the direct recovery of costs through water tariffs and according to the volume consumed is the most fair option. A reasonable increase of water-related charges for supporting improved quality of water services would be acceptable. On the other hand, half of the respondents would not be willing to pay more for sustaining the current level of water services despite increasing water stress.

With regard to the transparency and fairness of the current system for the recovery of costs, the majority states that the system is either unfair or non-transparent or both. Cited reasons concern:

- Limited reliability of consumption metering (need for proper maintenance, replacement of water meters with digital ones and on-time registration of consumption);
- Unclear invoicing to customers, as it is not evident which costs are recovered from which component of the water bill;
- The application of the same water rates in different areas (e.g. metropolitan and rural areas of Damascus) despite the significant differences in the quality of water provided.

Framework for water management

The integration of functions and the coordination of activities among the different institutions dealing with water management issues, and the development of the capacity required to deal with rapidly emerging problems, are identified as horizontal challenges, not limited to the water sector of Syria alone. Additional reforms in water management could focus in the provision of water supply and sanitation services, with the aim to enhance effectiveness, technology uptake and management efficiency. In this context, stakeholders were further asked to comment upon:

- The existing water and sanitation undertakings, in relation to meeting current demands and securing environmental protection;
- Margins for improvement, without considering complex organizational transformations;
- Potential contribution and involvement of the private sector;
- Acceptability of private sector involvement in the provision of water services.

Responses are illustrated in Figure 22.

The majority of respondents believe that current water service operations can be supported to respond to emerging challenges through enhanced cooperation, continuous training, involvement of stakeholders and enhanced application of new technologies. Institutional interventions would be required for simplifying bureaucratic procedures and introducing new standards. However complex organizational transformations are not considered precondi-

tions for improvement. The majority accepts enhanced involvement of the private sector, as means to improve efficiency and technical skills and enhance technology transfer. Despite this, it is underlined that any cooperation with private operators and companies should take the form of public-private partnerships with strong involvement of the State and that all relevant operations need to be closely monitored and regulated.

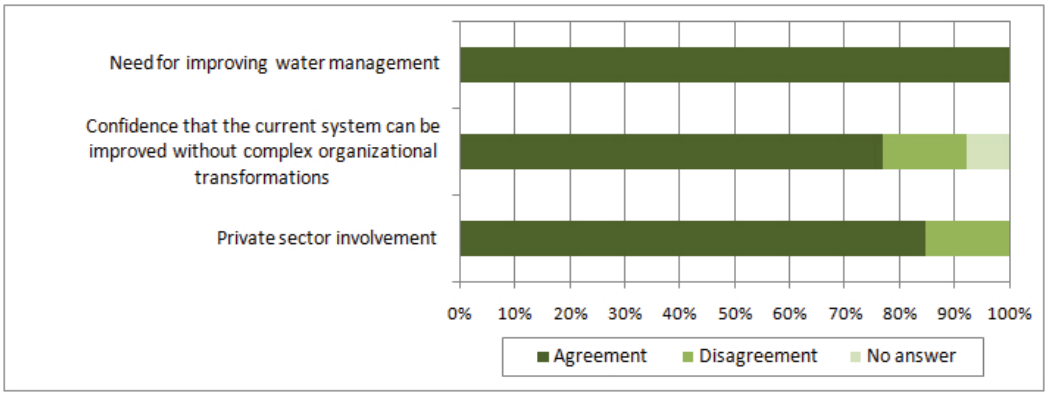

Figure 22: Stakeholder views concerning the framework for water management and provision of water services

Public participation and stakeholder involvement

Strengthening the involvement of stakeholders and water users in decision-making could significantly aid in the mitigation of water pollution issues in the Barada River Basin, as it can help identifying potential deficiencies of measures taken and developing supporting options to deal with the problem. Questions set forth to respondents were aimed at mapping:

- Perceptions on public participation and joint decision-making;
- Suggestions on ways through which water users could be further involved;
- Willingness of decision-makers to consider the outcomes of participatory planning processes;
- Actual accessibility to information on water management issues of common interest;
- Opinions on the impartiality and objectivity of decisions taken, as water management issues.

All respondents agree that public participation is a key factor for the development of comprehensive and integrated water management policies. The representation of water users through trade unions and associations can help in identifying problems at the early stages, and at developing win-win solutions likely to be easily adopted by water users and the society at large.

Stakeholders note however that it could prove difficult to enhance public involvement, due to the different levels of awareness among the diverse social groups. Most respondents are decision-makers, representing the views of the different Ministries involved in water management issues. As such, they envisage their own involvement in participatory processes in relation to their role as initiators or facilitators of public consultation processes. As depicted in Figure 23, and despite their significant expectations from participatory processes, the majority of is not confident that the corresponding outputs will be considered by policy makers. They further point out the need for transparency, honesty in approaching the different groups and willingness to try to integrate diverse views in a constructive way.

Access to relevant information on water management issues is a precondition for informed decision-making and stakeholder involvement. Some respondents, due to the nature of their work, have improved access to the outcomes of surveys and assessments carried out by the different bodies involved; others, however, comment that information and data provided are often inaccurate and inadequately describe the significance of the problems and their impact range. In this regard, and as pointed out in previous sections of this report, the enhancement of the knowledge base and the effective dissemination of information to decision-makers and to the general public is of considerable importance.

