Report No. 22602-SYR

Syrian Arab Republic Irrigation Sector Report

August 6, 2001

Rural Development, Water, and Environment Group
Middle East and North Africa Region

Document of the World Bank

CURRENCY EQUIVALENT

(Exchange Rate Effective)

Currency Unit = Syrian Pound (S.P)

S.P 46 = US$1.00

ABBREVIATIONS AND ACRONYMS

DIWU	Department of Irrigation and Water Use
DPC	Department of Pollution Control
DSS	Decision Support Systems
GDP	Gross Domestic Product
GIS	Geographic Information Systems
ICARDA	International Center for Agricultural Research in the Dry Areas
JICA	Japan International Cooperation Agency
MAAR	Ministry of Agriculture and Agrarian Reform
MHU	Ministry of Housing and Utilities
MIS	Management Information Systems
MOF	Ministry of Finance
MOI	Ministry of Irrigation
MOP	Ministry of Planning
O&M	Operations and Maintenance
SAC	Supreme Agricultural Council
SAR	Syrian Arab Republic
SPC	State Planning Commission
WUA	Water Users Association

Vice President:	Jean-Louis Sarbib
Country Director:	Joseph P. Saba
Sector Director:	Doris Koehn
Task Team Leader:	Shobha Shetty

Acknowledgments

This report was the work of the World Bank's Rural Development, Water, and Environment Group of the Middle East and North Africa Region. The core team responsible for the preparation of the report comprised Shobha Shetty (Task Team Leader/Sr. Economist), Satoru Ueda (Sr. Water Resources Specialist), Safwat Abdel-Dayem (Drainage Advisor), and Marcus Moench (Institutions Specialist, Consultant).

The report is based on the findings of a mission to Syria in May 2000. The report also draws extensively from existing documentation where available, in particular, the reports on water resources development in selected basins in Syria by the Japanese International Cooperation Agency (JICA). The draft report benefited from the comments and discussion during a national stakeholder workshop held in Damascus on April 7, 2001. The team would like to express their sincere thanks to the staff of the State Planning Commission, Ministry of Irrigation, Ministry of Finance, and the Ministry of Agriculture and Agrarian Reform of the Government of the Syrian Arab Republic for their cooperation, and for sharing information and insights.

The report was prepared under the guidance of Salah Darghouth, Sector Manager, Water and Environment, MNSRE. The peer reviewer was Fernando Gonzalez, Irrigation Advisor, RDV. Helpful comments were also provided by Inder Sud, Doris Koehn, Usaid El-Hanbali and Ashok Subramanian. Important administrative assistance was provided by Magalie Pradel and Marie-Françoise How Yew Kin.

SYRIAN ARAB REPUBLIC

IRRIGATION SECTOR REPORT

TABLE OF CONTENTS

List of Figures

List of Maps

EXECUTIVE SUMMARY

I. INTRODUCTION

1 In response to a request of the Government of the Syrian Arab Republic (S A.R), a Bank mission visited Syria in May 2000 to carry out a preliminary review of the Syrian irrigation sector. This report draws on the mission's discussions with the staff of the Ministry of Irrigation, Ministry of Agriculture and Agrarian Reform, Ministry of Finance, State Planning Commission, Ministry of Supply, and the Agricultural Cooperative Bank, Ministry of Economy and Foreign Trade at the central and governorate levels The report also draws extensively from existing documentation and reports made available to the mission by the Government, in particular, the extensive reports of the recent JICA study (October 1997; January 2000) The objective of the report is to analyze key issues and constraints facing the sector, and propose a set of recommendations and possible areas of support by the World Bank. As agreed with the Government at the outset, water resources management issues pertaining to international rivers are not discussed Urban water and sanitation issues are also not addressed in this note – this has been dealt with in an earlier Bank sector note [1] The first draft of this report was extensively discussed at a national stakeholder workshop held in Damascus, Syria in April 2001 which was attended by over 75 participants from various Ministries, farmer organizations, other non-governmental organizations (NGOs) and academia In summary, the participants of the workshop supported the analysis, the findings and recommendations of the report and the program proposed for future cooperation with Syria in the sector This report incorporates the comments received during the workshop and during discussions with Syrian government officials

II. WATER SUPPLY, USE AND BALANCE

2. In Syria, the total estimated water use volume is about 15 billion m3, with the Euphrates and Orontes basins accounting for about 50% and 20% respectively. As shown in the table below, the water balance in most basins has been in deficit and this will be exacerbated in those basins encompassing large urban areas such as Damascus and Aleppo. As in most other Middle East and North Africa (MENA) countries, agriculture is the largest consumer of water – over 85% While the urban water demands will rapidly increase due to relatively high population growth (about 2.5% per annum)[2] and industrial growth, new water sources are becoming scarce and extremely expensive to develop. Domestic water demands are expected to increase by nearly 30% in ten years, which would require an additional 110 MCM in Barada/Awaj basin and a further 80 MCM in the Aleppo basin to meet domestic water supply needs The water deficits are expected to worsen placing additional stress on all uses. Since drinking water needs are given top priority in the government's policy, water availability for agricultural use could face severe constraints

---

[1] **Syrian Arab Republic: Urban Water and Sanitation Sector Note**, January 1999 Infrastructure Development Group, Middle East and North Africa Region, The World Bank

[2] According to the 1999 Statistical Abstract (Central Bureau of Statistics, Syrian Arab Republic), the population growth rate between 1981-94 was 3 3% However, there has been a large decline in the fertility rate in the 1990s, reflected in the declining crude birth rate The result has been a steady decline in the population growth rate, from an average of 3 3 percent during the intercensal period 1981-1994 to about 2 5 percent in recent years (1995-2000)

Water Availability and Uses[3]
Unit: million m3/year

Basin	Irrigation		Domestic		Industrial		Use Total	Renewable Water Resources
	Volume	Share(%)	Volume	Share(%)	Volume	Share(%)	Volume	Volume
Yarmouk	360	82	70	16	10	2	440	500
Aleppo	780	68	280	24	90	8	1,150	500
Orontis	2,230	82	230	8	270	10	2,730	3,900
Barada / Awaj	920	68	390	29	40	3	1,350	900
Coast	960	86	120	11	40	4	1,120	3,000
Steppe	340	87	40	10	10	3	390	700
Euphrates	7,160	95	250	3	110	1	7,520	N.A.
Total	12,750	87	1,390	9	570	4	14,700	

3. Non conventional water resources include desalination of brackish and saline water, harvesting run-off, and reuse of treated domestic and industrial wastewater and agricultural drainage water. The government policy is to ultimately utilize, within each basin, all treated wastewater. Planned use of wastewater is an important and effective means for increasing water availability and protecting the environment and the public health. Syria ultimately expects to have 420 MCM of treated wastewater available on an annual basis which represents about 8% of current irrigation water uses (excluding the Euphrates). While this is important, it cannot be counted as an additional source of supply because, based on discussions with officials, much - if not most of it - is already used by agriculture in an untreated form.

Water Quality and Pollution Control

4. Contamination of surface and ground water resources has become an issue of serious concern in Syria due to the direct discharge of domestic and industrial wastewater to the water bodies (rivers, canals, streams and lakes). Until two years ago the country was virtually without domestic wastewater treatment facilities. Wastewater disposed into rivers is used downstream for irrigation and probably for drinking purposes too that has resulted in the spread of waterborne diseases such as typhoid, dysentery, and diarrhea. Potential for groundwater contamination through deep percolation is high where surface water and groundwater aquifers are interconnected. Although there is no systematic and regular monitoring of groundwater quality, there are several indications of pollution of ground water in different areas such as in the suburban area of Damascus (Ghouta) and South Aleppo. The World Bank-supported National Environmental Action Plan (NEAP) (1999) reports that the periodic monitoring campaigns carried out by the Ministry of Health, Ministry of Housing, MOI, and MAAR laboratories demonstrate convincingly that pollution of ground and surface waters with industrial and domestic wastes occurs across the entire country, near all major settlements. In addition, the ecosystems of many rivers and streams are showing serious deterioration or even irreversible damage. In spite of the rising official and public awareness about the state of the environment

[3] Adapted from JICA (1997) and others. These estimates are provisional and need to be reviewed. The renewable water resources are estimated based on average hydrological data showing only maximum potential supply in the absence of any other constraints.

and the pollution of surface and ground water, there is still no comprehensive framework for pollution control.

III. IRRIGATED AGRICULTURE

5. Agriculture dominates the Syrian economy as the single largest contributor to GDP at about 30 percent of the total, employing nearly 25 percent of the workforce, with another 50 percent of the manufacturing workforce dependent on it for employment. Agriculture also employs the majority of the female workforce. The cultivated land area in Syria was estimated at 5.5 million ha, or about 30% of the total country area in 1998 of which about 20 percent (1.2 million ha) was irrigated. With a rural population of 40%, agriculture, and irrigated agriculture in particular, have strong impact on poverty alleviation and income distribution. Despite some liberalization reforms in the early 1990s, the country's economic structure remains highly centralized. Government control over agriculture is strong. It intervenes in pricing, subsidy allocation, the provision of services, and concessionary finance and loans. Wheat, cotton, sugarbeet, tobacco, barley, and maize are among the key strategic crops. Marketing of cotton and tobacco is entirely controlled by the Government. Cotton is the major agricultural export accounting for about 10 percent of total value of exports in 1998.

6. In 1998, of the total cultivated area of 5.5 million hectares, wheat accounted for 31% (of which 40% is grown under irrigated conditions), followed by barley with 28% (mainly rainfed). All of the cotton crop (5% of total cultivated area), fruits and vegetables (3% of total cultivated area) and sugarbeet (0.5% of total cultivated area) are grown under irrigated conditions. However, it is the percentages as a proportion of total irrigated cropped area that are striking. In 1998, wheat accounted for the bulk of the total irrigated cropped area[4] (51%), followed by cotton (20%), fruits and vegetables (16%), sugarbeet (7%),and maize (5%). In terms of irrigation water use, cotton accounted for the greatest share (32%), followed by wheat (27%), fruits (17%), and other crops and vegetables (24%). According to recent estimates, the cost of water accounts for about 15 percent of the total cost of cultivation of cotton, a value of about 4 billion S.P.[5]

Irrigation Development

7. The total irrigated area increased from 650,000 ha in 1985 to 1.2 million ha in 1998. This remarkable expansion of irrigation can be attributed to the rapid increase in groundwater irrigation. (See Table below). Sixty percent of all irrigated areas in Syria is currently irrigated by groundwater, which are all privately developed and operated. Almost 50% of the total number of wells in the country are illegal leading to severe overdraft and pollution problems. *Unsustainable groundwater use has led to overdraft and pollution in many areas making groundwater management one of the key challenges in Syrian irrigated agriculture.* The Government of Syria is exploring various options to meet this challenge including a ban on all new licenses for wells in critical areas, and well consolidation.

8. There seems to be a large scope for the improvement of the water delivery efficiency through the construction of modernized water control and delivery systems including canal lining and pipeline distribution networks and improved measurement through telemetry control, etc. In the government surface irrigated systems, other than the concrete-lined canals of the Euphrates,

---

[4] 1.36 m ha for an irrigation cropping intensity of about 112%.

[5] Survey of the Syrian Cotton Sector, Syrian European Business Centre, October 2000.

most of the other irrigation canals are estimated to have a conveyance efficiency of only about 50-60%. On-farm water use efficiency in general, is low (about 40%-60%) due to over-irrigation, use of traditional irrigation techniques like surface (furrow) irrigation, and lack or inadequacy of land leveling. Cropping intensities are also low averaging around 112%.

Irrigated Area by Source

Year	Surface Irrigated ('000 ha)	Groundwater Irrigated ('000 ha)	Total Irrigated Area ('000 ha)
1988	350 (53%)	310 (47%)	660
1998	489 (40%)	724 (60%)	1213

Modern Irrigation Technologies

9. The Government is encouraging the use of advanced on-farm irrigation technologies like drip and sprinkler irrigation to improve on-farm irrigation efficiencies, and conserve water. The government has provided tax-free low-interest loans through the Cooperative Agricultural Bank to meet the capital costs of sprinkler and drip irrigation systems. The coverage of the credit has been expanded from 85% to 100% of total capital costs in response to recent droughts. However, the present level of adoption of these technologies is still fairly low, with sprinkler irrigation covering about 80,000 ha and about 8,500 ha for drip irrigation.

10. The principal constraint preventing small farmers from investing in these types of the modernized on-farm irrigation systems is their limited financial capacity. Further, most farmers do not seem to be convinced that the financial returns from the expected increases of agricultural production would justify the investment and O&M costs and increased labor costs associated with maintaining the system. Government tariff policies on public irrigation schemes also do not provide an incentive for farmers to conserve water. Other key factors are: (i) inadequate access to information and extension services, which would provide farmers with technical support for planning, design, and O&M of the on-farm irrigation system as well as for irrigation practices and scheduling also seems to be a major factor; (ii) inappropriate interface between the public irrigation distribution systems (particularly for public surface water irrigation schemes) and the advanced on-farm irrigation systems, which require more reliable and continuous water supply at farm-turnouts, and (iii) small field sizes which mitigate against the efficient layout and design of an advanced on-farm irrigation system. Advanced on-farm irrigation systems and water conservation technologies have to be introduced at an accelerated pace in order to address the depletion of water resources and to enable optimal irrigation and increase agricultural yields. *Improving the extension services and farmer awareness are urgent priorities.*

Policy Issues

11. The Government's policy objective of achieving food self-sufficiency, especially in wheat, and the encouragement of cotton production resulted in a rapid expansion of irrigated agriculture in the last decade. The overall thrust towards irrigation expansion coupled with the government's output price policies and subsidies on credit, energy and water, have proved to be strong incentives for farmers to take up groundwater irrigation in many areas. Present *irrigation tariff policies* do not provide any incentives to farmers to invest in modernized on-farm irrigation systems. For the public surface water irrigation schemes in particular, farmers do not have any incentives to save water since the O&M charge is a flat fee unrelated to water consumption and determined by the field size alone. Government *credit policies* have also promoted unrestricted (till recently) groundwater irrigation. Farmers can avail of tax-free low interest rates for loans

from the Cooperative Agricultural Bank (CAB) to finance wells. The Government has also provided tax-free, concessionary loans through the CAB to meet the capital costs of drip and sprinkler irrigation systems. However, in the absence of appropriate irrigation tariffs on a volumetric basis and subsidized energy cost, farmers prefer to utilize cheap credit on well drilling rather than on modernizing their irrigation systems. *Price policies* have also contributed to substantial irrigation water use in low-value crops like wheat and maize. As shown in the table below, support prices for these crops have remained much higher than world prices.

World Prices and Govt. Support Prices * ($/ton) for Major Crops: 1996-98

Crop	1996	1997	1998
Wheat	210 (224)	161 (224)	126 (224)
Maize	163 (195)	119 (195)	102 (195)

* Support prices are in parentheses

12. Syria thus faces a major question with regard to its current policy of encouraging agricultural production of crops such as wheat and cotton. According to discussions with officials, agricultural and particularly cereal production has been encouraged at a policy level over the past decade as a mechanism for ensuring food and income security. This appears to have been considered important in the context of Syria's overall security concerns and had the objective of ensuring both internal stability (the support of politically important farming populations) and buffering Syria's exposure to market fluctuations or political dynamics beyond its borders. High levels of self-sufficiency in food production and the support for cotton appear, however, to have come at the price of unsustainable water use patterns. Irrigation is already by far the dominant water use and key water basins are suffering overdraft. Declining groundwater tables are a serious concern in several parts of the country. Overall, expansion of irrigated agriculture in the absence of clear new sources of supply is likely to undermine Syria's food and economic security over the intermediate to long-term. *Improvements in water use efficiency through both irrigation efficiency improvements and encouraging the growth of diversified high value and/or less water-intensive crops appear to be the primary short-term avenue for increasing water availability for all uses, including agriculture.*

13. Insofar as the specific strategies of the Syrian government pertaining to irrigation and water use in the agriculture sector are concerned, several priority issues have been identified in the sector to improve water use efficiency and promote environmentally sustainable development. These have been endorsed by the Supreme Agricultural Council and are also fully supported in this report. This can provide the basic framework for developing the appropriate policies to effectively overcome the identified constraints. However, any future strategy in irrigation or water resources management will need to be closely linked with reforms in agricultural policy. The Government will need to recognize that achieving food security with respect to wheat and other cereals in the short-term as well as the encouragement of water-intensive cotton appear to be undermining Syria's security over the long-term by depleting available groundwater resources. The transformation of existing irrigation systems will need to be achieved within the context of a more diversified agricultural production system. In the long-term, crop prices will need to become more aligned with international market prices in order to provide the right incentives to farmers. Cropping patterns will need to shift towards more high-value crops and more research on improving irrigation water use on different cropping systems will be imperative. These structural reforms will require a long-term perspective and will need a sufficiently long period of adjustment over 10-20 years.

IV. FINANCIAL ASPECTS

O&M and Cost Recovery

14. The cost of O&M of both irrigation and drainage schemes (except dams) is recovered from the farmers in the form of service charges. Since 1997, the capital cost of construction of new[6] irrigation and drainage projects and rehabilitation is recovered by the government from the farmers over 30 years (in yearly installments) without interest. On average, according to MOI sources, about 40% of the capital costs are now recovered. This makes Syria one of the few countries in the developing world where an attempt to collect capital costs is being made. The capital costs are computed as average costs in each basin, and the user cannot sell part/all of the reclaimed land before all the 30-year payments are made. While the O&M fees go directly to the Treasury, the capital cost payments are funneled into the National Debt Fund which is autonomous within the Ministry of Finance.

15. The O&M charge is periodically reviewed and modified by a committee of the Supreme Agricultural Council. In 1996, the charge was SP 2500 / ha (about $ 50 / ha) while the total average O&M costs were computed at SP 3600 / ha (about $ 80 / ha). As of December 1999, the O&M charge to farmers was increased to SP 3500 / ha (about $ 75 / ha) with the estimated average total (regular) maintenance costs of the diversion weirs, delivery canals and pumps up to farm gates excluding dams were estimated at about SP 4000 / ha (about $ 90 / ha). Responsibility of O&M at present is fully undertaken by MOI up to the farm gate level. The O&M fee can be regarded as a property tax since the amount of the fee to be paid is notified by the Ministry of Finance to each governorate based on the irrigated area for each household and is paid at the local branch offices of the Central Bank. No penalties are imposed if the user defaults on a payment. However, surcharges are applied on late fees in accordance with the laws governing late payment of taxes. However, fee collection rates have far exceeded projections in the last few years. According to Ministry of Finance sources, this can be attributed to errors in the preparation of lists of users at the governorate level by the MOI, underestimation of the number of farmers, compounded by inefficiencies in the billing and collection processes. However, there is no linkage between the collected O&M fees and the actual budget for the O&M activities. Farmers thus, do not perceive that the O&M charges that they are paying are associated with the actual O&M.

16. Syria, like many other developing countries, has an irrigation tariff system of a flat rate/ha that is administratively simple and easy for users to understand. According to MOI data, Syrian farmers pay about 80% of the O&M costs which is very high compared to other countries. Again, as is common, this is based on average rather than marginal costs of supply, and does not include provisioning for depreciation. However, since the fees are not related to the volume of water consumed, farmers have no incentive to use water efficiently. Volumetric pricing through metering is ideal but is usually associated with high implementation costs. However, this option will need to be carefully reviewed with the Government to assess its implementation on a pilot basis. In the absence of volumetric pricing, other countries use a combination of the two methods as is done by the water agency in Mexico where the federal water commission charges the WUA for quantity taken at the turnout of the secondary canal. In turn, the WUAs charge individual members on the basis of irrigated area and type of crop. Countries like Brazil and Korea use two-part tariff structures - a fixed fee to cover overhead expenses, and a variable fee based on use. This has the advantage of providing a reliable stream of income for irrigation authorities, while

[6] Since the issuance of Decree No. 7 of 1996 related to the 1984 Law.

retaining incentives for farmers to conserve water[7]. In Tunisia, three types of irrigation pricing coexist: a lump sum per hectare when metering is not available; a per cubic meter tariff for large public irrigation perimeters; and a two-part tariff with a fixed per hectare component and a volumetric component. *Syria will need to explore alternative tariff structures that would provide incentives for farmers to reduce wastage and use water more efficiently.*

Demand Management

17. Reforms in irrigation tariffs will not be sufficient to improve sustainable water use. Private groundwater irrigators who constitute the bulk of Syrian farmers today, do not pay any charges to the government except for the well licenses. As indicated by recent research results, *energy pricing* can have a significant impact on farmers' pumping behavior. The Government's efforts to curtail new well licenses is the right way forward, but enforcement will have to be more effective. In addition, *non-price measures* are equally important to encourage water-use efficiency. International experience has shown that *transferring management responsibilities to water users associations can have positive impacts on water use efficiency and cost recovery.* In this regard, the management of groundwater by the local water users association in the Nabak area in rural Damascus is notable. The association has established differential water charges for members and non-members and charges are doubled for non-authorized crops. In Tunisia, the government has made a clear strategic shift from water mobilization to demand management through the progressive phasing of financial/pricing, technical, legal, and institutional measures which will be implemented under the new World Bank-supported Water Sector Investment Project. The Government has proposed well consolidation schemes to reduce groundwater pumping in critical areas. However, this is extremely complex to implement and the institutional and regulatory framework for O&M of the consolidated well fields remain unclear. Beneficiary participation at all levels of the project cycle is essential. Overall, Syria may benefit from a careful review of international experiences with regard to institutional designs for water management, including groundwater management and well consolidation. Particularly in the groundwater case, it should be recognized that no single set of "best practices" has yet been identified. In most countries, groundwater management and the development of institutions for it is a relatively recent process. A wide variety of relevant experiences do, however, exist and these should be harvested before Syria finalizes its own approach.

V. THE INSTITUTIONAL CHALLENGE

Sector Organization

18. The Ministry of Irrigation (MOI) has overall responsibility for water resources management in the country. The administrative structure of the MOI is mirrored in the basin hydrological boundaries wherein the seven General Directorates are assigned responsibilities on the basis of the basin areas. This type of division of responsibilities is unique in MENA, and rare in other parts of the world too. Compared to other countries in the region, Syria is thus relatively well-positioned to promote decentralized water management at the basin-level. The Ministry of Agriculture and Agrarian Reform (MAAR) is the other key Ministry involved in irrigation also has its directorates in all basins. Its main water management activity is through its advisory role on cropping patterns, on-farm water use, and basic extension and research services to farmers. The Department of Irrigation and Water Use (DIWU) in particular, carries out nationwide

---

[7] *Water Pricing Experiences: An International Perspective*, eds. A. Dinar and A. Subramanian, World Bank Technical Paper No.386, 1997.

research work on crop water requirement, farm water management and irrigation methods and technologies.

19. Syria as a country is at an historic juncture. Until recently, substantial water resources remained undeveloped. Now, according to the MOI, most surface water resources have been developed. The groundwater balance in all basins (except the Coastal and Steppe basins) is negative. Furthermore, both surface and groundwater resources are threatened by pollution. *Government organizations need, as a result, to make a transition from a water development to a water management focused role.* This transition necessitates the building of management institutions and capacities within the government and local user populations.

Data Limitations

20. The government's ability to collect data in key areas, such as groundwater resource availability and water quality, is clearly limited. Computer capabilities within the government organizations appear weak, particularly in relation to water resource modeling, Geographic Information Systems and other forms of data processing and analysis. This represents a critical constraint on Syria's ability to analyze water resource concerns, to implement integrated water resources management, and to identify the strategic and institutional issues it may face. *There is a critical need for consolidated and reliable data on surface and groundwater resources to facilitate integrated water resources management including both water quality and quantity.*

21. At present, the capacity of government organizations to support water management (as opposed to water resources development) appears limited. Organizations appear structured and staffed primarily for the development of large water supply schemes. Component organizations dealing with data, pollution control, enforcement and other functions essential for management need to be strengthened. Capacities in research and extension are also limited. Insofar as the legal aspects are concerned, the Government has presented a comprehensive water law to the Parliament for consideration on October 3, 2000 which is a welcome step. However, ambiguities are likely to remain in relation to enforcement. User-based organizations such as the Farmers' Union are quite strong and well represented in high-level policy as well as at the implementation level. There may be significant opportunity for the development of user-based approaches to water management. Developing the necessary regulatory framework and the institutional arrangements are immediate priorities.

22. One of the urgent requirements for developing a comprehensive water quality management and pollution control plan is to establish well functioning water quality monitoring net work. The monitoring network that has been established by the Department of Pollution Control (DPC) of MOI is only for surface water quality (rivers, lakes, reservoirs, and sea coast), and monitoring of Ground water quality is occasional and are carried out at ad-hoc basis. The new draft water law proposed by MOI includes sections about water pollution control and legal actions in case of violations. The enforcement of the law will certainly help in pollution control but this would be insufficient unless it is done within comprehensive framework which include strengthening the monitoring capacity, treatment of wastewater and its reuse, improved water quality management, intersectoral coordination, development of adequate standards and specifications for wastewater disposal, wide involvement of all stakeholders and sufficient public awareness of the dangers of continuing with the status quo. The development and implementation of such comprehensive framework should be a top priority and should benefit from the existing initiatives undertaken by the government such as the construction of new wastewater treatment plants and the new draft water law currently under review by Parliament. The institutional capacity of the MOI in terms

of organization, staffing and equipment needs immediate strengthening to carry out an effective pollution abatement mandate. Cooperation with the Ministry of Environment would also be essential in order to identify major polluters and critical hot spots.

VI. POTENTIAL FOR WORLD BANK AND DONOR COOPERATION

23. From all available accounts, it is indubitable that Syria would benefit by undertaking a comprehensive initiative to develop an integrated water resources management strategy. Existing reports clearly indicate the fragmented nature of water management institutions, information and management capacities. However, Syria has the advantage of already having in place, an effective basis for decentralized management through its seven General Directorates at the basin level. Available studies also emphasize the magnitude of the emerging pollution, groundwater overdraft and general water scarcity problems Syria faces. If these are to be addressed, Syria will need a comprehensive, well-informed and effective strategy for managing its water resources. The earlier the development of such a strategy can be initiated, the greater the likelihood that effective policies can be implemented before problems become intractable.

24. The urgent need for a clear country strategy with respect to water does not imply that this needs to be undertaken prior to the implementation of specific projects where a clear need exists. Potential project interventions are described in the subsequent sections. Given the basic data that has already been collected through the various studies by JICA, efforts to collate basic data within Syria may be less important than in many other cases and need not be a pre-condition for the Government to proceed.[8] Water strategy work supported by the World Bank has followed different courses in India, Jordan, Nepal, Tunisia, and Yemen – countries where there is also a high reliance on groundwater in many areas. Each of these courses has different characteristics. This has, in turn, influenced the effectiveness of the strategy development exercise. Syria might, as a result, wish to review the approaches taken by a cross section of countries before designing and ultimately initiating its own water sector strategy work. Reviewing the strategies other countries have developed could create a basis for dialogue and joint understanding while respecting the sensitivity of Syria to water resource issues. In this regard, the recommendations contained in the World Bank's Urban Water and Sanitation Sector Note (1999) appear fully warranted. These include suggestions to develop a comprehensive policy framework for efficient water allocation and use, introduce charges for irrigation water that better reflect the cost of supply, and encourage growth of higher-value crops and/or less water intensive crops.

25. Based on the priorities of the Government, the results of the May 2000 mission, and the analysis presented in this note, proposed project interventions could be classified into three levels as shown below. The World Bank could assist the Government of Syria in securing financing - either through the Bank itself and/or through mobilizing other donors and cofinanciers - for financing entire package of interventions, partly or wholly, based on Government priorities. The proposed project interventions are described in the following paragraphs:

Level I

IA- Integrated Basin Management

- *Hydro-geological monitoring and assessment*
- *Demand Management*
- *Supply Management*
- *Conjunctive Use*

[8] This is to be confirmed in discussions with the MOI and JICA.

- *Water Quality Management*
- *Participatory Groundwater Management*

IB - Institutional Strengthening in WRM

- *Data Collection and Management*
- *Capacity Building and Training*

Level II

IIA - Irrigation System Improvement

- *Rehabilitation and modernization of existing irrigation systems*
- *Improved on-farm water management (incl. participatory management)*

IIB- Drainage and Water Quality Improvement

- *Drainage improvements in the Euphrates and other basins*
- *Development of a comprehensive water quality management framework and action plan*

Level III

Pilot Projects

- *Participatory groundwater management projects*
- *Appropriate technologies for treatment of wastewater and reuse in agriculture in rural communities*

Level I envisages an integrated, cross-cutting approach as follows:

I. A. Integrated Basin Management

Integrated water resources management is a cross-cutting approach for addressing the complicated and critical issues of both surface and groundwater including the water quality aspect. The Barada-Awaj and Aleppo basins would be priority basins for the implementation of this approach considering the magnitude of their water scarcity and pollution problems. The major components would be: i) basin-wide hydro-geological monitoring and assessment, ii) demand management (irrigation efficiency improvement coordinated with urban water supply efficiency improvement, which would be addressed by a different project(s)), iii) supply management (water harvesting / recharge dams, treated wastewater reuse for irrigation, potential inter-basin water transfer to be studied, iv) conjunctive use of surface and groundwater; v) water quality management (small-scale rural sanitation system in upper basins and intensive water quality monitoring), vi) Capacity enhancement of hydro-geological monitoring and computerized decision support systems as well as legislative / institutional mechanisms for improved water resources management; and vii) promotion of community-based approaches to groundwater management. For the case of Barada-Awaj basin, close coordination would be ensured with the proposed Greater Damascus Water and Sewerage Project, preparation of which is being supported by the World Bank through a grant to the MHU. The project objectives are be to improve the quality and increase the efficiency of water supply and sanitation services through rehabilitation of existing infrastructure; expansion of networks; modernization of operation and management systems; and provision of satisfactory wastewater collection and treatment. In particular, the recommendations of the ongoing Wastewater Strategic Planning and Priority Investment Study in Barada and Ghouta Gharbiyah area will be incorporated in any future project in the Barada/Awaj basin.

I. B Institutional Strengthening in Water Resources Management:

This could include the following elements:

(i) Data collection and management:
Establishing a national program for the monitoring necessary for integrated surface and ground water resources management (quantity and quality) and strengthening the capacity of the Pollution Control and Basins Departments of the MOI for field and laboratory measurements, data analysis, quality assurance and control of data, data bases and reporting. This should be a part of developing a comprehensive frame work for pollution control and integrated water resources management at the national scale.

(ii) Capacity building:
This would include capacity building and training in the Water Research Center (MOI) and the Department of Irrigation and Water Use (MAAR) to strengthen their capacity to carry out research for improved water management, modern irrigation and drainage systems and practices, water quality and other related issues. Strengthening the Irrigation and Water Resources Department and the Planning and Follow-up Department (MOI) to carry out water resources and project planning using modern concepts and tools of planning such as interactive data bases, management information systems(MIS), geographical information systems (GIS) and decision support systems (DSS) would also be necessary. Governmental capacity in regard to education, community outreach and stakeholder participation also needs to be strengthened. Government capacity in legal, economic, social science, and management skills will also need to be addressed.

Level II outlines specific areas where well-defined programs or projects can be implemented in selected basins or representative project sites as follows:

II. A. Irrigation System Improvement:

This could be implemented within a broader framework of the development of a major agricultural demand side management program in Syria. This would focus on irrigation efficiency improvements at both the system and end-use levels. It would include the rehabilitation of existing irrigation and drainage systems in selected basin(s), modernization works, and improved on-farm management (including participatory management) to achieve savings in water use and improving overall irrigation efficiency. It should also address the institutional and other incentives necessary to create incentives for efficient use. A review of the proposed water law and investigation of opportunities for strengthening it should be a central part of preparation for any demand side management project.

II. B. Drainage Improvement and Water Quality Management:

Syria has made good progress in meeting the *drainage needs in the irrigated agriculture* during the last quarter of the 20th century. However, to keep pace with the agricultural development and to increase the productivity of the irrigated agriculture and to ensure its sustainability, the implementation of new drainage projects must be accelerated. The Bank can support a program similar to that in Egypt and Pakistan to implement new drainage schemes, reduce waterlogging, and rehabilitate existing networks. Such program could be separate or combined with an irrigation improvement program as

required. This would be mainly in the Euphrates basin, and to a lesser extent in the lower Orontes and Coastal basins.

A major area of possible cooperation is the development of a *comprehensive water quality management* and institutional framework and action plan. The World Bank as a knowledge base could provide the necessary expertise for planning, best practices and capacity building. The establishing of national surface and ground water quality monitoring program (monitoring network, analytical capabilities, data processing and information system) is a priority requirement. The Bank could support upgrading the research capability in water quality management, pollution control and re-use practices.