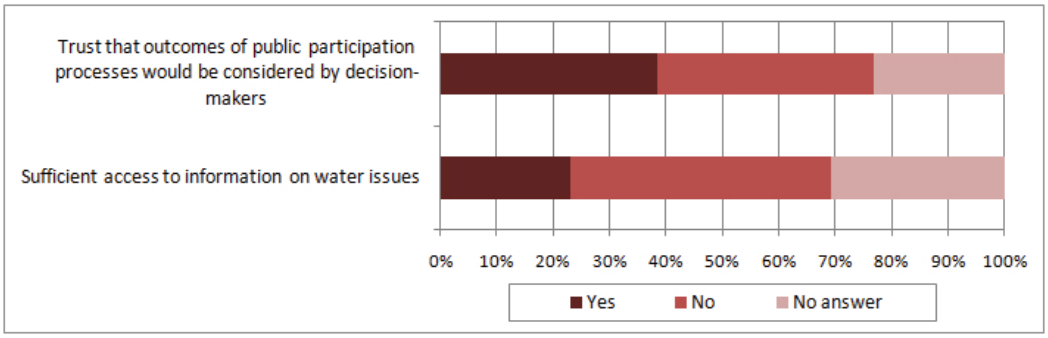

Figure 23: Stakeholder views on factors affecting public participation processes

CONCLUDING REMARKS

Mitigation options for coping with the serious environmental issues encountered in the Barada River Basin, as identified through the INECO processes, address the whole spectrum of water related issues present in the area. They are targeting the minimisation of pollution from industrial effluents through engaging into the 'polluter pays' principle and to environmental friendly practices, the regulation of the use of agrochemicals, the rehabilitation or enhancement of existing infrastructure, and the strengthening of the socio-economic environment through public and institutional empowerment.

More specifically, the INECO attempt to reach local actors in the Barada Basin has resulted in a series of suggestions related to (a) the encouragement of the industrial and the commercial sector to invest into water-efficient practices, and of the agricultural sector through increasing the awareness of farmers on the benefits of adopting water saving technologies; (b) enhancement of liability systems, through the enforcement of environmental regulations in the public and the private sector, legislative reforms to control illegal connections and drillings, and wide implementation of the 'polluter pays' principle; (c) cost recovery schemes in combination with institutional and legal reforms, allowing water and wastewater authorities to establish tariffs in a more autonomous way; (d) differentiation of cost allocation policies for agricultural and industrial use, and of tariff structures addressed to these sectors, to offer enhanced incentives towards water conservation; and (e) establishment of well licensing systems that take into account groundwater conditions.

As response to the options identified, focus needs to be placed on developing policies and strategic planning frameworks for the water sector, targeting short, medium and long-term objectives. Priorities need to address the introduction of cost recovery policies (respecting affordability concerns), the regulation of agricultural water use and crop production patterns, decentralization of responsibilities and coordinated efforts to reduce overlap between different bodies and governmental agencies. The training of experts (administrative and

technical positions) on new technologies, the transparency in information exchange, as well as the increase of public awareness on water saving practices at household level, and the strengthening of the role of the Water Users Associations, are essential in promoting holistic and integrated water management.

The water management issues analysed for the Barada River Basin reflect the overall conditions, concerns, and responses also at national level. As with the above mentioned responses, the national water management strategy needs to focus on strengthening public involvement, adopting new economic and technical instruments in the sectors of industry and agriculture, and planning for interventions at administrative and institutional level. Starting from the latter, comprehensive management of water resources is regarded essential for coping with the water stress issues faced nationwide. Therefore, the need for further training the employees of the relevant authorities in water management initiatives, so as to update them with the new applicable standards, is essential. Focus also needs to be placed on strict legislation enforcement when water regulations are violated, and on reforms for placing water use rights under the supervision of the competent authorities.

The clustering of industries in specifically designated zones needs to be supported through appropriate financial incentives and support for the development of collective systems for wastewater collection and treatment. Similarly, collective systems for irrigation supply could ensure better regulation of water use. Furthermore, wide introduction of modern irrigation methods, use of reclaimed water and adaptation of cropping patterns to water availability need to become components of an overall national strategy towards water conservation. This shift could be supported through the provision of appropriate financial and technical assistance to farmer associations, industries, and individual users, according to their ability to bear the corresponding financial costs. Especially with regard to industry, an award system needs to be developed, addressed to those who invest towards enhanced environmental protection, ensure proper treatment and eliminate their pollution loads. Pollution charges could also be applied, depending on the type and size of the industry, so as to avoid overcharging small and medium enterprises. Overall, emphasis could also be placed on increasing the costs allocated to big investors, while encouragement is also needed in different phases for private sector investments.

Finally, extensive public awareness campaigns in the local and national media, also utilising the experiences of NGOs would assist in the implementation of the national water management strategy. The engagement of civil society associations, town councils, commerce and tourism chambers into participatory approaches could assist in formulating more efficient and better targeted water management responses that would be more easily acceptable by the water users. Public education towards rational water use and elimination of pressure on water resources, in combination with improving the transparency between the decision makers and water users, are expected to further support the aims and objectives of the national water strategy.

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ANNEX

SYRIAN STANDARDS FOR DISCHARGE IN THE WATER ENVIRONMENT

Parameter	Unit	Recipient body			
		Seas	Onto land	Rivers	Agricultural drainage canals
Color	Platinum cobalt scale	No color	No color	No color	No color
pH		6 –9	6 –9	6 –9	6 –9
Temperature	Degree celcius	10>average temp of recipient	5 degrees >average - temp of recipient		
BOD	mg/l	60	20	40	60
COD	mg/l	200	30	150	100
Oil and grease	mg/l	15	10	10	10
Total suspended solids	mg/l	60	30	30	60
Total dissolved solids	mg/l	-	800	1200	1000
Setteable solids	mg/l	-	-	-	-
Phosphate	mg/l	10	1	15	10
Ammonia	mg/l	10	5	5	0.5
Nitrate	mg/l	50	30	50	40
Phenol	mg/l	0.5	0.01	0.02	0.5
Fluorides	mg/l	1	0.5	1.5	0.5
Sulfide	mg/l	1	1	1	1
Residual chlorin	mg/l	-	1	1	-
Surfactants	mg/l	2	0.05	0.05	0.5
Minimum dissolved oxygen	mg/l	4	4	4	4
Petrolum hydrocarbons	mg/l	15	5	5	-5
Floating matter	No floating matters				
Aluminum	mg/l	3	1	1	3
Arsenic	mg/l	0.1	0.1	0.1	0.1
Barium	mg/l	2	-	1	-
Beryllium	mg/l	0.05	0.05	0.05	0.05
Cadmium	mg/l	0.05	0.01	0.05	0.05
Cyanides	mg/l	0.15	0.1	0.1	0.05
Chromium	mg/l	0.5	0.5	0.5	0.5
Chromium VI	mg/l	0.5	0.05	0.05	0.05
Nickle	mg/l	0.5	0.3	0.3	0.5
Mercury	mg/l	0.005	0.005	0.005	0.005
Iron	mg/l	2	1	2	2
Antimony	mg/l	1	0.3	0.3	0.3
Copper	mg/l	1.5	1	1	1

Parameter	Unit	Recipient body			
		Seas	Onto land	Rivers	Agricultural drai-nage canals
Manganese	mg/l	1	0.5	0.5	0.5
Zinc	mg/l	2	1	2	2
Lead	mg/l	0.5	0.2	0.2	0.5
Silver	mg/l	0.1	0.05	0.05	-
Total value for heavy metals[1]	mg/l	2	1	1	2
E. Coli	Total bacterial count per100 ml	5000	2500	100	5000

[1] Heavy metals include: mercury, lead, berlium, chromium, nickel, zinc, and copper.

WATER QUALITY MEASUREMENTS IN THE BARADA RIVER BASIN (2006, 2007 AND EARLY 2008)

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
01/2006	1	Spring	7.6	14.5	387	8.4	1	0.12	21	25	2		
01/2006	2	Tekeyeh	7.4	11.8	450	4.2	10	1.8	23	15	5.2		
01/2006	3	Kfeir Elzayt	8.21	11.8	478	8.5	6	0.77	107	20	3.5		
01/2006	4	Before Fijeh Spring	8.22	11.6	487	8.5	10	1.4	89	14	3.9		
01/2006	5	After Fijeh Spring	8.21	11.6	487	8.5	10	1.4	89	15	3.5		
01/2006	6	Al Hameh	8.21	12.2	505	7.6	15	0.65	76	20	3.6		
01/2006	7	Al Difaa Factories	8.22	12	511	7.1	5	1.25	75	25	3		
01/2006	8	Glass Factory	8.22	11.9	514	7.5	15	1.7	90	15	4		
01/2006	9	Tora - Alkasr	8.23	12.9	530	9	25	2.1	124	20	4		
01/2006	10	Banias Al Rabweh	8.22	12.5	540	7.9	30	2.3	466	25	3		
01/2006	11	Al Rabweh	8.21	12.3	536	8.2	20	2.19	405	25	12		
01/2006	12	Al Dabaghat	8.22	12.7	541	8.8	20	1.29	90	20	4		
01/2006	13	Ghouta	8.23	12.8	567	3.4	80	11.9	297	25	13		
01/2006	15	Jisrin	7.5	13.1	580	2.9	130	13.5	180	30	13		
01/2006	24	Daayani Dabaghat	7.7	13.4	1130	2.5	100	10.3	120	150	12.5		
02/2006	1	Spring	7.4	14	380	8.9	1	0.129	5	2.5	0.8		
02/2006	2	Tekeyeh	7.8	12.7	454	5	5	1.5	11.5	15	1.5		
02/2006	3	Kfeir Elzayt	7.93	12.8	465	8	4	0.77	26.1	10	1.5		
02/2006	4	Before Fijeh Spring	7.91	12.6	469	8.6	6	0.96	37.7	15	1.6		
02/2006	5	After Fijeh Spring	7.95	12.6	470	8.5	6	1	38.7	15	1.5		
02/2006	6	Al Hameh	7.4	13.2	500	8.3	10	2.16	14.7	15	1.5		
02/2006	7	Al Difaa Factories	7.3	12.9	495	8.6	10	1.56	14	20	1.3		
02/2006	8	Glass Factory	7.6	13.3	507	8	10	1.8	17	5	1.2		