Level III envisages pilot schemes which could be prepared to test innovative approaches in the following areas:

III. Pilot Projects:

(i) Development of groundwater management projects in areas around Damascus, Homs and possibly Ras al Ain in the Khabour basin on either a pilot or, if appropriate, implementation basis. These projects should combine initiatives to address both overdraft and pollution/quality problems. Further investigation of both project possibilities is important. In addition to specific sites, this investigation should involve a detailed review of existing water user associations and the Farmers' Unions with respect to the role they could play as focal organizations for management. Any proposal for collective groundwater management should be carefully evaluated in light of local/international experiences and must be combined with the introduction of the advanced on-farm irrigation systems to ensure the sustainability of the system. A careful social assessment would also be required.

(ii) Effective use and appropriate management of treated wastewater reuse in irrigation including cost-effective options for treatment of domestic wastewater of small communities in rural areas (e.g., in the Barada-Awaj basin). Pilot projects for testing different technologies and practices and integrated management practices is recommended specially for the re-use of effluent from the new municipal waste water treatment plants (as in Damascus) or agricultural drainage water as in Maskana Gharb. This would be closely linked to the outcome of the ongoing World Bank-supported Wastewater Strategic Planning and Priority Investment Study in Barada and Ghouta Gharbiyah.

VII. SUMMARY OF RECOMMENDATIONS

26. The table below summarizes the set of recommendations:

Theme	Recommendations
RESOURCE MANAGEMENT ASPECTS	Construction of modernized water control and delivery systems including canal lining and pipeline distribution networks combined with measurement devices must be expanded and accelerated to improve water delivery efficiency. Future development of the non-drained areas and the rehabilitation of existing drainage schemes could be phased in successive projects within a national drainage program. The implementation of new subsurface drainage projects should be coupled with on-farm irrigation improvement including land leveling and efficient irrigation practices. Advanced on-farm irrigation systems (drip and sprinkler) have to be introduced at an accelerated pace in order to address the depletion of water resources and to increase agricultural production. There is a clear need for the strengthening of the capacity of the extension service of MAAR in order to provide farmers with the required technical assistance. Hydrological monitoring networks should be rehabilitated or upgraded for both surface and groundwater resources. Integrated water resources management is a cross-cutting approach for addressing the critical issues of both surface and groundwater including the water quality aspect. It is recommended that this approach be implemented in a few priority basins such as the Barada-Awaj, and Aleppo. Monitoring and guidelines for treated wastewater and agricultural drainage water for reuse for irrigation based on pilot studies and results from ongoing projects and studies.
ECONOMIC AND FINANCIAL MANAGEMENT ASPECTS	The Government should review its agricultural policy (specifically, its policy on wheat and other cereals) in parallel with any efforts in the irrigation sector. This will require a long-term period of structural adjustment but it is essential in order to ensure that the gains from transformation of the existing irrigation systems will not be dissipated. Fundamental policies underlying the existing cropping patterns, irrigation water use, and incentives for farmers will need to be reformed in the long-term.

ECONOMIC AND FINANCIAL ASPECTS (contd.)	Policies to encourage the growth of diversified high value and/or less water-intensive crops while reducing incentives for growing low value added crops will be the primary short-term avenue for increasing water availability for all uses, including agriculture. The current O&M charges on an area basis do not provide an incentive to farmers to reduce water consumption. A new tariff system will have to be established that would provide incentives for farmers to reduce wastage and use water more efficiently. There should also be a clear linkage between the O&M charges paid by farmers and actual O&M works carried out. Demand management through energy pricing and transferring management responsibilities to water users associations can have positive impacts on water use efficiency and cost recovery.
INSTITUTIONAL ASPECTS	With most water resources having been fully developed, Government organizations especially the MOI needs to make the transition from a water resources development to a more water resources management focused role. In this regard, the seven regional basin Directorates can provide an excellent basis for effective decentralized management. From a management perspective, there are major institutional limitations with regard to data collection, data management and analysis. Strengthening data collection appears central to developing an accurate understanding of water management challenges and options. It is also essential to focus on *how* the data need to be analyzed and communicated using modern information technology (IT) so that they assist in creating the social and political foundations for management. Capacity in the social sciences in the key Ministries need to be strengthened since water management depends heavily on detailed understanding of the social, legal and economic factors influencing the viability of different approaches and their effects on different user groups. Technical capacity (including training) in several key government departments needs to be strengthened. Government organizations like the Department of Pollution Control in the Ministry of Irrigation must be invested with real enforcement authority so that they may carry out their pollution abatement mandate effectively.

INSTITUTIONAL ASPECTS (contd.)	Enforcement of well restrictions would be best approached on a localized basis. Spacing regulations set at a national-level are likely to be ineffective. A concerted effort at public awareness and outreach is essential in this regard. The institutional aspects of treated waste water reuse still needs attention through better organization and regulation on the basis of well defined standards and practical guidelines and operational rules. Farmers seems to have a key role in planning and management of the agricultural sector in Syria. Although they may have no direct organized role in managing the irrigation water in large scale schemes, the present farmer organizations provide a strong base for giving farmers more institutional and legal responsibilities in the participatory management of the irrigation and drainage schemes. Extension services of the MAAR need to be strengthened in order to transfer, *inter alia*, results of water use optimization research, and modern irrigation technologies to farmers. Overall, Syria may benefit from a careful review of international experiences with regard to institutional designs for water management, including groundwater management and well consolidation. In most countries, groundwater management and the development of institutions for it is a relatively recent process. A wide variety of relevant experiences do, however, exist and these should be harvested before Syria finalizes its own approach.

1. INTRODUCTION

A. BACKGROUND

1.01 In response to a request of the Government of the Syrian Arab Republic (SAR), a Bank mission visited Syria in May 2000 to carry out a preliminary review of the Syrian irrigation sector. This report draws on the mission's discussions with the staff of the Ministry of Irrigation, Ministry of Agriculture and Agrarian Reform, State Planning Commission, Ministry of Finance, Ministry of Supply, and the Agricultural Cooperative Bank, Ministry of Economy and Foreign Trade at the central and governorate levels The report also draws extensively from existing documentation and reports made available to the mission by the Government, in particular, the extensive reports of the recent JICA study.

1.02 The objective of the report is to analyze key issues and constraints facing the sector, and propose a set of recommendations and possible areas of support by the Bank However, several data gaps exist Many technical estimates are thus preliminary and incorporate a high degree of uncertainty due to the limited data As agreed with the Government at the outset, water resources management issues pertaining to international rivers are not discussed Urban water and sanitation issues are also not addressed in this report – this has been dealt with in an earlier Bank sector note.[9] The first draft of this report was extensively discussed at a national stakeholder workshop held in Damascus, Syria in April 2001 which was attended by over 75 participants from various Ministries, farmer organizations, other non-governmental organizations (NGOs) and academia In summary, the participants of the workshop supported the analysis, the findings and recommendations of the report and the program proposed for future cooperation with Syria in the sector This report incorporates the comments received during the workshop and during discussions with Syrian government officials.

1 03 The report is organized as follows. the introductory chapter describes the agricultural context. This is followed by a review of the key issues in irrigation and water resources management The third chapter presents an overview of the institutional and legal framework and sector organization The final chapter discusses the future strategy for the sector and identifies future areas for potential Bank cooperation

1.04 The land area of the Syrian Arab Republic (SAR) totals about 18.5 million ha. It is bordered in the north by Turkey, in the east and southeast by Iraq, in the south by Jordan, in the south-west by Israel and in the west by Lebanon and the Mediterranean sea The population of the country is about 16.1 million (official mid-1999 estimates) of which about 40 percent is rural Syria has a relatively high population growth rate of about 2 5% per year, which is putting severe pressure on the country's infrastructure and resources. Literacy rates are fairly high with 60% of men and 50% of women being able to read and write

1 05 The country is divided into 14 *Mohafazats* (governorates), namely Damascus (city), Damascus Rural, Aleppo, Homs, Hama, Latakia, Deir-ez-Zor, Idlib, Al-Hasakeh, Al-Rakka, Sweida, Daraa, Tartous, Quneitra. Each mohafazat is divided into several *mantiqa* (districts) The sub-unit of the mantiqa is the *Nahia*, and the smallest administrative unit is the village. Administrative boundaries are displayed in Map 1.

---

[9] Syrian Arab Republic Urban Water and Sanitation Sector Note, January 1999 Infrastructure Development Group, Middle East and North Africa Region, The World Bank

1.06 Syria's weather is characterized by two seasons, hot and dry summer and cool and wet winter More than 80% of the annual rainfall is concentrated in winter from October to April and there is almost no rainfall in summer from June to September. Two hydrological spatial classifications in Syria are of particular importance since they are essential for water resources management planning and the administrative structure within the irrigated agriculture sector. The first classification pertains to the rainfall zones and the second classification is based on the surface water basins in the country These are described in the following paragraphs.

1 07 The first classification is the division of the country into five (six) **agro-climatic zones** based on the rainfall patterns (see Table 1). Rainfall is highest in the coastal region in the West (Zone 1) and along the Turkish border in the North. Annual rainfall decreases towards the Central parts of Syria and in the South and East (Zone 5) The zones basically follow average rainfall contours, but are adjusted to administrative boundaries. (See Map 2). On average, about 65% of the total country area receives less than 200 mm of rainfall annually, and about 45% of the country area is composed of steppe and pastures

Table 1: Rainfall Zones in Syria (see Map 2)

Zone	Average annual rainfall (mm)	Area (1,000 ha)	% of total area
IA	More than 600	2,701	15
IB	350 – 600		
II	250 – 350 and not less than 300 for 2 years out of 3	2,450	13
III	More than 250 and not less than 250 for 1 year out of 2	1,330	7
IV	200 – 250 and not less than 200 for 1 year out of 2	1,850	10
V	Less than 200	10,187	55
TOTAL		18,518	100

1 08 The second hydrological spatial classification is the nine **surface water basins**, namely, the Yarmouk, Barada & Awaj, Orontes, Aleppo, Coastal, Steppe, Euphrates, Khabour and the Tigris (See Map 2) The basin structure is mirrored in the administrative structure of the Ministry of Irrigation wherein the seven General Directorates are assigned responsibilities on the basis of the basin areas (discussed in further detail in Chapter 3). This type of division of responsibilities is unique in MENA, and rare in other parts of the world too The characteristics of the seven major basins in Syria are summarized in Table 2.

Table 2: Characteristics of Seven Basins in Syria (see Map 2)

Basin	Elevation (m)	Annual Rainfall (mm)	Annual Evaporation (mm)
Yarmouk	0 to 1800	275 to 775	1600 to 2300
Barada / Awaj	600 to 2000	150 to 600	1200 to 2000
Orontes	0 to 2000	300 to 800	1200 to 2000
Coast	0 to 1000	800 to 1400	1200 to 1600
Aleppo	500 to 600	300 to 350	1600 to 1800
Steppe	375 to 1250	Less than 200	1800 to 2800
Euphrates	165 to 325	200 to 250	1600 to 2800

Note From JICA (1998) and other sources

B. THE AGRICULTURAL SECTOR

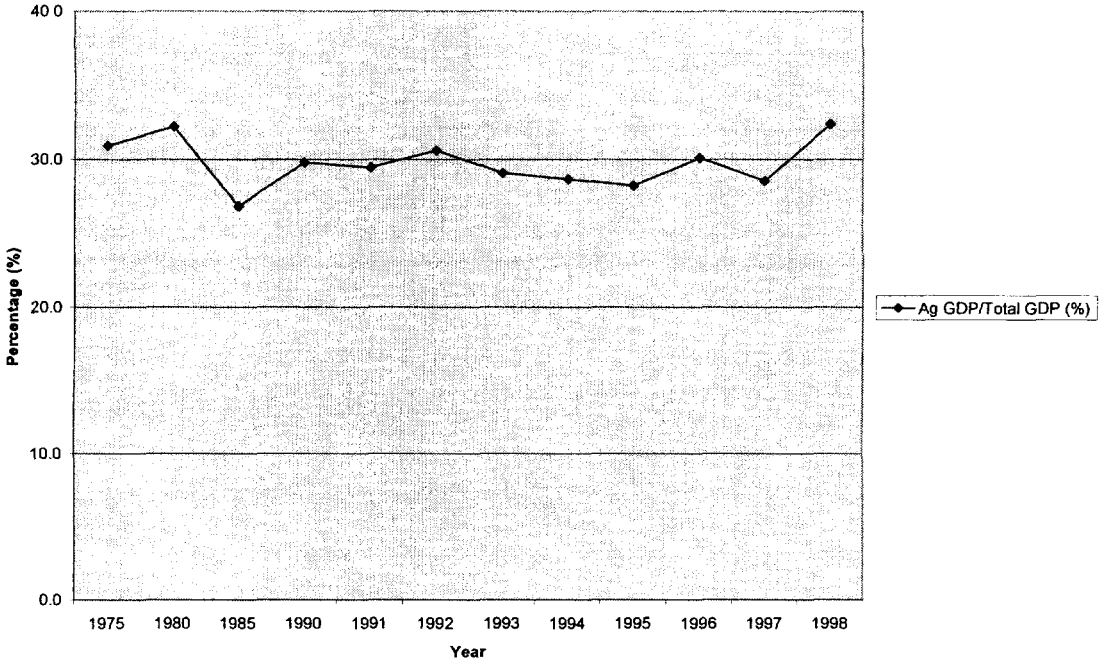
Place of Agriculture in the Economy

1.09 Like other countries in the region, Syria is largely arid with less than one-third of its total area being arable land and forest. The cultivated land area in Syria is estimated at 5.5 million ha, or about 30 percent of the total land area of the country. Land use in most areas used to be dominated by rainfed agriculture of crops with little water requirement such as barley, lentils and chick peas and livestock grazing, but the need to increase food production, particularly for wheat, has resulted in a rapid increase in irrigated agriculture. In 1998, of the total cultivated area of 5.5 million hectares, just under 20 percent (1.2 million ha) was irrigated and the rest rain-fed. Inevitably, therefore, agricultural production is vulnerable to the changes in climate with periods of drought causing sharp declines in GDP as with the severe drought in 1999. The Government of Syria has placed great emphasis on agricultural development and on stabilizing agricultural production through the expansion of irrigation facilities. The main crops are wheat, cotton, sugarbeet, barley, and fruits and vegetables. Of the total area cultivated, wheat accounts for 31% (of which 40% is grown under irrigated conditions), followed by barley with 28% (mainly rainfed). All of the cotton crop (5% of total cultivated area), sugarbeet (0.5% of total cultivated area) and most fruits and vegetables (3% of total cultivated area) are grown under irrigated conditions. Wheat, cotton, sugarbeet, tobacco, barley, and maize are among the key strategic crops. Cotton is the major agricultural export accounting for about 10 percent of total value of exports in 1998.

1.10 Agriculture dominates the Syrian economy as the single largest contributor to GDP at about 30 percent of the total, (See Annex 1, Table A.1) employing nearly 25 percent of the workforce, with another 50 percent of the manufacturing workforce dependent on it for employment. Agriculture also employs the majority of the female workforce. The 1994 Agricultural Census records about 615,000 agricultural landholders nationwide with an average landholding size of 8 ha – ranging from a minimum of 1.8 ha in the governorate of Tartous to 28 ha. in the governorate of Al-Rakka. A 1983 law established a maximum ownership size of 16 ha for lands under government irrigation and reclamation projects. Other maximum ownership sizes are detailed in Annex 1, Table A.7. Irrigation is the driving engine of the agricultural economy as evidenced by the fact that the irrigated area produced over 65 percent of the total value of agricultural production in 1998. Between 1994 and 1998, the total value of agricultural production (1995 constant terms) increased modestly from S.P 226 billion (~ US$5 bn) to S.P 308 billion (~ US$7 bn) with sharp dip in 1997 due to the drought (See Annex 1, Table A.2). In terms of contribution to overall GDP, growth in real terms which was stagnant in the late 80s, registered a decline in the early 90s, and has picked up modest momentum since as seen in Figure 1. However, this figure does not include data for 1999 which was the worst drought in the country since 1959 with rainfall in key areas between 25 and 67 percent below normal illustrating the vulnerability of the agricultural economy to drought.

1.11 Despite some liberalization reforms in the early 1990s, the economic structure remains highly centralized. Public sector control over agriculture is strong. The Government intervenes in pricing, subsidy allocation, the provision of services, and concessionary finance and loans. Government intervention in the cereals and cotton market is particularly strong. The private sector dominates livestock farming, and has full control over the production, pricing and marketing of fruit and vegetables.

Figure 1: Contribution of Agricultural GDP to Total GDP: 1975-98



1.12 Agricultural self-sufficiency is a stated objective of the national Five-Year Plans, and overall, self-sufficiency has shown marked improvement especially in wheat, barley, cotton (The self-sufficiency measure used was production/consumption, where consumption = production + imports – exports). For wheat, the ratio has increased from 0.51 in 1989 to 1.41in 1997. Similarly, barley has increased from 1.0 to 1.43 and cotton from 1.56 to 1.74 during the same period. Aggregate cereal [10]self-sufficiency generally increased from 0.83 to 0.92. (Annex 1, Table A.6). Self-sufficiency for eggs and livestock/meat declined during the decade.

1.13 Syria faces a major question with regard to its current policy of encouraging agricultural production of crops such as wheat and cotton. According to discussions with officials, agricultural and particularly cereal and cotton production has been encouraged at a policy level over the past decade as a mechanism for ensuring food and income security. Internal production of wheat, for example, grew from 50% of demand in 1989 to 140% of demand in 1997. This appears to have been considered important in the context of Syria's overall security concerns and had the objective of ensuring both internal stability (the support of politically important farming populations) and buffering Syria's exposure to market fluctuations or political dynamics beyond its borders. High levels of self-sufficiency in food production and the promotion of cotton cultivation for exports appear, however, to have come at the price of unsustainable water use patterns, as will be discussed in further detail in the following chapter.

[10] Excludes rice.

Agriculture in the Eighth Five-Year Plan: 1996-2000

1.14 Agricultural production planning is done on an annual basis within the context of national Five-Year Plans. The key actors in this process are the farmers, the MAAR, the Farmers' Union, the Cooperative Agricultural Bank (CAB), and the Supreme Agricultural Council (SAC). Preparation of the annual plan is a two-way exercise: top-down, general indicators and production targets, and bottom-up, a detailed production plan including cropping patterns and input needs from the sub-district level (See Annex 2 for details). The Supreme Agricultural Council (SAC), which is chaired by the Prime Minister, establishes broad objectives, provides production targets and investment indicators, and later makes the final decision on the production plan and a number of commodity prices. Among the fundamental objectives which have been established the highest priority is accorded to self-sufficiency in major food crops at the national level.

1.15 Implementation of planned cropping patterns is carried out by means of a licensing process administered by the MAAR and the Farmers' Union. Crop licensing has been an integral part of crop production policy and planning; it is the instrument used to link plan targets, credit, and input requirements, and farm production. The license is a pervasive instrument required for all major crops (including cereals, cotton, tobacco, and sugarbeets) as well as perennial tree crops. It forms the basis of obtaining inputs on credit from the CAB, which is the sole legal supplier for fertilizers and seeds[11]. However, MAAR officials concede that cropping patterns are no longer imposed. They are meant to serve only as recommendations to ensure that technically sound crop rotations are practiced.

1.16 Five-year plans provide the guidelines for government decision making. These plans, which are annually evaluated and revised within the general goals of the plans, set out the economic and social objectives for the economy as a whole, and for each individual sector, and the general policy measures to achieve said objectives. The plans also set out the indicative investment program, and the quantitative production and input targets. However, in recent years, the importance of the achievement of the targets specified in the 5 -Year Plans has dwindled, with more importance being paid to annual budgetary allocations. Evaluations of the 5-Year Plans which used to be the norm before the preparation for the next Plan have been replaced by a general assessment of the previous Plan prior to the start of the next one.

1.17 The Eighth 5-Year Plan (1996-2000) allocated S.P 105,165 million (US$2.3 billion equivalent) or about 20% of the total planned public investment budget (S.P) to the agriculture sectors. Irrigation commands the bulk of the investment budget during the Plan period at about 78% of the total as shown in Table 3. However, of the total investment budget, only 3% has been earmarked for new projects with about 90% being allocated for completing projects carried over from previous plans as shown in Table 4. The total initial annual budget between 1996-2000 as shown in Annex 1, Table A.10, is about 80% of the size of the public investment budget in the Eighth Five-Year Plan.

[11] Pesticides are also sold on credit by the CAB, but are also available to farmers from the private sector, which, CAB asserts, is of variable quality.

Table 3: Investment in Agriculture and Irrigation in the Eighth Five-Year Plan: 1996-2000

Sub-sector	Public investment (m.S.P)	Private investment (m.S.P)	Total (m.S.P)
Irrigation	82,222	5,000	87,222
Other sub-sectors	22,943	82,141	105,084
Total Agriculture	105,165	87,141	192,306

Table 4: Allocation of Investment for Rehabilitation and New Projects in the Eighth Five-Year Plan: 1996-2000

Sub-sector	Rehabilitation projects (m. S.P)	Carryover projects (m S.P)	New projects (m S.P)	Total (m S.P)
Irrigation	6,578	74,538	1,106	82,222
Other sub-sectors	522	20,136	2,285	22,943
Total	7,100	94,674	3,391	105,165

Source: 1993-98 JICA study; 1999-2000, MOI sources.

1.18 However, according to the actual expenditures incurred by MOI in 1999 was SP 11,865 million, which is equivalent to about 70% of the initial budget. The MOI budget in 1999, SP 16,900 million, accounted for about 7% of the total national budget SP 237,300 million (See Annex 1, Table A.11). The O&M budget for irrigation was SP 1,556 million in 2000, which is equivalent to about 9% of the MOI 2000 budget. According to MOI sources, this O&M budget is not sufficient to meet the major O&M needs (about 70-80% of routine maintenance charges are paid for by the farmers). However, the percentage of shortfall cannot be estimated due to lack of data.

Recent Agricultural Production Performance

1.19 Land resource use improved gradually for irrigated crop land, where cropping intensity increased from 0.8 in 1990 to 1.12 in 1998. However, cropping intensity for rainfed agriculture has remained relatively stagnant at about 0.60. These intensities exclude perennial tree crops which have expanded rapidly on both irrigated and non-irrigated land. Trends in the major crops are described in the following paragraphs. Detailed data tables are presented in Annex 1.

1.20 Cereals. The principal food cereal, wheat, and the primary feedgrain barley, occupy about 60 percent of total cropped area. The relative importance (in terms of planted area) of the two cereals was reversed during the last decade, with wheat area increasing at an average annual rate of 4%, and barley area decreasing at an average annual rate of 6%. Irrigated wheat has shown a remarkable increase from 14% of total wheat area planted in 1981 to about 40% in 1998 (Figure 2). Irrigated wheat accounted for 60% of total wheat production in 1998 (Figure 3). Yield and production of both cereals fluctuated considerably, responding to annual rainfall patterns, especially in 1997. A comparison of Figures 2 and 3 illustrates the important stabilizing role that irrigation has played in the case of wheat production. According to an FAO/WFP report[12], the impact of the 1999 drought has been devastating on the barley crop which is largely grown under rainfed conditions. Barley production in 1999 was 72 percent below the previous

[12] Special Report: FAO/WFP and Food Supply Assessment Mission to the Syrian Arab Republic, August 1999.

five-year average. In the case of wheat, the impact of the drought has been less severe, but still significant. Production was about 28 percent below average in 1999.

Figure 2
Trends in wheat area: 1981-1998

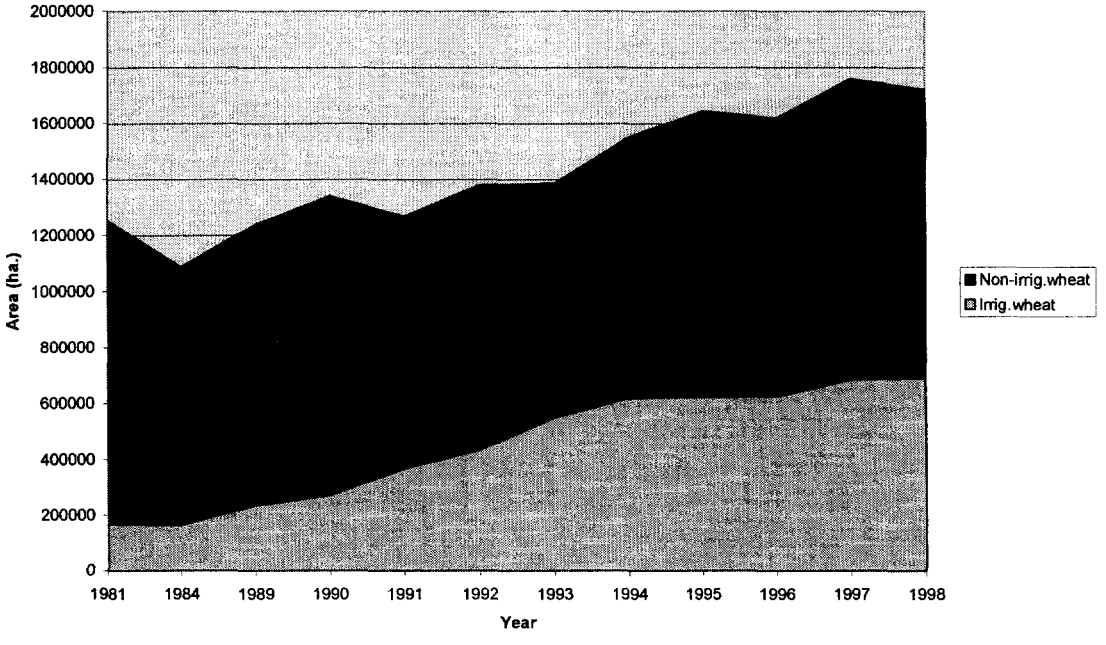
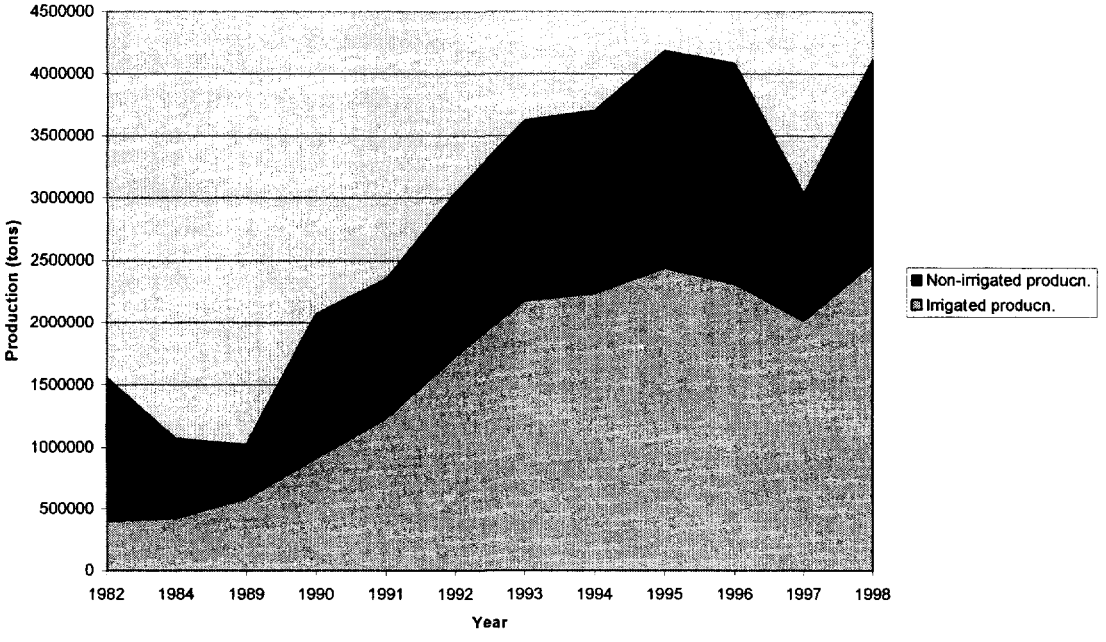


Figure 3
Irrigated and non-irrigated wheat production: 1982-1998



1.21 Industrial crops. All of the *cotton* crop is irrigated. According to recent estimates, the cost of water accounts for about 15 percent of the total cost of cultivation of cotton, a value of about 4 billion S.P.[13] In absolute terms, area planted to cotton increased by about 74 percent, from 158,050 ha in 1989 to 274,585 ha in 1998. Cotton production reached its peak in 1998 at 1 million tons – a 136% increase over the level in 1989. However, as a proportion of cultivated area, cotton has remained relatively constant at about 5% of the total. Irrigated cotton yields have increased steadily from 2.7 t/ha in 1989 to 3.7 t/ha in 1998 (a 37% increase).

1.22 All the cotton produced in the country is purchased by the Cotton Ginning and Marketing Organization (CGMO) which is an autonomous government organization established by presidential decree number 106 in 1965. CGMO buys cotton from farmers at support prices higher than international prices. CGMO has sole control over the purchase, ginning and marketing of cotton in Syria. Almost 60% of ginned cotton is exported without processing. Foreign investment in cotton farming and cotton ginning are prohibited.[14]

1.23 *Tobacco* production has also seen similar gains in yields and production. About a third of the tobacco crop is grown under irrigated conditions today – a slight increase from the 25% in 1989. Irrigated tobacco yields have increased by 30% over the last decade. Area planted to tobacco has remained almost constant at about 15,000 ha representing about 0.3% of total cultivated area. In 1998, about 53% of the total production (23,000 t) came from irrigated tobacco. Tobacco exports have steadily increased over the decade – the self-sufficiency ratio increased from 1.04 to 1.15 during the decade.

---

[13] Survey of the Syrian Cotton Sector, Syrian European Business Centre, October 2000.

[14] Ibid.

1.24 *Sugarbeet* occupies about 5% of total cultivated area and is grown under wholly irrigated conditions. Sugarbeet production increased consistently between 1989-1998, averaging an annual increase of about 20%. Most of this increase is attributable to yield increases of 121% (1.9 t/ha to 4.2t/ha) with an area increase of 32% (22,000 ha to 29,000 ha) over the decade.

1.25 Tree crops. Area planted to fruit trees increased by only 7% during the last decade. However, productivity increases resulted in a production increase of over 40%. Olives and grapes, the overwhelmingly important tree crops are grown mainly under rainfed conditions, although the proportion of irrigated olives and grapes are increasing.[15] Olives and grapes occupy about 70% of the tree crop areas. Citrus trees which are 100% irrigated experienced the greatest production[16] growth rate of about 12% annually. Total plantings of citrus also increased by 40% between 1989-98.

1.26 Vegetables. Watermelons occupy the largest area of the vegetable crops, although areas fluctuate greatly. Watermelons are mainly produced under rainfed conditions. Production increased from 129,000 tons in1989 to 402,000 tons in 1998 representing an increase of over 200%. Area planted however decreased steadily from 31,000 ha to 24,000 ha during the same period. Area planted to the major summer vegetables, tomatoes, potatoes, and onions (dry) which are primarily produced under irrigation have remained relatively constant or declined slightly. Onion production increased by about 47% during the decade while that of potato increased by 33%. Tomato production showed no significant increase primarily due to the decline in area planted of over 36%.

Agricultural Trade and Exports

1.27 The pattern of Syria's foreign trade has changed dramatically over the past decade as oil exports have emerged as the main foreign-exchange and the collapse of regimes in eastern Europe has forced a change in the direction of trade. From a high of more than 40% in 1989, the former Soviet Union and Warsaw pact countries now account for only a small proportion of Syria's exports, while the EU's share has grown from 30% in 1989 to around 55% in 1998 (EIU Country Profile, 2000). This pattern is likely to continue, particularly if negotiations on a free-trade agreement with the EU progress, improving Syrian exporters' access to European markets.

1.28 Over the last ten years, other than the 1991 Investment Law No.10 designed to encourage resident and expatriate Syrians and other Arabs to invest in Syria, the only other major policy change has been the gradual depreciation and unification of the complex, multi-tier exchange rate. Most foreign-currency transactions are now conducted at the "neighboring countries' rate", which has gradually been allowed to slide towards the free-market rate[17], in a bid to boost exports. In agriculture, the Government has allowed mixed-sector companies, in which it holds a minimum 25% stake, to enter the market. These companies are exempted from certain taxes, customs duties, and import and exchange control regulations.

---

[15] Irrigated olives increased from 3% of total area to 6% while grapes grown under irrigated conditions increased from 11% to 15% during 1989-1998.