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
02/2006	9	Tora - Alkasr	7.6	12	524	8.1	10	1.4	14.4	20	1.3		
02/2006	10	Banias Al Rabweh	7.7	12	526	8.1	15	2.32	54	20	1.3		
02/2006	11	Al Rabweh	7.7	12	524	8.2	15	1.54	25.8	25	1.5		
02/2006	12	Al Dabaghat	7.4	11.2	507	8.5	15	1.7	28.1	25	1.3		
02/2006	24	Daayani Dabaghat	7.7	11	501	7	15	1.7	120	25	1.5		
02/2006	34	Mlehani	7.7	8.6	533	6	15	1.9	126	40	1.2		
03/2006	1	Spring	7.6	14.6	390	8.7	1	0.2	7.2	2.5	0.8		
03/2006	2	Tekeyeh	7.5	14.8	430	5.3	3	1.1	11	5	1.2		
03/2006	3	Kfeir Elzayt	8.3	15.4	433	7.3	7	0.7	21.1	10	1		
03/2006	4	Before Fijeh Spring	8.3	14.8	437	7	7	0.9	22.8	20	4		
03/2006	5	After Fijeh Spring	7.9	14.3	391	8.2	3	0.4	20.4	5	1.2		
03/2006	6	Al Hameh	7.7	15	397	8.1	3	0.5	20.5	5	1.3		
03/2006	7	Al Difaa Factories	7.8	14.7	396	8.2	4	0.4	13.6	5	1		
03/2006	8	Glass Factory	7.9	15	398	8.3	4	0.4	19.2	5	1.1		
03/2006	9	Tora - Alkasr	7.8	14.8	410	8.2	5	0.8	13.7	7.5	1		
03/2006	10	Banias Al Rabweh	7.9	14.7	411	8.1	6	0.8	14.4	5	1.2		
03/2006	11	Al Rabweh	7.9	15	413	7.9	8	0.6	16.7	7.5	1.5		
03/2006	12	Al Dabaghat	8.1	15	410	6.3	15	2.5	12.3	10	2		
03/2006	20	Al Gisr Al Abyad	7.9	16.7	407	7.1	12	0.7	40.2	5	1.6		
03/2006	21	Kuria Embassy	7.8	15.5	408	6.3	15	0.5	64.9	10	2.6		
03/2006	22	Zamalka	8.1	14.9	442	6.4	15	0.6	31.6	7.5	2		
03/2006	24	Daayani Dabaghat	8	14.7	398	6.8	10	3	24.2	10	1.9		
03/2006	32	Al Akrabani Rislan	7.6	14.8	439	3.4	30	2.1	28.2	30	2		
04/2006	1	Spring	7.9	14.3	355	8.5	1	0.08	7.2	2.5	0.8	3.66	
04/2006	2	Tekeyeh	8.1	14.4	402	5	6	1.32	13.4	15	5	4.096	

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
04/2006	3	Kfeir Elzayt	8.15	15.4	425	7.8	3	0.6	21.9	15	2.8	3.07	
04/2006	4	Before Fijeh Spring	8.2	14.6	406	8.1	3	0.55	19.8	15	2.5	6.49	
04/2006	5	After Fijeh Spring	8.2	14.4	325	8.3	2	0.19	19.1	10	2	9.87	
04/2006	6	Al Hameh	7.2	14.3	344	8.4	4	0.37	20.4	10	1		
04/2006	7	Al Difaa Factories	7.4	13.3	346	8.1	2	0.3	29.1	10	1.1	4.52	
04/2006	8	Glass Factory	7.52	15.3	348	7.5	2	0.27	36.6	15	1	3.867	
04/2006	9	Tora - Alkasr	7.6	13.8	354	7.2	4	0.5	34.9	15	1.2	3.92	
04/2006	10	Banias Al Rabweh	7.7	14.2	362	7.5	6	0.7	26.6	10	1.3	5.681	
04/2006	11	Al Rabweh	7.7	13.7	364	7.4	8	0.87	35.7	10	1.5	1.25	
04/2006	12	Al Dabaghat	8.3	14.6	340	7.2	2	0.34	48.6	15	2.5	3.027	
04/2006	20	Al Gisr Al Abyad	7.74	14.2	353	7.4	4	0.4	21.7	10	1.87	2.59	
04/2006	21	Kuria Embassy	8.27	13.1	344	6.9	2	0.3	30.1	20	1.6	3.15	
04/2006	22	Zamalka	7.7	14.5	419	6.7	24	2.3	34.1	20	2	3.064	
04/2006	24	Daayani Dabaghat	7.9	14.8	550	6.3	54	3.75	67.8	50	6		
04/2006	32	Al Akrabani Rislan	8.18	14.4	350	6.8	8	0.5	42.1	15	5	1.38	
04/2006	34	Mlehani	8.03	14.1	392	7.1	12	0.56	68.8	15	7	1.71	
05/2006	1	Spring	7.95	17.4	295	8.9	1	0.02	8.2	5	0.5	2.9	
05/2006	2	Tekeyeh	8.33	16.6	405	5.2	6	0.6	25.6	5	0.5	3.07	
05/2006	3	Kfeir Elzayt	8.32	16.8	421	8.4	9	0.8	34	5	0.6	1.81	
05/2006	4	Before Fijeh Spring	8.43	16.2	426	8.2	8	1.1	38	5	0.7	2.07	
05/2006	5	After Fijeh Spring	8.23	16.3	406	8	9	0.8	42.6	10	0.6	5	
05/2006	6	Al Hameh	7.76	16.4	455	7.9	18	1.47	53.4	15	1		
05/2006	7	Al Difaa Factories	7.81	16	450	7.9	6	0.876	37.5	15	0.9	2.05	
05/2006	8	Glass Factory	7.92	16.2	440	8	8	0.757	41	10	0.9	1.71	

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
05/2006	9	Tora - Alkasr	8	16.1	465	8	8	0.9	25.8	10	1	2.59	
05/2006	10	Banias Al Rabweh	7.98	16.2	445	7.9	10	0.37	24	10	0.8	1.49	
05/2006	11	Al Rabweh	8	15.8	442	7.6	12	0.87	30.4	10	2.5	0.54	
05/2006	12	Al Dabaghat	8.4	15.8	380	7.7	15	0.54	23.9	20	1		
05/2006	20	Al Gisr Al Abyad	8.34	16.4	399	8	10	1.26	35	15	1		
05/2006	21	Kuria Embassy	8.26	15.3	350	7.3	15	0.26	28.1	10	1.2	0.66	
05/2006	22	Zamalka	8.47	16.1	432	6.8	20	0.88	30.2	20	1	0.63	
05/2006	23	Harasta - canned food factory	8.3	16.8	413	6.6	20	0.75	20.6	20	1		
05/2006	32	Al Akrabani Rislan	8.32	16.2	376	4.5	30	2.3	24.9	20	1.4	0.83	
06/2006	1	Spring	8.2	17.9	308	8.8	6	0.26	?	5	0.5		
06/2006	2	Tekeyeh	8.29	21.8	460	4.5	12	3.7	?	5	0.8		
06/2006	3	Kfeir Elzayt	8.3	20.3	493	7.6	17	1.63	?	5	0.6		
06/2006	4	Before Fijeh Spring	8.65	17.9	465	7.2	12	0.65	?	5	0.8		
06/2006	5	After Fijeh Spring	8.43	18.3	443	6.9	13	0.37	?	10	0.6		
06/2006	6	Al Hameh	8.83	19.1	583	6.8	30	2.4	?	10	0.9		
06/2006	7	Al Difaa Factories	8.66	20.3	566	6.4	30	2.54	?	15	1		
06/2006	8	Glass Factory	8.84	19.5	584	6	25	2.18	?	20	1.2		
06/2006	9	Tora - Alkasr	8.2	20.3	620	6.1	25	3.28	?	20	0.9		
06/2006	28	Derani Rabwa Handasa	8.29	20.5	629	4.1	35	3.16	?	20	1.2		
08/2006	1	Spring	8.1	18	300	8.6	10		18	15	0.6		
08/2006	4	Before Fijeh Spring	7.8	16.5	440	7.6	15		6.9	15	1.1		
08/2006	5	After Fijeh Spring	8	16.8	433	7.7	20		6.1	25	1		
08/2006	6	Al Hameh	7.9	20	588	4.6	30		9.1	45	1.8		

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
08/2006	8	Glass Factory	7.7	21.3	688	6.2	30		7.5	110	1.9		
09/2006	1	Spring	7.8		302		9	0.3	19.7	5	1.4		
09/2006	2	Tekeyeh	8.1		543		22	1.3	41.3	15	2.1		
09/2006	4	Before Fijeh Spring	8.1		407		33	0.7	35.3	10	1.2		
09/2006	5	After Fijeh Spring	8		413		21	.0.8	30.1	15	2.1		
09/2006	6	Al Hameh	7.7		566		60	3.3	21.2	20	0.9		
09/2006	8	Glass Factory	8		670		20	3	21.99	40	1		
09/2006	28	Derani Rabwa Handasa	7.8		752		15	2.1	33.03	20	1.1		
10/2006	1	Spring		13.4		7	12	0.6	22.9	20			
10/2006	2	Tekeyeh		14.2		2.5	22	13	9.3	25			
10/2006	4	Before Fijeh Spring		16.3		6.6	36	0.6	12.6	15			
10/2006	5	After Fijeh Spring		14.5		6.2	30	12.4	5.8	20			
10/2006	6	Al Hameh		13.5		4.4	40	3.2	25.8	35			
10/2006	7	Al Difaa Factories		13		5.3	50	3.1	9.9	25			
10/2006	8	Glass Factory		13.1		6.7	40	5.5	20	100			
10/2006	19	Yazid - Electricity Station		14		2.8	30	12.2	27	100			
10/2006	20	Al Gisr Al Abyad		14.8		3.6	40	12.2	21	90			
11/2006	1	Spring	7.9		310		10		25	20	0.6		The river is dry
11/2006	4	Before Fijeh Spring	7.8		432		16		7	10	0.5		The river is dry

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
12/2006	6	Al Hameh	7.02	11.3	594	6.5	45	6.5	7.5	25	16		The water in the riverbed was from the Wastewaters and some wells because the spring was dry
12/2006	7	Al Difaa Factories	6.97	14.2	744	7.1	30	4	6.5	12.5	14		The water in the riverbed was from the Wastewaters and some wells because the spring was dry
12/2006	8	Glass Factory	7.41	11.6	614	7	10	6.5	6	30	0.9		The water in the riverbed was from the Wastewaters and some wells because the spring was dry
12/2006	9	Tora - Alkasr	7.5	28.2	762	6.5	35	6.7	6.9	10	3.2		The water in the riverbed was from the Wastewaters and some wells because the spring was dry
12/2006	18	Kaboun	7.48	17.8	639	4.5	20	8.5	6.3	10	2.8		The water in the riverbed was from the Wastewaters and some wells because the spring was dry
12/2006	20	Al Gisr Al Abyad	7.68	9.6	755	6.5	10	8	6.2	8	1.6		The water in the riverbed was from the Wastewaters and some wells because the spring was dry