[16] Total production increased from 330,000 t in 1989 to 740,000 t in 1998.

[17] The unofficial market rate of S.P£50-52:US$1 is available in Lebanon and on the Syrian black market. The so-called neighboring countries' rate was valued at S.P£46.45:US$1 in early 2000.

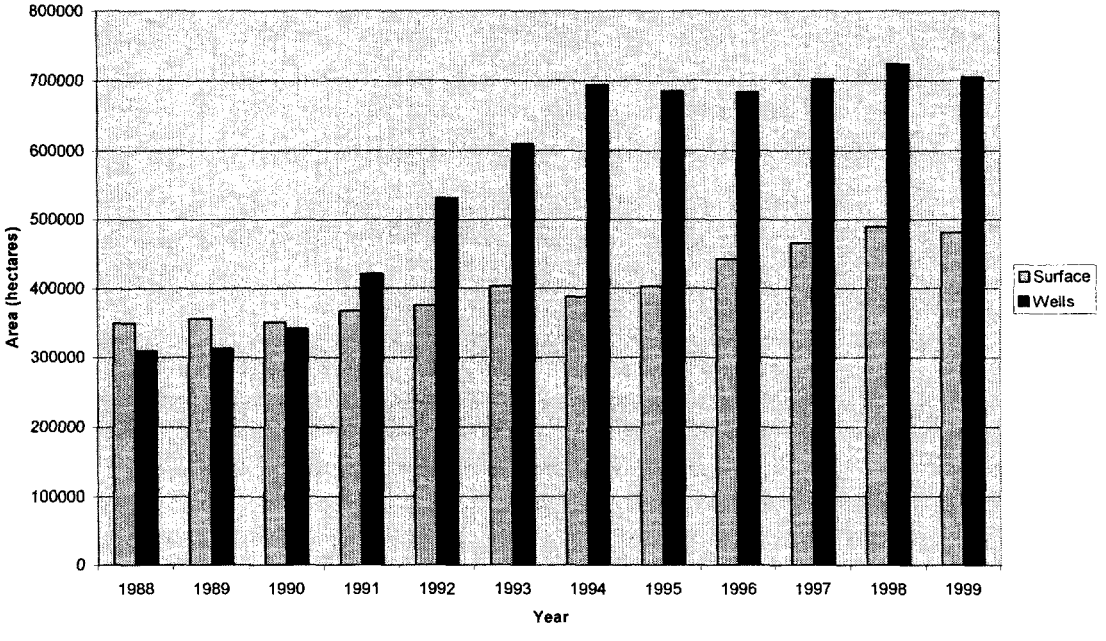
1.29 Agricultural products and commodities form a significant part of Syria's exports and imports. Food and beverage imports have held relatively steady at about 16% of the total. Fruits and vegetables, wheat, and cotton accounted for about 26% of total exports in 1998. (See Annex 1, Table A.9).

2. IRRIGATION AND WATER RESOURCES

A. Background

2.01 The Government's policy objective of achieving food self-sufficiency, especially in wheat, resulted in a rapid expansion of irrigated agriculture in the last decade. Total irrigated area increased from 650,000 ha in 1985 to 1.2 million ha in 1998, which was equivalent to about 20% of the total cultivated area in that year. This expansion can be attributed to the rapid increase in groundwater irrigation (Figure 4). Sixty percent of all irrigated areas in Syria is currently irrigated by groundwater which also serves as the main source of drinking water except in the Euphrates and Tigris basins and in Aleppo city (which receives domestic water from the Euphrates), as surface water from other sources is usually of poor quality.

Figure 4
Irrigated Area by Source: 1988-1999



B. Water Resources Management

Water Supply, Use and Balance

2.02 In Syria, the total water use volume is about 15 billion m3; the Euphrates and Orontes basins account for about 50% and 20% respectively. The total irrigation water accounted for over 85% of the total water use in Syria in 1998 with the Euphrates and the Orontes basins accounting for the major share (Figure 5). The surface and groundwater shares of total irrigated area are about 40% and 60% in average and the breakdown of the irrigation water sources for each basin is shown in Table 6. The share of groundwater is highest in the Barada/Awaj basin and the lowest in the Coastal basin.

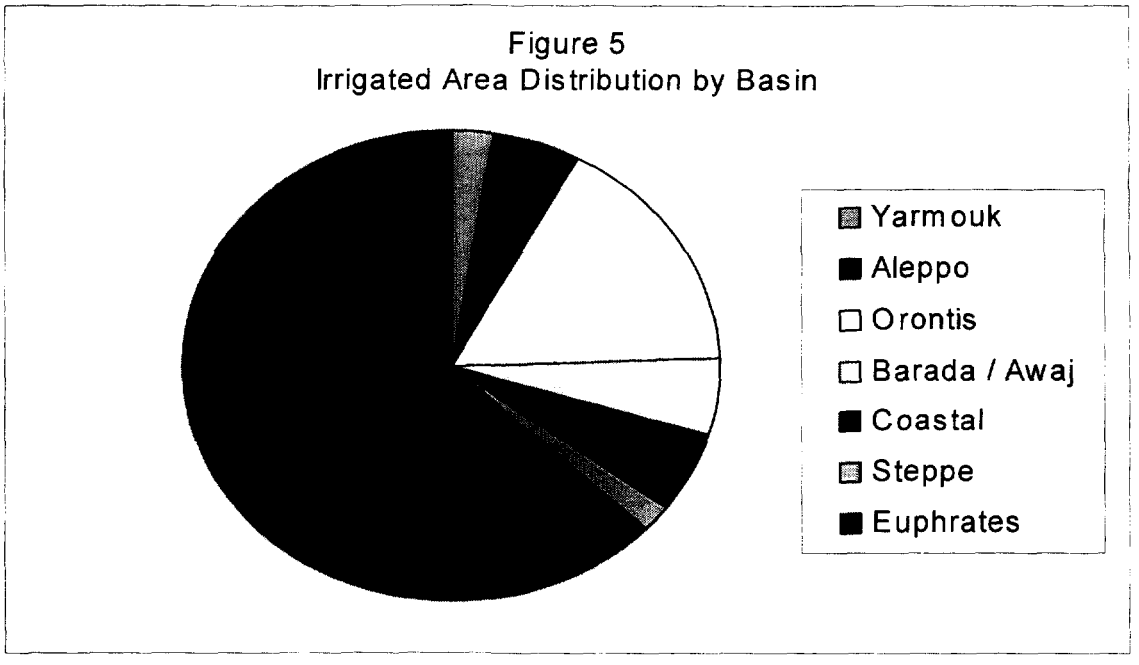


Table 5: Irrigated Area and Sources for Basins

Unit of Area 1,000 ha

Basin	Irrigated Area	Area supplied by wells	Area supplied by pump from surface water	Area supplied by gravity from surface water	Groundwater Area Share (%)	Surface Water Area Share (%)
Yarmouk	30	12	16	2	40	60
Aleppo	66	44	10	11	68	32
Orontis	202	115	12	75	57	43
Barada/Awaj	62	47	0	14	76	24
Coastal	67	15	15	37	22	78
Steppe	26	18	2	5	71	29
Euphrates	761	472	161	128	62	38
Total	1,213	724	215	275	60	40

Note: Adapted from 1998 Agricultural Statistical Abstract

2 03 The water use pattern also varies widely among the basins. While the irrigation water share was more than 95% in the Euphrates basin, the domestic and industrial water share in Barada / Awaj and Aleppo basins accounted for more than 30%, which is expected to increase to about 50% of the total water use in ten or fifteen years.[18] (Table 6). Given the 2 5% population

[18] It is noted that the irrigation water use was estimated based on the crop area statistics, crop water requirements, irrigation efficiency (60%), which was set at higher side considering irrigation return flow use Also, domestic water use was calculated on population statistics and information on the daily water consumption per capita (urban: about 200 l/day/capita, rural: 120 l/day/capita) as well as leakage loss ratio (urban: 30%, rural: 25%) Most of the information was derived from JICA report - The Study on Water Resources Development in the Northwestern and Central Basins in the Syrian Arab Republic (Phase I) - and government agriculture statistics

growth per annum, the domestic water demands are expected to increase by nearly 30% in ten years, which would require an additional 110 MCM in the Barada/Awaj basin and 80 MCM in the Aleppo basin to meet domestic water supply needs The water balance in most basins has been in deficit and this will be exacerbated in those basins encompassing large urban cities, such as Damascus and Aleppo. While the urban water demands will rapidly increase due to strong population growth and industrial growth, new water sources are becoming scarce and extremely expensive to develop by inter-basin transfer.

Table 6: Basin Water Balance
Unit million m3/year

Basin	Irrigation		Domestic		Industrial		Use Total	Renewable Water Resources
	Volume	Share(%)	Volume	Share(%)	Volume	Share(%)	Volume	Volume
Yarmouk	360	82	70	16	10	2	440	500
Aleppo	780	68	280	24	90	8	1,150	500
Orontis	2,230	82	230	8	270	10	2,730	3,900
Barada / Awaj	920	68	390	29	40	3	1,350	900
Coast	960	86	120	11	40	4	1,120	3,000
Steppe	340	87	40	10	10	3	390	700
Euphrates	7,160	95	250	3	110	1	7,520	N A
Total	12,750	87	1,390	9	570	4	14,700	

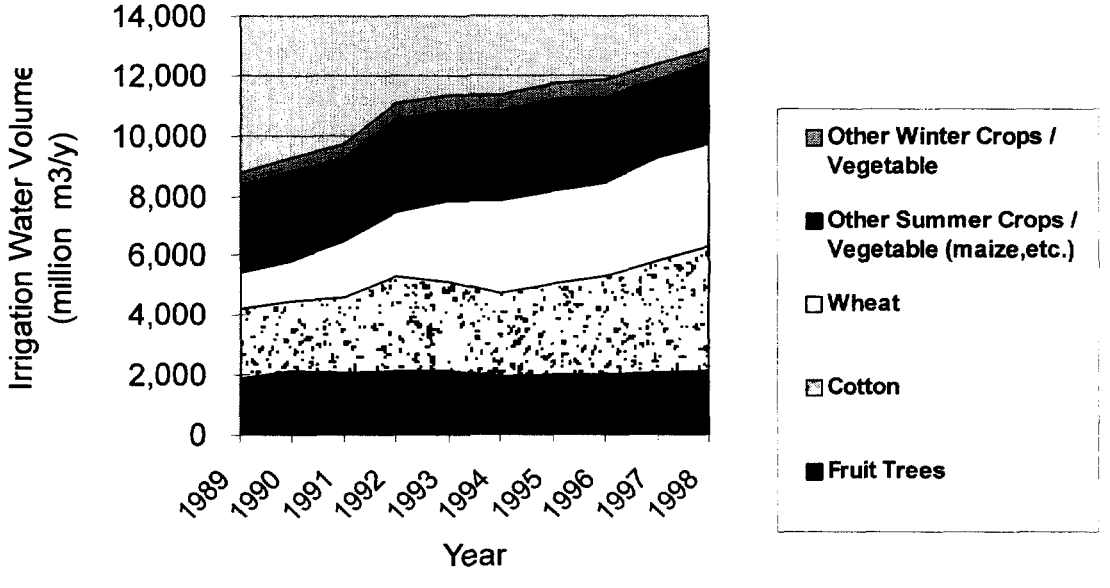
Notes:
1) Adapted from JICA (1997) and others These estimates are provisional and need to be reviewed The renewable water resources is estimated based on average hydrological data showing the maximum potential supply in the absence of any other constraints
2) Industrial water use estimates for 2000 are directly derived from JICA Phase I report except for the Yarmouk and Euphrates, which are derived from ESCWA/WHO, 1993
3) Irrigation (1998) and domestic (2000) water use estimates are based on government statistics and other references including the JICA reports
4) The available water volumes (normal year) are derived from the JICA report with the Yarmouk and Aleppo figures adapted from other sources The available water from the Euphrates is not considered These estimates are provisional and need to be carefully assessed

supported by other references To calculate water use in basins, statistics of irrigated areas and population per governorate were converted to those by basins based on the interpretation of the references

Irrigation Water Use and Cropping Pattern Changes

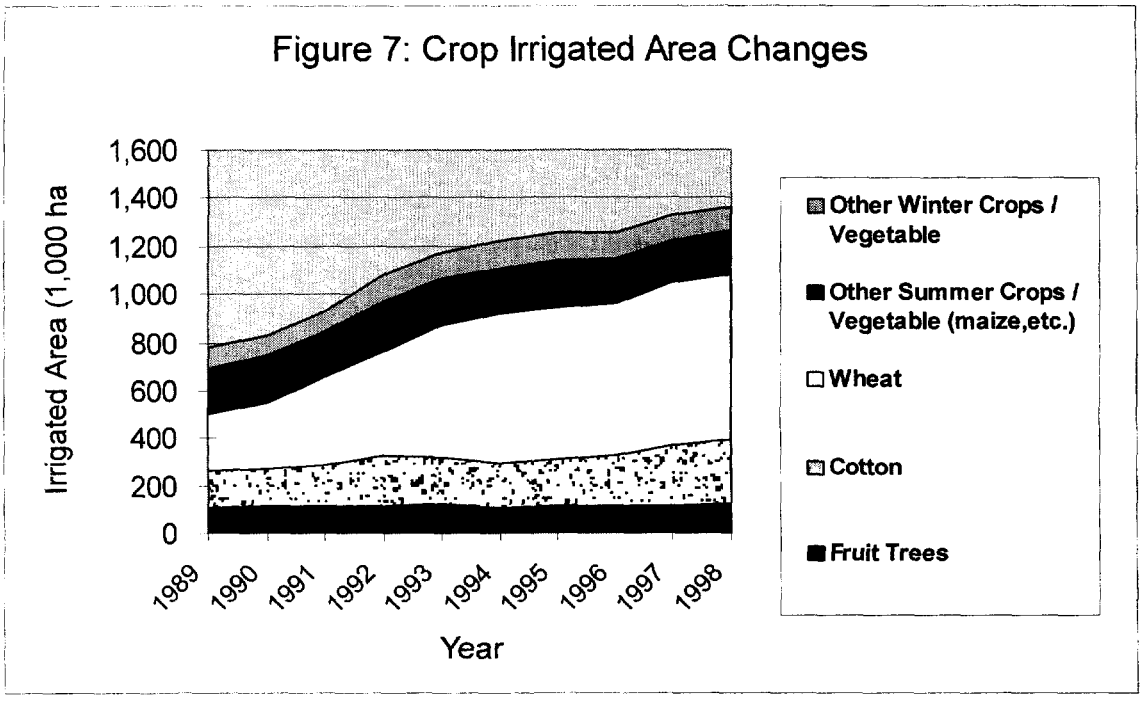
2.04 Regarding crop water requirements, winter wheat has a far lower water demand (200-300 mm) than many other crops like sugarbeet (600-700mm), cotton (700-900mm), citrus (900-1200mm) which are primarily grown under irrigated conditions in summer. Cotton accounted for the greatest share of the total irrigation water use (32 % in 1998). Wheat showed the greatest increase of the irrigation water use (from 14% in 1989 to 27% in 1998) due to the rapid expansion of its irrigated area as indicated in Chapter 1. Fruit trees, such as citrus, apple, olive, etc. accounted for 17% (Figs. 6 and 7)[19].

Figure 6: Crop Irrigation Volume Changes



Annex 1, Table A.11 presents crop water use by basin for all groups of crops. Further, Annex 1, Table A.11-2 and A.11-3 present the corresponding tables indicating the historical changes in irrigation water use and cropping patterns.

[19] Adapted from 1998 Agricultural Statistical Abstract.



River Basin Water Management

2.05 In the seven major basins, 16 main rivers and tributaries flow in the country, of which there are six main international rivers:

- The Euphrates, which comes from Turkey, flows into Iraq, and which then flows over 680 km in Syria out of the total length 2330 km;
- The Afrin in the north-western part of the country, which comes from Turkey to Syria and returns to the Alexandretta region bordering Turkey and Syria;
- The Orontes originates in Lebanon, flowing through Syria and into Turkey;
- The Yarmouk in the south-western part of the country with sources in Syria and Jordan and forms the border between these two countries before flowing into the Jordan river;
- The Khabour, which originates from Turkey and merges with the main Euphrates;
- The Tigris, which forms the border between Syria and Turkey in the far north eastern part.