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
12/2006	28	Derani Rabwa Handasa	7.9	14	758	5.5	10	7	6	8	1.3		The water in the ri-verbed was from the Wastewaters and some wells because the spring was dry
01/2007	4	Before Fijeh Spring	7.2	14	514	7.2	20	0.1		20	1		
01/2007	5	After Fijeh Spring	7.2	13.2	515	7.1	25	0.1		25	1.2		
01/2007	6	Al Hameh	7.7	10.4	572	6.2	46	1.5		30	13		
01/2007	7	Al Difaa Factories	7.7	10	543	5.8	3.6	1.6		25	12		
01/2007	8	Glass Factory	8	9.5	595	7	16	2.2		30	1.2		
01/2007	9	Tora - Alkasr	8	9.9	666	6.8	36	2.5		30	5.2		
01/2007	28	Derani Rabwa Handasa	7.9	9.3	666	7.2	30	3		35	4		
02/2007	3	Kfeir Elzayt	7.2		692		164	2.9	29.4	50	3		
02/2007	4	Before Fijeh Spring	6.7		599		164	5.9	29.9	20	4		
02/2007	5	After Fijeh Spring	7		585		164	5.8	29.4	25	4		
02/2007	6	Al Hameh	7.2	14.7	611	6.9	14	4.5	17	30	4.5		
02/2007	7	Al Difaa Factories	7.3	15.1	602	7	10	4.5	33.1	30	3.5		
02/2007	8	Glass Factory	7.5	14.1	626	7.4	16	2.5	35.4	30	3.5		
02/2007	9	Tora - Alkasr	7.6	14.4	670	7.3	8	10	39.7	35	8.5		
02/2007	11	Al Rabweh	7.4	15.9	677	6.8	8	6	20.6	35	3		
02/2007	28	Derani Rabwa Handasa	7.3	13.4	673	6.1	24	2.9	29.4	50	4.5		
03/2007	1	Spring	7.7	19.2	383	7.4	5	0.3	12	25	0.8		
03/2007	2	Tekeyeh	7.6	14.3	440	3.5	5	5	27	15	1.6		
03/2007	3	Kfeir Elzayt	7.4	13.6	480	7	5	3.5	45	30	1.5		

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
03/2007	4	Before Fijeh Spring	7.2	13.2	505	7.8	10	4.5	98	20	1.3		
03/2007	5	After Fijeh Spring	7.3	14	385	7.7	10	2	32	15	1		
03/2007	6	Al Hameh	7.6	14.3	468	6.7	12	3	18	25	1.7		
03/2007	7	Al Difaa Factories	7.5	14.5	456	7	12	3.5	19	20	1.6		
03/2007	8	Glass Factory	7.7	14.3	472	7.1	4	3.2	64	25	1.5		
03/2007	9	Tora - Alkasr	7.7	14	447	7.5	22	4.5	95	25	2		
03/2007	10	Banias Al Rabweh	7.7	14	512	7.3	10	9.48	634	30	4		
03/2007	11	Al Rabweh	7.8	14.5	500	7.5	15	15.4	85	30	2.2		
03/2007	12	Al Dabaghat	7.7	12	434	7.3	25	7.7	52	25	2		
03/2007	13	Ghouta											Wastewaters
03/2007	14	Zebdin	7.7	12.2	810	1.2	90	90.3	130	80	120		
03/2007	15	Jisrin	7.6	18	830	1.3	95	90	120	95	110		
03/2007	16	Bet Naiem	7.7	12.3	860	1.5	90	90	110	90	100		
03/2007	17	Keftaro											Wastewaters
03/2007	18	Kaboun	7.7	13	560	3.5	70	83.8	182	25	86		
03/2007	20	Al Gisr Al Abyad	7.7	14.5	485	6.4	6	2	49	25	2		
03/2007	21	Kuria Embassy	7.8	10.5	430	6.5	21	5.8	48	15	1.1		
03/2007	22	Zamalka	7.8	12	575	5.3	20	6.5	91	90	30		
03/2007	23	Harasta - canned food factory	7.8	11.1	543	6.5	25	16	34	30	2.5		
03/2007	24	Daayani Dabaghat	7.7	11.2	600	5.3	60	70	34	50	2.5		
03/2007	32	Al Akrabani Rislan	7.7	11.2	440	6.8	35	9.7	103	20	2.5		
03/2007	34	Mlehani	8	11.1	471	6.8	20	38.7	84	30	2		
4/2007	1	Spring	7.8	14.6	376	8.3	0	0.1	12.2	5	0.85		
4/2007	2	Tekeyeh	7.8	14.1	422	5.5	2	2.5	20	5	1.3		

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
4/2007	3	Kfeir Elzayt	7.85	14.6	440	8.8	2	2	13	5	1		
4/2007	4	Before Fijeh Spring	7.86	15.1	448	8.4	8	2	13.5	5	1.8		
4/2007	5	After Fijeh Spring	7.94	14.5	425	8.3	10	1.5	14.6	5	1.5		
4/2007	6	Al Hameh	7.76	14.3	450	8.8	14	3	9.1	5	1.4		
4/2007	7	Al Difaa Factories	7.8	14.4	446	8.1	14	3	18.2	10	1.1		
4/2007	8	Glass Factory	7.8	14.5	455	8.6	6	2	14.8	5	1.9		
4/2007	9	Tora - Alkasr	7.71	14	483	8	20	7.7	28.7	10	2		
4/2007	10	Banias Al Rabweh	7.7	16.5	488	9.1	6	4.16	21.5	5	2		
4/2007	11	Al Rabweh	7.82	17	491	9.3	10	1.6	12.6	10	1.7		
4/2007	12	Al Dabaghat	7.85	13.2	470	9.8	12	0.6	16	10	2.5		
4/2007	13	Ghouta											Dry
4/2007	14	Zebdin											Swamp/Wastewaters
4/2007	15	Jisrin											Dry
4/2007	16	Bet Naiem											Dry
4/2007	17	Keftaro											Swamp/Wastewaters
4/2007	18	Kaboun											Swamp/Wastewaters /Waste
4/2007	19	Yazid - Electricity Station											Swamp
4/2007	20	Al Gisr Al Abyad	7.87	15.2	474	8.5	6	0.9	28.8	5	2.5		
4/2007	21	Kuria Embassy	7.96	13.5	462	7.3	4	1.2	41.6	5	2.5		
4/2007	22	Zamalka	7.86	13.9	572	6.2	9	3.8	33.2	10	2.4		
4/2007	23	Harasta - canned food factory	7.86	15.2	540	6.5	10	5.1	25	5	2.5		
4/2007	24	Daayani Dabaghat											Swamp/Wastewaters

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
4/2007	25	Daayani Kafer Batna											Dry
4/2007	26	Derani Razi											Dry
4/2007	27	Derani KaferSou-seh											Dry
4/2007	28	Derani Rabwa Handasa	7.87	15.2	487	8.2	14	3.8	50	5	15		
4/2007	29	Derani Mathaf	7.97	14.1	515	5.4	16	4.32	260	5	7		
4/2007	31	Banias Mathaf											Closed
4/2007	32	Al Akrabani Rislan	7.99	13.1	473	8.1	18	0.9	25.9	5	2.5		
4/2007	33	Al Akrabani Ma-tarRoad											Wastewaters
4/2007	34	Mlehani											Wastewaters
5/2007	1	Spring	7.8	16.5	294	6.4	7	0.3	22	10	1		
5/2007	2	Tekeyeh	7.9	17.1	421	3.1	8	1.85	26	15	1.5		
5/2007	3	Kfeir Elzayt	8.1	17.5	445	6.3	14	2.15	27.1	10	1.2		
5/2007	4	Before Fijeh Spring	8	17.6	447	6.2	20	2.3	32	10	1.5		
5/2007	5	After Fijeh Spring	7.9	17.6	436	6	10	1.45	18	15	1		
5/2007	6	Al Hameh	7.9	18	476	5.8	30	1.58	22.2	20	1.1		
5/2007	7	Al Difaa Factories	8	18.7	467	5.4	32	1.46	16	20	1.8		
5/2007	8	Glass Factory	7.9	20	501	5.8	14	2.7	15.1	20	1.5		
5/2007	9	Tora - Alkasr	8	20	543	5.4	14	2.14	17	30	1.3		
5/2007	10	Banias Al Rabweh	8	21.4	543	6.1	38	1	22.3	35	1.6		
5/2007	11	Al Rabweh	7.3	21.5	559	6	26	1.1	24	30	1.2		
5/2007	12	Al Dabaghat	7.9	22	561	9	60	2.8	27	30	1.2		
5/2007	13	Ghouta											Dry

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
5/2007	14	Zebdin											Swamp/Wastewaters
5/2007	15	Jisrin											Swamp/Wastewaters
5/2007	17	Keftaro											Dry
5/2007	18	Kaboun	8.1	2.3	560	1.1	55	27.5	24.4	25	2.5		
5/2007	19	Yazid - Electricity Station											Dry
5/2007	20	Al Gisr Al Abyad	8.1	20	523	3.4	10	2.14	28	20	1.5		
5/2007	21	Kuria Embassy	7.9	20.5	543	3.8	30	6.9	26	25	1.7		
5/2007	22	Zamalka	7.6	22.5	642	2.4	45	15.7	17.3	45	2.1		
5/2007	23	Harasta - canned food factory	7.5	22.3	690	2.2	55	18.9	26	40	1.4		
5/2007	24	Daayani Dabaghat											Dry
5/2007	25	Daayani Kafer Batna											Dry
5/2007	26	Derani Razi											Dry
5/2007	27	Derani KaferSou-seh											Dry
5/2007	28	Derani Rabwa Handasa	7.7	20.3	544	3.7	18	2	38	35	1.1		
5/2007	29	Derani Mathaf											Dry
5/2007	30	Derani Khazan											Dry
5/2007	31	Banias Mathaf											Dry
5/2007	32	Al Akrabani Rislan	7.6	21.5	562	8.3	60	6.3	17	35	1.1		
5/2007	33	Al Akrabani Ma-tarRoad											Dry
5/2007	34	Mlehani											Dry
6/2007	1	Spring	7.2	19.6	378	6.4	5	0.5	13	30	1		
6/2007	2	Tekeyeh	7.2	19.2	441	1.7	15	2.8	12.8	30	2		