2.06 Traditionally, surface water has been developed strongly in the Euphrates, Orontes and Coastal basins and a large share of the surface water is supplied by dams. There still remains some potential for further development of dams and augmentation of storage volume and the Government is keen on exploiting this as indicated in the objectives of the 8th Five Year Plan. About 160 dams have been built thus far with a total storage capacity of about 18 billion m3. The largest dam is Al-Tabka with a storage capacity of 14.16 billion m3 in the Euphrates basin. In the Orontes basin, more than 40 dams have been built with a total capacity of about 1 billion m3. In the Coastal basin, more than 20 dams have been built with a total capacity of 0.6 billion m3. Most of the water is provided for irrigation with some for domestic water supply, hydropower

generation, and flood control. Some dams in Steppe basin are built for livestock water supply. With regard to the water balance, the Steppe and Coastal basins are in less critical condition than the others. The major issues in the four critical basins, namely Barada-Awaj, Aleppo, Orontes, and Khabour, are summarized below:

- ***Barada / Awaj*** basin has no significant water sources, both surface and groundwater, other than the Barada and Fijeh springs, which supply drinking water for 1.5 million residents of Damascus. An inter-basin water transfer scheme from the Coastal basin has been proposed to meet the rapidly growing domestic water demands. However, the hydrological monitoring data is not sufficient to examine the feasibility and the unit cost of water is estimated at about SP 32.5 / m3 (US$ 0.65 / m3), which is more than ten times as expensive as the current surface and groundwater schemes (Further discussed in the final chapter). A large-scale wastewater reuse pilot for irrigation has been started in Ghouta (about 19,000 ha) downstream of Damascus city. Demand management of domestic water, reducing pollution and improving water quality, controlling the high leakage losses (30 to 50%) and per capita consumption (200 to 300 l/c/day), in addition to irrigation efficiency improvements are urgently required to postpone the inevitable water crises.

- ***Aleppo*** basin has also serious water deficit problems. Wastewater from Aleppo city is the only water sources for Quwayq river, which has supplied water for irrigation in the area. The domestic water of Aleppo city is supplied from the Euphrates river and will be increased by a pipeline project under construction (2.5 m3/s). In order to meet the rapidly increasing water demands due to the strong population and industries' growth as well as to some planned irrigation schemes, inter-basin water transfer plans need to be analyzed. Further, the water quality of Quwayq river is also a major problem that needs to be addressed.

- ***Orontes*** basin is the second largest basin next to the Euphrates in terms of water supply and use volume. The total storage capacity of 39 dams, most of which provide irrigation water to Hama, Homs, and Ghab areas, is 736.2 million m3. Groundwater also has been extensively developed and overdrafted in Homs. Modernization of the existing irrigation schemes have been proposed to improve the irrigation efficiency. Also, new projects involving the reuse of the treated domestic wastewater and irrigation drainage water for irrigation use have been proposed.

- The ***Khabour***, which is one of the tributaries of the Euphrates originating from Turkey, has experienced serious declines in river flow and in the groundwater table. Rapid groundwater extraction both in Turkey and Syria from the trans-boundary aquifer system (Ras-al-Ain) has reduced the spring flow discharges to the river. A consolidated groundwater irrigation scheme totaling about 30,000 ha coupled with a strong monitoring and regulatory program has been proposed by the government to address the serious groundwater overdraft.

C. Groundwater Resources and Management

Data Limitations

2.07 Despite numerous studies, data availability on groundwater availability and quality appears fragmented and scattered. According to officials, MAAR and MOI data are also highly unreliable. This is reported to be a major factor constraining management. As one official stated: "there is no management because there are no data."

2.08 Overall, there appear to be substantial gaps in the monitoring of groundwater resources, and the general water resources monitoring network. In the Orontes basin, for example, most observation wells are reported to be heavily concentrated in the area of Al Ghab-Al Hamurah, Seramiah, Al Ruj and Al Nu'man with little monitoring in other areas. In the Aleppo basin, the period of record for groundwater observation is too short in some areas to estimate fluctuations despite the fact that some portions of the basin have shown dramatic water level declines of as much as 20 meters over a 4-year period.

Groundwater Resources

2.09 Water balance analyses made by the MOI, suggest that groundwater resources in all basins except the coastal and steppe basins are fully, and in some cases over, developed. Mining of non-renewable groundwater is particularly evident in the Barada/Awaj Basin and Orontes Basin. Water level declines in these basins are reported as –3.1 mm/day (1.1 meters/yr) and –3.3 mm/day (1.2 meters/yr) respectively. A large groundwater depression is developing between the Zabadani and Damascus areas in the Barada/Awaj basin with rapid falls occurring particularly between 1989 and 1992. Similarly, in the Orontes basin, the areas of Seramiah and Al Ghab-Asharneh have shown drops of 10 meters over a six year period. As early as 1979-84, studies carried out by the USSR indicated that the Barada/Awaj, Orontes and Aleppo basins had negative groundwater balances and a serious overall shortage of groundwater. Overall, there are clear regions where overdraft is substantial. According to officials, this is having a major impact on surface sources, such as spring flows. In the headwaters of the Khabour River near Ras-al-Ain, for example, MOI officials report that extraction from approximately 1000 wells in Turkey and 1550 wells (see para 2.07 below) in Syria has caused flow in the world's second largest spring to decline from a long-term average of 50 m^3/s to a few m^3/s at present and down to zero during drought years as in 2000.

2.10 Agricultural demand is the core factor underlying groundwater overdraft. Groundwater use, particularly for irrigation, has increased dramatically over recent decades. In the Khabour river headwaters at Ras-al-Ain where spring flows have declined, irrigated agriculture covers some 30,000 ha with water supply from 1,550 wells within Syria and another 27,000 ha of groundwater irrigated area just across the border in Turkey. While the above example is localized, at a regional level, extraction also often exceeds recharge. Recharge and surface flows in the Barada and Awaj basins are, for example, estimated at 900 MCM/annum while total irrigation withdrawals from ground and surface sources amount to 920 MCM/annum plus withdrawals of 390 MCM/annum and 40 MCM/annum for domestic and industry purposes.

2.11 A substantial portion of the increase in groundwater use is related to increases in irrigation for cotton, wheat, the dominant winter crop, cotton, citrus, and sugar beet. Area increases have been substantial over the last decade in sugarbeet (32%), cotton (75%), irrigated wheat (40%), and citrus (40%) as indicated in Chapter 1. Much of the expansion in wheat has been driven by increasing support prices for wheat while water costs have remained low[20]. The ICARDA/MAAR research indicates that farmers from public irrigation schemes obtain water at extremely subsidized rates and groundwater costs do not reflect their real value because the energy required for pumping is also subsidized. As a result, most farmers tend to over-irrigate with water use reported at three times the optimal rate as defined by research trials. Irrigation water continues to be subsidized while support prices for wheat have been higher than world prices for several years (See Annex 1, Table A.10).

---

[20] ICARDA, 1993.

Groundwater Management

2.12 Groundwater is probably the single most important water management challenge facing Syria. A very large percentage of its rural agricultural economy and Syria's urban and domestic water needs are met through groundwater. As in many other developing countries, private groundwater wells represent an "on-demand" source of irrigation in contrast to the government surface (gravity) irrigation schemes. Thus, it provides a more reliable supply of water to the farmer compared to government gravity-irrigation schemes, which provide either too much or too little water when farmers need it. Results from an ICARDA research study in Atareb, NW Syria showed that the average use of groundwater was 532 mm per unit of irrigated area which was less than one-half of the typical allocation of water under government schemes, which allocate between 1200 and 1400 mm annually per unit of irrigated area.[21] Legally, licenses are required to drill and use wells; the licenses specify the extent of water use and require renewal every ten years. However, poor enforcement has resulted in a large increase in the number of illegal wells in recent years (almost 50% of the total number of wells) that has contributed to the groundwater table declines in many areas. This trend seems to be most pronounced in the Barada/Awaj basin (Table 7). The poor maintenance of the groundwater monitoring system has resulted in some of the hydrological monitoring stations and observation wells being abandoned or converted to other purposes. Thus, the lack of critical information, such as the amount of renewable groundwater resources, the interaction between the surface and groundwater system has made the task of enforcement all the more difficult, if not impossible.

Table 7: Licensed and Non-Licensed Wells by Basin: 1998

	Non-licensed Wells (unit)	Licensed Wells (unit)	Total Wells (unit)	Share of non-licensed wells (%)
Yarmouk	1,282	1,889	3,171	40.4
Aleppo	3,460	6,374	9,835	35.2
Orontis	13,306	17,545	30,851	43.1
Barada/Awaj	22,169	3,315	25,483	87.0
Coastal	12,948	13,569	26,517	48.8
Steppe	2,737	2,480	5,218	52.5
Euphrates	10,218	28,606	38,824	26.3
Total	66,120	73,779	139,899	47.3

Source: Adapted from Agricultural Statistical Abstract in 1998

2.13 Government policies have also contributed in no small measure to the tremendous increase in groundwater irrigation with its attendant negative consequences. The overall thrust towards irrigation expansion coupled with attractive output prices, have proved to be strong incentives for farmers to take up groundwater irrigation in many areas. Annex 1, Table A.13 shows the gross margins/ha are the highest for cotton, wheat, and vegetables. In addition, groundwater costs do not reflect their real value because the energy required for pumping (diesel) is also subsidized. In areas where groundwater tables are declining due to overpumping, energy costs can increase substantially. This has negative equity and environmental implications since the larger farmers continue to pump the over-exploited aquifer while the smaller farmers are forced to leave the

[21] Groundwater Use and Supplemental Irrigation in Atareb, Northwest Syria, Rodriguez, A., Salahieh, H., Badwan, R., and Khawam, H. ICARDA Social Science Paper No.7, 1999.

market. Further, farmers can avail of low tax-free interest rates[22] for loans from the Cooperative Agricultural Bank to finance well drilling. In the last decade, the Cooperative Agricultural Bank has lent a total of S.P10.3 billion (~ U.S$225 million) towards irrigation well development benefiting about 61,000 farmers on 400,000 ha. (Annex 1, Table A.14).

2.14 Although groundwater overdraft is a growing problem, resources may be available for development in the Coastal and Steppe basins. It is estimated that 933 MCM/year are available in the Coastal Basin and 487 MCM are available in the Steppe Basin on a renewable basis.[23] Insofar as the exploitation of non-renewable resources is concerned, in addition to economic factors, strategic and social considerations may also be important. Most calculations of the economics of groundwater use focus simply on the immediate costs and benefits. The longer-term strategic and insurance value of maintaining a buffer against drought or disputes over water supplies is rarely included in economic analyses of groundwater extraction. Given the vulnerability of Syria to drought or other water supply disruption, this larger strategic value of maintaining the resource "in-place" should be evaluated before developing supplies in the Coastal and Steppe basins.

2.15 There are further reasons for caution in further developing groundwater in the Steppe and Coastal Basins. Where the steppe is concerned, it would be useful to review and confirm the amounts of recharge estimated. The average annual rainfall is only 200 mm and the evaporation is very high: 1800-2800 mm. In this situation, recharge is likely to be very low and the data base for estimating it very weak (because of high rainfall and stream flow variability and highly dispersed networks for monitoring of precipitation, stream flows, groundwater levels, and other water resources data). Certainly, maps indicating the major meteorological observatories in Syria indicate very scattered monitoring locations in the steppe zone and a much higher density of stations in the more densely populated and more humid regions. As a result, there are often major uncertainties in estimating recharge in arid zones such as this. If recharge is lower than anticipated, aquifer depletion could occur much more rapidly that expected even under a planned depletion schedule. Where the Coastal basin is concerned, precipitation and runoff are much higher but coastal geology and coastal aquifers are often vulnerable to saline intrusion. Based on available geologic information, the main groundwater bearing strata in the coastal basin appear to be recent alluvial deposits in stream valleys, quaternary calcareous sandstones, middle Miocene limestones, Pliocene and Upper Miocene basalts, and faulted, often karstic, Cenomanian-Turonian limestones (the most productive formations). Saline intrusion is already noted as a problem in the lower and middle quaternary limestones and the middle Miocene limestones. The rock types in many of the other formations often allow rapid flow and could also be vulnerable to saline intrusion adjacent to the coast if groundwater extraction increases. In addition, the ecology of coastal zones often depends heavily on freshwater inflows to estuaries and in some cases submarine spring. Large-scale diversion of ground or surface water from coastal areas to meet inland needs could, as a result, have substantial environmental implications. Overall, available information on groundwater availability in Syria provides clear evidence of emerging overdraft problems in many basins and suggests caution where development of resources in the Coastal and Steppe basins are concerned.

---

[22] The rate of interest is 4% p.a. for members of cooperatives and 5.5% p.a. for non-members, payable over 5 years in yearly installments. Approximately, half of all farmers seeking loans belong to cooperatives. If the farmer does not invest the loan proceeds within three months of signing, the interest rate is increased to 9%. A license from MOI is a prerequisite for any such loan.

[23] JICA Report, 1997.

Responses to Overdraft

2.16 At present, governmental responses to groundwater overdraft and pollution appear limited. They generally emphasize supply side approaches along with limited regulatory roles focused on licensing and metered supply. The MOI has banned new drilling wells in most areas for two years. According to recent Government regulations, all drilling rigs must be placed under a specific depository controlled by the government. Drilling contractors are required to get permits for moving the rigs for any new job. One experiment under the MAAR involved the closure of wells near Aleppo. Well closure has also apparently been attempted in other areas and has generated substantial backlash.[24] According to MOI officials, the new Prime Minister has emphasized that if wells are to be closed, farmers need to be given alternatives. There will be no well closures without alternatives. As a result, the MOI and the MAAR are proposing well consolidation. According to MOI officials, this would involve the closure of private wells and would provide water to farmers through a much more limited number of collective wells. This would reduce well interference problems and allow wells to be carefully located where resources are sufficient. In addition, it would establish clear points where control could be exerted over extraction levels and water use efficiency could be encouraged. According to MOI and MAAR officials, this approach has been approved by the Supreme Agricultural Council and is supported by the Farmers' Union. The Government is also relying on social enforcement mechanisms in some areas through Farmers Unions.

Non-conventional Water Sources

2.17 Non conventional water resources include desalination of brackish and saline water, harvesting run-off, and reuse of treated domestic and industrial waste water and agricultural drainage water. The Syrian government has been active through MOI and MAAR for investigating and tapping these resources. Although in most cases this is still in the stage of research and studies, the planned reuse of treated waste water and agricultural drainage water is at an initial stage of implementation. The government policy is to ultimately utilize, within each basin, all treated waste water. Planned use of wastewater is an important and effective means for increasing water availability and protecting the environment and the public health. In this context waste water includes treated domestic and industrial effluents and agricultural drainage water. Syria ultimately expects to have 680 MCM of treated wastewater available on an annual basis. This represents 15% of current irrigation water uses. While this is important, it can't be counted as an additional source of supply because, based on discussions with officials, much – if not most – of it is already used by agriculture in an untreated form. Nonetheless, the Syrian Government considers this a strategic issue and is paying it increasing attention.

2.18 Domestic Wastewater. Currently, there exists only one municipal wastewater treatment plant in operation in Damascus, with other plants under construction in Homs, Hama, and Aleppo (World Bank, 1999). These and other wastewater treatment plants for the main cities will serve a population of 6.5 million and will produce 420 MCM per year of treated effluent (Table 8). The treated effluent from Damascus treatment plant is now fully utilized for irrigating 19,000 hectares mainly cultivated with fruit trees in Damascus's Ghouta area. A pump station and concrete lined channels were specially constructed for this purpose. The quality of the treated effluent is monitored occasionally. Institutional arrangements for close coordination between the management of the treatment plant and the management of the irrigation schemes are currently inadequate to meet emergency situations when the treated effluent does not meet required health standards for reuse on such a large scale.

---

[24] Reportedly, the Government closed 72 wells in the Ras al Ain area in 1996 causing a severe backlash.