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
6/2007	3	Kfeir Elzayt	7.9	21.4	525	6.9	15	3.5	10.6	25	1.5		
6/2007	4	Before Fijeh Spring	8	16.4	444	4.8	20	2.2	17	5	1		
6/2007	5	After Fijeh Spring	7.8	17	431	4.5	20	1.7	18.1	25	2		
6/2007	6	Al Hameh	7.8	18.2	534	4.6	25	7.74	16.1	35	1.3		
6/2007	7	Al Difaa Factories	8	18	524	3.6	20	3.2	13	20	1.6		
6/2007	8	Glass Factory	7.9	18.7	553	5.1	10	1.9	12.5	30	3.5		
6/2007	9	Tora - Alkasr	7.9	19.2	605	4.6	20	4.1	13.6	45	2		
6/2007	10	Banias Al Rabweh	8.2	21.2	610	5.3	20	1.29	19.3	30	2		
6/2007	11	Al Rabweh	8.1	20.1	610	5.1	20	2.58	20.9	25	1.5		
6/2007	12	Al Dabaghat	8.2	23.1	633	7.8	24	3.2	22.2	25	2.5		
6/2007	13	Ghouta											Swamp/Waste
6/2007	14	Zebdin											Wastewaters
6/2007	15	Jisrin											Wastewaters
6/2007	16	Bet Naiem											Wastewaters
6/2007	17	Keftaro											Swamp
6/2007	18	Kaboun											Swamp
6/2007	19	Yazid - Electricity Station											Swamp
6/2007	20	Al Gisr Al Abyad	8.2	24.1	612	4.2	20	3.2	26.3	35	2.5		
6/2007	21	Kuria Embassy											Swamp
6/2007	22	Zamalka											Swamp
6/2007	23	Harasta - canned food factory											Dry
6/2007	24	Daayani Dabaghat											Dry
6/2007	25	Daayani Kafer Batna											Dry

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
6/2007	26	Derani Razi											Dry
6/2007	27	Derani KaferSou-seh											
6/2007	28	Derani Rabwa Handasa	8	18.6	650	2.3	35	12.9	17.9	35	2.9		
6/2007	29	Derani Mathaf											
6/2007	30	Derani Khazan											Dry
6/2007	31	Banias Mathaf											Dry
6/2007	32	Al Akrabani Rislan	8	22	645	7.6	30	5.3	30	30	2.7		
7/2007	1	Spring	7.8	19	258	10.4	10	0.35	17	25	1.6		
7/2007	2	Tekeyeh	7.63	23	610	2.4	30	7.75	20.9	30	1.5		
7/2007	4	Before Fijeh Spring	8.18	19.5	446	6.7	10	0.5	10.5	35	2		
7/2007	6	Al Hameh	8.25	18.5	520	3.6	30	2.5	18	25	1.5		
7/2007	7	Al Difaa Factories	8.29	19	531	3	20	2.7	40	30	1.75		
7/2007	8	Glass Factory	8.4	20	611	6.2	20	2.5	15	25	1.5		
8/2007	4	Before Fijeh Spring	7.8	21	365	5.6	10	0.9	13.9	20	0.3		
8/2007	5	After Fijeh Spring	7.7	20	370	4.1	20	3.5	50.4	25	0.5		
8/2007	6	Al Hameh	8.1	20.2	660	2	40	11.2	30.7	45	0.8		
8/2007	7	Al Difaa Factories	7.6	16.1	600	2.3	20	11.5	21.8	55	0.7		
8/2007	8	Glass Factory	7.7	16.2	743	3.5	20	30	21.2	35	0.8		
9/2007	4	Before Fijeh Spring	7.8	16.1	445	5.5	16	2.6	13.5	40	2		
9/2007	5	After Fijeh Spring	7.7	18.4	428	4.1	16	2	14	25	2.5		
1/2008	1	Spring											Dry
1/2008	2	Tekeyeh	7.8	11.3	568	6.9	25	15	42	100	35		

Date	Area Code	Area Name	pH	C	Cond us/cm	DO	BOD	NH_4	SS	CL	NTU	Q (m^3/s)	Comments
1/2008	3	Kfeir Elzayt											Dry
1/2008	4	Before Fijeh Spring											Dry, Fixing River Bed
1/2008	5	After Fijeh Spring											Dry, Fixing River Bed
1/2008	6	Al Hameh	7.6	10	677	6.3	34	2	39.1	75	28		
1/2008	7	Al Difaa Factories	7.9	10.5	674	7	30	10	17.9	50	17		
1/2008	8	Glass Factory	7.9	1.2	704	7.9	12	5	18.5	50	29		
1/2008	9	Tora - Alkasr	7.9	11.9	760	6.5	30	20	38	100			
1/2008	10	Banias Al Rabweh											Wastewaterss
2/2008	3	Kfeir Elzayt	7.9	10.5	753	4.7	10	2.3	20.4	50	18		
2/2008	4	Before Fijeh Spring	7.8	11.1	774	4.8	24	4.1	22.2	60	25		
2/2008	5	After Fijeh Spring	7.9	11.2	794	4.8	16	3	80.4	55	40		
2/2008	6	Al Hameh	7.6	10.1	667	3.5	64	8.3	55.3	70	18		
2/2008	7	Al Difaa Factories	7.7	10	710	3.3	32	6.4	32.3	65	19		
2/2008	8	Glass Factory	7.8	10.4	750	3.9	30	9	28.8	75	16		
2/2008	9	Tora - Alkasr	7.6	10.5	764	4.7	24	8.3	70.3	95	26		
2/2008	20	Al Gisr Al Abyad	7.5	10.4	782	3.5	35	8.1	54.1	80	30		
2/2008	32	Al Akrabani Rislan	7.6	10.2	790	3.5	25	11.8	344	80	25		