Table 8: New and Planned Treated Domestic Waste Water Plants

Location	Design Year	Population Served	Daily Discharge(m^3/Day)
Damascus	1997	2,200,000	485,000
Aleppo	1998	2,000,000	255,000
Hama	1998	500,000	70,000
Homs	1998	655,000	133,900
Dar'aa	2005	124,000	21,800
Al-Sweida	2002	138,200	18,750
Idleb	2002	182,537	30,000
Latakia	2000	506,600	100,830
Tartous	2010	154,370	33,437
Selemiyah	2005	45,000	5,850
Total		**6,505,707**	**1,154,567**

Source: JICA Report, Phase I, 1997

2.19 Agricultural Drainage Water: Drainage water from irrigated lands often flows back to rivers and reused down stream. Only water which flows into the sea in the coastal basin and to lakes as the Jaboul Lake near Aleppo can be considered as incremental water sources. The drainage water from East and West Maskana and Al-Assad Establishment Irrigation Projects (total area 91,600 hectares) is reported to be of adequate quality for reuse in irrigation. Farmers in the area already use this drainage water unofficially for irrigation when they face shortage in fresh water supply. There is another 10,000 hectares in the Balegh River catchment area (Orontes Basin), irrigated with a mixture of agricultural drainage water and untreated waste water. A study has been proposed by the Water Research Center of the MOI to develop a management plan and impact analysis of the reuse of drainage water on a large scale.

Recommendations

2.20 Hydrological monitoring networks should be rehabilitated or upgraded for both surface and groundwater resources. Groundwater observation wells need to be set up to start more intensive monitoring in critical areas, such as Hasakeh, and the Orontes basin. Since the monitoring data are presently collected by different institutions (MOI, MAAR, and Ministry of Defense), there is a clear need for its consolidation in a consistent and compatible manner in a common data base, to serve as a decision support system that can be accessed and shared by all institutions concerned.

2.21 Basin-wide comprehensive water resources management plans (master plans) need to be prepared in order to discuss water allocation policy (possibly across sectors at some later stage) and prioritization of future investment projects. MOI has a list of priority investment projects in the Orontes and Coastal basins (see Annex 3) which could be potential candidates for such a type of basin master plans. GIS and other satellite data on land use, soil and cropping pattern, etc. would provide the basic data for these master plans. Also, a comprehensive hydro-geological simulation model would be useful in assessing the surface / groundwater interaction, renewable groundwater recharge, water quality impacts by wastewater reuse, and other aspects.

2.22 Insofar as the surface water conveyance and distribution system are concerned, canal lining and modernized water control systems combined with efficient control structures and measurement devices would improve the water delivery efficiency by 10 to 20% compared to the

traditional canals. Also, a pipeline conveyance / distribution system would provide a more reliable and continuous water supply allowing for the introduction of pressurized on-farm irrigation systems. For higher capacity conveyance systems, open lined canals for the main sections and pipe distribution systems for the tail-end sections would provide the most economical solution. Buffer storage or farm ponds at strategic locations could reduce the maximum discharge capacity and the sizes of the conveyance facilities.

2.23 For groundwater distribution systems, the pipeline conveyance / distribution system is more important than in the case of surface irrigation system. A buried system of PVC pipes provided with hydrants would distribute the water to individual fields quite efficiently and should be more economical than that of a surface irrigation system reflecting the stability and lower discharge capacity. The groundwater can be pumped into an elevated tank, which would provide working pressure and be equipped with sensors to regulate the pumped water automatically. Although this could be initially capital intensive, the long-term benefits of improved water use efficiencies are high. This approach is being currently used in the Spanish-supported project on consolidated well management in Aleppo. For this type of consolidated groundwater management, a strong hydro-geological assessment and monitoring system should be established to ensure the sustainability of the groundwater resources. This should be implemented in conjunction with a modernized distribution and on-farm irrigation system to save irrigation water use and to reduce groundwater extraction volume. However, there are indications from the Aleppo project that due to a lack of proper social assessment, conflicts over the use and management of the water have arisen. Careful social assessment must be carried out in advance to identify the needs and concerns of the farmers to avoid potential conflicts.

2.24 As Syria begins to evaluate options for addressing the combination of overdraft and pollution problems that threaten groundwater resources within the country, a detailed review of international experiences could contribute to identification of effective strategies. Several experiences appear particularly relevant given the approaches indicated as currently under consideration by MOI officials. These relate to:

- The ability of highly centralized approaches to respond to the diverse groundwater conditions and management needs that are generally encountered within a country or region.

- Experiences with user-group operation and management of community irrigation wells.

2.25 Overall, Syria may benefit from a careful review of international experiences (See Annex 4 for a brief review) with regard to institutional designs for water management, including groundwater management, well consolidation, and the degree to which the country relies on centralized versus decentralized strategies. Particularly in the groundwater case, it should be recognized that no single set of "best practices" has yet been identified. In most countries, groundwater management and the development of institutions for it is a relatively recent process. A wide variety of relevant experiences do, however, exist and these should be harvested before Syria finalizes its own approach. The experience of Jordan is of particular relevance (See Box 1).

Box 1: Jordan's Groundwater Management Challenge

Jordan faces severe limitations of water resources availability that have become more acute with time, as population and water consumption have grown. Most water is drawn from groundwater aquifers, both renewable and nonrenewable. Groundwater mining reached dangerously unsustainable levels in the 1990s. However, since then, the Water Authority of Jordan (WAJ) has succeeded in reducing abstractions from each aquifer but one from 1993-97. There has been a significant downward trend in abstraction rates in all aquifers except the Al Azraq aquifer, although all aquifers still exceed the (ideal) 100% of the sustainable yield. This has been achieved mainly due to the significant accomplishments with regard to establishment of monitoring and institutional arrangements:

- The issuing of new licenses for new or renewal wells has almost completely stopped and educational institutions are the only exceptions to a ban on new well drilling that is enforced through strict control over drilling rigs;

- About 90 percent of wells are equipped with flow meters and a quota specified in the well abstraction permit limits the quantity of water that may be abstracted without payment of a penalty for overuse;

- The responsibility for groundwater monitoring has been transferred from WAJ to the Ministry of Water and Irrigation, together with close monitoring of the work of the groundwater inspection field unit.

However, significant issues remain, including the expansion of irrigated agriculture, the low value added to water used for irrigation compared to industrial use, irrigation tariffs that fail to recover any of the capital investments in irrigation schemes, and the inefficiency of publicly-managed irrigation systems at a time when urban consumers are facing much higher tariffs to develop new resources such as at Disi. The recent Bank Water Sector Update indicates that continued effort at metering, ensuring operational performance of the meters, enforcement of licensed quantities, together with stakeholder participation will continue to be top priorities for the government.

Source: "Groundwater Management in Jordan: Policy and Regulatory Issues", by A. Macoun and H. Naser in **Groundwater: Legal and Policy Perspectives**, ed. S. Salman, World Bank Technical Paper No.456, 1999.

D. Irrigation Management

2.23 On-farm irrigation is under the jurisdiction of the Directorate of Irrigation and Water Use (DIWU) of the MAAR in terms of research, testing, piloting, and demonstration programs regarding on-farm irrigation techniques, scheduling, wastewater reuse, etc. although farmers are responsible for the irrigation management at the field level. MAAR has thirteen Irrigation and Water Use Research Stations in all basins in order to conduct research and to disseminate information on crop water requirements, optimized irrigation methods, etc suitable for local conditions. The MAAR also provides farmers with the technical support for planning, design and maintenance works of the on-farm irrigation systems.

2.24 The most typical irrigation system at the field level is a surface gravity system using furrows for cotton, vegetables and maize. On-farm water use efficiency is in general low (about 40-60%) due to over-irrigation, use of traditional techniques like surface (furrow) irrigation, and lack or inadequacy of land leveling. In most cases, the design of the traditional furrow irrigation system is not optimal. Also, fields and furrows are not well maintained which results in some parts of the field receiving excessive water, while crops in other parts receive inadequate water due to the lack of land leveling at regular intervals (every three to five years). Thus, there seems to be a large scope to reduce water use in surface furrow irrigation systems.

2.25 Irrigation efficiencies: The distribution system of the irrigation schemes along the Euphrates comprises concrete lined canals, whose conveyance efficiency is estimated at about 60 to 70%.[25] Except for the Euphrates, most of the other canals were built in 1950s and 1960s and the conveyance efficiency is estimated at about 50%. In order to improve the conveyance efficiency and to provide a more reliable water supply to the fields, MOI has planned to introduce a direct pipeline connection from dams to farm gates feeding on-farm sprinkler / drip irrigation system for small to medium scale irrigation projects (about 5,000 ha to 20,000 ha) in Orontes, Yarmouk, and other basins. The pipelines can be staged with boosting pumps for up to about 20 km and the average costs are estimated at about SP 180,000 – 200,000 / ha ($ 3,600 – 4,000 / ha) including pump stations according to MOI sources.

Modern Irrigation Technologies

2.26 The Government is encouraging the use of advanced on-farm irrigation technologies like drip and sprinkler irrigation to improve on-farm irrigation efficiencies, and conserve water. Drip irrigation systems are also encouraged for improving productivity since yields are increased due to the regular supply of water directly to the root zone of the crop thereby reducing moisture stress. It is reported that the average wheat yield increased to around 6,300 kg/ha by sprinkler irrigation method from around 2,600 kg/ha by surface irrigation method in experimental fields.[26] The government has provided tax-free low-interest loans through the Cooperative Agricultural Bank to meet the capital costs of sprinkler and drip irrigation systems. The coverage of the credit has been expanded from 85% to 100% of total capital costs in response to recent droughts. However, the present level of adoption of these technologies is still fairly low, with sprinkler

---

[25] The efficiency of different technical levels are: traditional open canal system with manual control (50%); open canal system with hydraulic control (60%); open canal system with hydraulic control, buffer or on-farm storage (70%). For the case of the groundwater irrigation, the conveyance and distribution system efficiencies vary from 80% (lined field channels) to 95% (pipe system) thanks to the smaller conveyance losses over shorter distances. (World Bank, 1993).

[26] "Technical and Economical Impacts of the Water Resources Management Improvement in Agricultural Research Project on the Water Use Efficiency in Irrigation in Syria", UNDP, 1997.

irrigation covering about 80,000 ha and about 8,500 ha for drip irrigation (Annex 1, Table A.14). Loans by the Cooperative Agricultural Bank for drip and sprinkler irrigation reached a total value of 826 million S.P (~ U.S$18million) benefiting around 8,000 farmers. Sprinkler irrigation systems have been gradually introduced for cotton, wheat, vegetables, etc. mostly in the Hama, Aleppo, Idlib, and Hasakeh governorates. Equipment purchase costs, which account for about 95% of the total investment costs, have been significantly decreased due to the increased number of domestic products and companies (about 20). For example, the unit cost of the PVC lateral pipe for drip irrigation systems, which is required to be installed for about 13,000 m per hectare[27] and accounts for a significant share of the equipment costs, have decreased from about SP 12 to 15 per m to SP 6 per m. Table 9 shows the approximate costs of drip and sprinkler system including equipment purchase and installation works.

Table 9: *Costs of Drip and Sprinkler System*

Drip	Trees	SP 50,000 – 70,000 / ha ($ 1,000 – 1,400 / ha)
	Vegetables, cotton	SP 120,000 – 150,000 / ha ($ 2,400 – 3,000 / ha)
Sprinkler	Fixed	SP 100,000 – 120,000 /ha ($ 2,000 – 2,400 / ha)
	Manual	SP 20,000 / ha ($ 400 / ha)

Source: MAAR

Constraints to Adoption of Modern Irrigation Technologies

2.27 The principal constraint preventing small farmers from investing in these types of the modernized on-farm irrigation systems is their limited financial capacity even though costs have been gradually decreasing. Most farmers do not seem to be convinced that the financial returns from the expected increases of agricultural production would justify the investment and O&M costs and increased labor costs associated with maintaining the system.

2.28 Government credit policies towards investments in drip/sprinkler systems appear at odds with other policies pertaining to irrigation and energy subsidies. Government irrigation tariff policies do not provide any incentives to farmers to invest in modernized on-farm irrigation systems. For the public surface water irrigation schemes in particular, farmers do not have any incentives to save water since the O&M charge is a flat fee unrelated to water consumption and determined by the field size alone. For the individual groundwater irrigation systems, farmers have access to cheap credit to finance their initial capital investments, and pay subsidized energy costs – again, there is no incentive to adopt modern irrigation technologies.

2.29 Other factors include: (i) inadequate access to information and extension services, which would provide farmers with technical support for planning, design, and O&M of the on-farm irrigation system as well as for irrigation practices and scheduling, (ii) inappropriate interface between the public irrigation distribution systems (particularly for public surface water irrigation schemes) and the advanced on-farm irrigation systems, which require more reliable and continuous water supply at farm-turnouts, and (iii) smaller field sizes (2 to 4 ha on average per well) and increasing fragmentation due to inheritance modes compared to the optimal size which

[27] The actual installation length/ha can vary depending on the layout and spacing of pipes for each type of crop.

would enable the efficient layout and design of an advanced distribution and on-farm irrigation system. (See Annex 1, Table A.15).

Recommendations

2.30 Advanced on-farm irrigation systems and water conservation technologies have to be introduced at an accelerated pace in order to address the depletion of water resources and to increase agricultural production. The sprinkler and drip irrigation system at the farm level combined with the modernized conveyance / distribution system could increase the efficiency to about 70 to 80% compared to efficiencies of 40-60% with traditional surface irrigation. With the support of improved extension services, such advanced on-farm irrigation systems could enable optimal irrigation and increase agricultural yields.

2.31 On-farm surface irrigation systems can also be improved through: i) land leveling by laser techniques, and ii) better distribution of water by siphoning irrigation water from a head ditch into the furrows or by PVC pipe. Currently, land leveling service is provided by the government at around SP 3,000 / ha (US$ 60 / ha). Since the land leveling needs to be repeated every two to three years, a system of leasing the equipment, possibly through the Farmers' Unions, can be established.

2.32 In order to maximize the benefits of the modernized on-farm irrigation system, the selection of the appropriate on-farm irrigation technology and system is very important. This should take into account the local soil, climate, and crop characteristics and the available level of management skills. A introductory manual should be prepared for extension engineers and farmers covering the key factors such as topography, climate, soil conditions, crop characteristics, expected yield levels, crop values, investment / maintenance costs, and the required and expected management skills and labor. The research currently carried out by DIWU at the provincial level provides a good basis for the development of such a manual.

2.33 Farmers are in need of technical and extension assistance for increasing on-farm efficiency of water use through the introduction of the modernized distribution systems, installing drip/sprinkler systems and so on. There is a clear need for the strengthening of the capacity of the extension service of MAAR.

2.34 The role of the private sector in advanced irrigation equipment is dominant in Syria. The IFC recently[28] made an equity investment of U.S $1 million in a private drip irrigation company. The project is expected to enhance farmers' access to advanced irrigation equipment, systems, and techniques. It is expected that with the right incentives, the private sector will produce more affordable sprinkler and drip irrigation equipment. There is a need however, for standardization of the equipment in order to ensure quality control – regulation by the Government in this regard would be essential. Certification currently provided by the DIWU is not mandatory and the testing process needs to be institutionalized under the umbrella of the Ministry of Industry to ensure that the local manufacturers comply with international standards. The private sector could also potentially play an important role in the O&M of irrigation systems and extension services for the farmers.

[28] December 1999.

E. Irrigation Operations and Maintenance and Cost Recovery

2.35 The MOI is principally in charge of irrigation dams, as well as those for domestic water supply and hydropower generation. For the domestic water supply dams, MOI carries out the O&M without contributions for capital and O&M costs from urban users (cities or Ministry of Housing and Utilities). Except for some dams in the Euphrates, dams including hydropower generation are also managed by MOI with O&M costs contributed by the power authority for its share. The General Directorates of MOI are in charge of O&M for dams, delivery canals and pumps up to farm gates. In the Euphrates Basin, O&M is carried out by the local departments of the Establishment of Land Reclamation. The basic O&M activities, such as sedimentation and weed removal, are carried out during the winter season (Jan. and Feb.) when the irrigation system is shut down and includes the flushing of the horizontal pipe drains. To meet the temporary increased work loads, seasonal workers are hired in the local areas. The maintenance of the field open drains is the responsibility of farmers. For the O&M of dams, General Directorate dispatch engineers to the sites to carry out regular operation, inspection and maintenance. Only a few large dams have permanent control offices at the sites. Generally, the maintenance level seems to be good according to MOI sources. However, a few dams have sedimentation and leakage problems, which do not affect dam safety but which would require expensive rehabilitation works. Water quality in reservoirs is occasionally checked in addition to regular monitoring of water level and discharge volume.

2.36 The cost of O&M of both irrigation and drainage schemes (except dams) is recovered from the farmers in the form of service charges. The O&M charge is periodically reviewed and modified by a committee of the Supreme Agricultural Council. In 1996, the charge was SP 2500 / ha (about $ 50 / ha) while the total average O&M costs were computed at SP 3600 / ha (about $ 80 / ha). As of December 1999, the O&M charge to farmers was increased to SP 3500 / ha (about $ 75 / ha) with the estimated average total (regular) maintenance costs of the diversion weirs, delivery canals and pumps up to farm gates excluding dams were estimated at about SP 4000 / ha (about $ 90 / ha). Responsibility of O&M at present is fully undertaken by MOI up to the farm gate level. The O&M fee is charged only for the irrigated areas and is waived when no irrigation water is available. The O&M budget in 2000 was SP 1,556 million, about 9% of the total MOI budget. However, there is no linkage between the collected O&M fees and the actual budget for the O&M activities. Farmers thus, do not perceive that the O&M charges that they are paying are associated with the actual O&M. According to MOI and MOF sources, since 1997, the capital cost of construction of new irrigation and drainage projects and rehabilitation is recovered by the government from the farmers over 30 years (in yearly installments) without interest[29]. On average, according to MOI sources, about 40% of the capital costs are now recovered. This makes Syria one of the few countries in the developing world where an attempt to collect capital costs is being made. The capital costs are computed as average costs in each basin, and the user cannot sell part/all of the reclaimed land before all the 30-year payments are made. While the O&M fees go directly to the Treasury, the capital cost payments are funneled into the National Debt Fund which is autonomous within the Ministry of Finance.

2.37 The O&M fee is regarded as a type of property tax since the amount of the fee to be paid is notified by the Ministry of Finance to each governorate based on the irrigated area for each household and is paid at the local branch offices of the Central Bank. No penalties are imposed if the user defaults on a payment. However, surcharges are applied on late fees in accordance with the laws governing late payment of taxes. However, fee collection rates have far exceeded projections in the last few years as shown in Table 10. According to Ministry of Finance sources,

[29] Since the issuance of Decree no. 7 of 1996 related to the 1984 law.

this can be attributed to errors in the preparation of lists of users at the governorate level by the MOI, underestimation of the number of farmers, compounded by inefficiencies in the billing and collection processes.

Table 10: Irrigation O&M Fees: 1996-2001

Year	O&Mfees–projected (million S.P)	O&M fees actually collected (million S.P)	Collection as % of projections
1996	60	136	227
1997	90	149	166
1998	120	179	149
1999	120	145	121
2000	150	175	117
2001	250	n.a	n.a

Source: Ministry of Finance

2.38 Syria, like many other developing countries, has an irrigation tariff system of a flat rate/ha that is administratively simple and easy for users to understand. According to MOI data, Syrian farmers pay about 80% of the O&M costs which is very high compared to other countries. Again, as is common, this is based on average rather than marginal costs of supply, and does not include provisioning for depreciation. However, since the fees are not related to the volume of water consumed, farmers have no incentive to use water efficiently. Volumetric pricing is ideal but is difficult to implement. Often, agencies use a combination of the two methods as is done in Mexico where the federal water commission charges the WUA for quantity taken at the turnout of the secondary canal. In turn, the WUAs charge individual members on the basis of irrigated area and type of crop. Countries like Brazil and Korea use two-part tariff structures - a fixed fee to cover overhead expenses, and a variable fee based on use. This has the advantage of providing a reliable stream of income for irrigation authorities, while retaining incentives for farmers to conserve water[30]. However, the success of this system depends on the methodology used to calculate the fixed tariff, and the extent to which fixed O&M charges can be recovered from farmers irrespective of whether they grow crops or not as illustrated in the case of Brazil (Box 2).

[30] *Water Pricing Experiences: An International Perspective*, eds. A.Dinar and A. Subramanian, World Bank Technical Paper No.386, 1997.

Box 2: Brazil: Two-Part Irrigation Tariffs in Practice

In Brazil, the irrigation law requires that water tariffs for public irrigation projects be set as the sum of two coefficients, K1 and K2 where K1 reflects the capital costs of the project, and is calculated based on the assumptions of a 50-year repayment period and a subsidized interest rate. Per hectare values are computed by dividing the total value by the total number of hectares under irrigation: in 1995, the K1 value was about $3.69 per hectare/month. K2 is supposed to cover the O&M costs of the project, and is estimated as a function of the volume of the water used. Irrigation water is metered in most public irrigation projects. The K1 tariff is paid to the sponsoring federal agency, while the K1 component is normally paid directly to the water users district. However, a lack of clarity regarding the methodology to estimate the annual value of K1 has led to problems. Furthermore, charging farmers for the water on the basis of use alone sometimes leads to a failure to cover the fixed O&M costs of projects since revenues from this source are not predictable. The law does allow irrigation districts to charge a fixed volumetric bill to cover fixed O&M costs. But this is not always sufficient, particularly since farmers choosing not to grow crops in a season rarely have to pay K2 charges at all.

A revised tariff system is under consideration for some projects, for example, Jaíba. The approach would involve dividing the K2 coefficient into two factors, one representing the fixed O&M costs, and the other the variable costs. Farmers choosing not to grow crops in one season would still be responsible for the fixed O&M costs. The Jaíba irrigation project is one of Brazil's best managed irrigation projects. Since the project started operation, nearly 29,700 bills have been issued, of which 19,600 have been paid (66%). The value attributed to K1 was about 26% and that for K2 about 74%.

Source: Brazil by Azevedo, G. in Dinar, A. and Subramanian, A. eds. **Water Pricing Experiences: An International Perspective,** World Bank Technical Paper No. 386 (1997).

Recommendations

2.39 The need for a comprehensive integrated water resources management strategy is clear. Whatever the overall strategy, it is clear that *demand side management* must play a critical role. (See Box 3) have already been developed. In addition, groundwater extraction substantially exceeds recharge in many basins and this is having a major impact on surface flows. In this context, demand side management is essential. ICARDA research results indicate that energy pricing may be one possibility. ICARDA researchers report that the increase in diesel costs from 4 S.P/l in 1993 to 6 S.P/l in 1994 affected two-thirds of the irrigators in the Atareb region in NW Syria who reduced their total volume of groundwater pumping. It was estimated that the cost of extracting one cubic meter of water from a 150-m deep well increased by 24%, from 1.45 to 1.80 S.P which represented a proportional change of 48% of total extraction costs. Despite stated opposition to pricing water per se as an economic good, at a minimum, the water charges should cover 100% of the costs of supply. Further, the irrigation tariff must relate charges to actual water use in order to provide incentives to farmers to utilize water more efficiently. A new tariff system will have to be established that would provide incentives for farmers to use water more efficiently and reduce wastage.

Box 3: Tunisia: Implementing a Demand Management Strategy

The Government of Tunisia recently endorsed a new Water Sector Strategy (prepared with the support of the World Bank) whose main thrust is participatory demand management. This strategy has been endorsed by the Government as the basis for the new World Bank supported Water Sector Investment Project (WSIP) and all future investments in the sector. This strategy specifically addresses the integrated management and conservation of water resources; economic efficiency of irrigation water use; and institutional restructuring and capacity building.

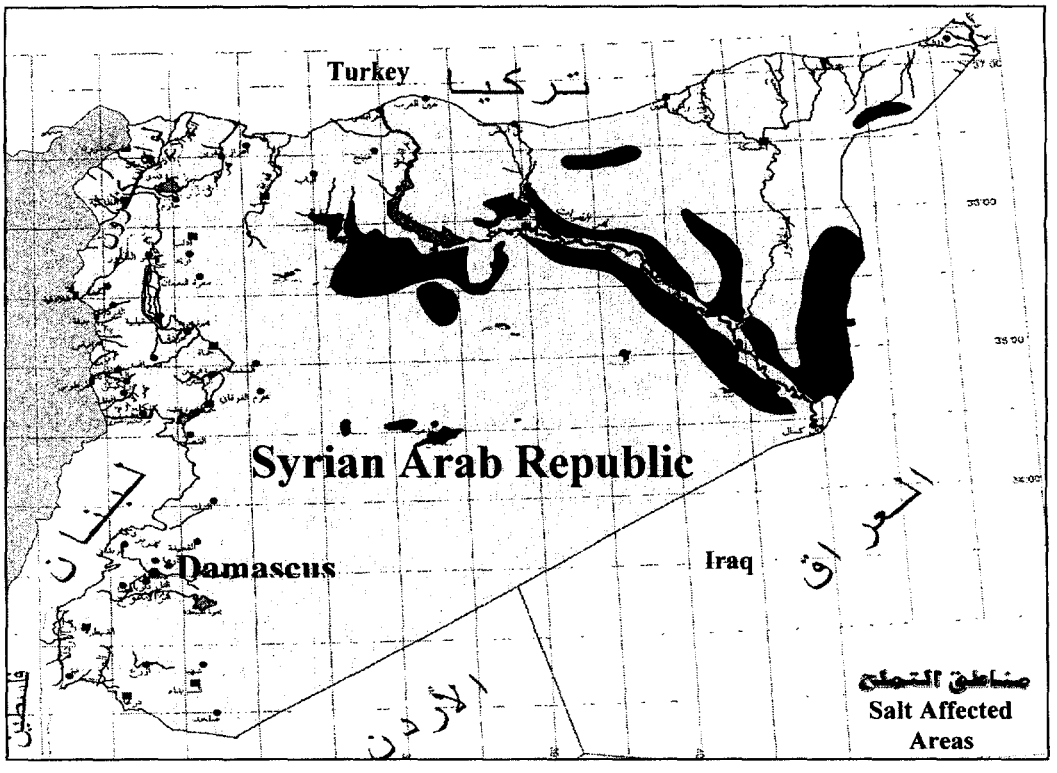
Under the WSIP, reforms include (i) delegating progressively overall responsibility for the management of irrigation perimeters, including public perimeters, to WUAs; (ii) extending modern cost and income accounting practices to all governorates with a view to introducing transparent contracting and billing between Government and WUAs, and reduce the cost of water delivery in irrigation; (iii) implementation of a binomial irrigation tariff structure with a 15% nominal increase for irrigation water per year; (iv) establishing a socio-economic unit for water resources management to facilitate future intersectoral water allocation decisions; and (v) formulation of a communication strategy for water conservation.

F. Drainage

2.40 Current State: The majority of the drainage needs exist in the arid Euphrates Basin where surface irrigation from the Euphrates river is practiced on a large scale. Salt affected areas are shown in Figure 8[31]. The main problem in the Euphrates area is salinity. Minor water logging problems due to excess rainfall exist in the wetter (rainfall exceeding 250 mm year) Coastal and Orontes Basins. The common practice in Syria is to provide drainage simultaneously with irrigation when new lands are reclaimed and developed for irrigation. The term land reclamation in Syria refers to construction of all the irrigation and drainage infrastructure including storage or diversion dams, pumping stations, main and field irrigation and drainage systems as well as land leveling and salt leaching if necessary. Rainfed and traditional irrigated land are converted into modern irrigation schemes when sufficient water and suitable land are available.

[31] Source: GIS Unit of the Water Research Center, MOI.

Figure 8. Salinity Affected Soils



2.41 The total area provided with drainage at present is about 200,000 hectares where sub-surface pipe drains dominate in the Upper Euphrates Basin and vertical drainage in the Lower Euphrates (Table 11). Open drains are widely practiced in the Central Euphrates. A total of about 340,000 hectares are identified as having drainage problems or potential to develop problems in the future. Much of this area is currently subject to investigations and studies to determine their drainage needs and prepare the necessary designs. The general trend at present is to implement sub-surface horizontal pipe drainage at the farm level as a more effective drainage measure with less maintenance requirements compared with open drains and far less operational cost compared with the tube wells. Furthermore, horizontal pipe drains mobilize less salts from subsurface soils compared to tubewells.

2.42 The government is currently considering the conversion of irrigation canals into low pressure pipelines. It is expected for consistency that open drains in such areas will be converted too into subsurface horizontal drains. Control of waterlogging and salinization requires that improved on-farm irrigation and drainage go hand-in-hand. Annex 5 provides a detailed listing of the existing drainage projects and the location of future drainage projects. The studies and designs of the drainage systems are carried out by the (State) Company for Water Studies (MOI). The company carries out initial topographical and hydrogeological surveys and investigations followed by pre-feasibility studies before preparing the detailed designs.

Table 11: State of Drainage and Drainage Needs in Syria

Region	Open Drains (Ha)	Pipe Drains (Ha)	Vertical Drains (Ha)	Total Existing Drains (Ha.)	Drained Area that Needs to be Rehab. (Ha)	Area to be drained (Ha)	Total Area (Ha)
Lower Euphrates	-	1,600	30,000	31,600	-	93,400	125,000
Central Euphrates	60,200	2,400		62,600	5,800	105,180	173,380
Upper Euphrates	3,400	91,600	-	95,000	-	137,000	232,000
Orontes Basin	7,200	-	-	7,200	-	-	7,200
Coast Basin	-	3,000	-	3,000	-	-	3,000
Total	70,800	98,600	30,000	**199,400**	5,800	**335,580**	540,580

(1) Values in the table were obtained through interviews with MOI staff and may need verification.

2.43 Non-point source pollution due to drainage of irrigated lands could have adverse effects on downstream users particularly when the river water is used for drinking purposes. When drainage water is reused for irrigation, it contains high concentrations of soluble salts and toxic ions, therefore there is a risk of long term effects on the soils, crops, ground water and eventually, on public health once pollutants enter the food chain. Information about the quantity and quality of agricultural drainage water in Syria is scarce and the available literature have conflicting data. However, there are definite plans for expanding the re-use of drainage water for irrigation driven by the deficit in fresh water supplies.

Recommendations

2.44 Future development of the non-drained areas and the rehabilitation of existing drainage schemes could be phased in successive projects within a national drainage program. The program may include in addition to construction of drainage system, institutional strengthening and capacity building of the institutions working in design, construction and maintenance of drainage projects. The design of the program will depend on the capacity of the institutions involved and drainage contractors. The implementation of new subsurface drainage projects should be coupled with on-farm irrigation improvement including land leveling and efficient irrigation practices.

2.45 The quality of drainage water in terms of salinity, toxic ions and residues of agricultural chemicals should be assessed. Planned disposal and reuse of drainage water needs close monitoring of its temporal and spatial distribution - whether the drainage water flows back into rivers (return flows), into lakes and seas (sinks) or locally reused for irrigation. International experience and research (local and international) provide management options for safe use of saline water in irrigation. Farmers using drainage water for irrigation should be made aware, through extension, of the limitations and risks involved and need to be trained in the best practices for mitigating or minimizing any possible adverse effects.

G. Water Quality and Pollution Control

Current State

2.46 The basaltic and limestone aquifers common in much of Syria are highly vulnerable to pollution and this is emerging as a major problem in urban areas such as Damascus. Data on groundwater quality are, however, limited. Unlike surface water monitoring, no extensive or comprehensive monitoring program of groundwater has been undertaken. Despite the lack of data, pollution appears very widespread and there are clearly documented cases where

groundwater pollution is a major concern. Contamination of surface and ground water resources has become an issue of serious concern in Syria due to the direct discharge of domestic and industrial waste water to the water bodies (rivers, canals, streams and lakes). Until two years ago the country was virtually without domestic waste water treatment facilities. Wastewater disposed into rivers is used downstream for irrigation and probably for drinking purposes too that has resulted in the spread of waterborne diseases such as typhoid, dysentery, and diarrhea. Potential for ground water contamination through deep percolation is high where surface water and groundwater aquifers are interconnected. Although there is no systematic and regular monitoring of ground water quality, there are several indications of pollution of ground water in different areas such as in the suburban area of Damascus (Ghouta) and South Aleppo. The World Bank-supported National Environmental Action Plan (NEAP) (1999) reports that the periodic monitoring campaigns carried out by the Ministry of Health, Ministry of Housing, MOI, and MAAR laboratories demonstrate convincingly that pollution of ground and surface waters with industrial and domestic wastes occurs across the entire country, near all major settlements. Ground water pollution by nitrates from agricultural areas is reported in Dar'aa and Edlib. BOD concentrations and levels of ammonia are dangerously high in the Barada, Sajour (near Aleppo) and Orontes rivers. High coliform counts are reported in the domestic supply wells in the Coastal basin and the springs and groundwater in the Barada. In addition, the ecosystems of many rivers and streams are showing serious deterioration or even irreversible damage. In spite of the rising official and public awareness about the state of the environment and the pollution of surface and ground water, there is still no comprehensive framework for pollution control.

2.47 One of the most important requirements for developing a comprehensive water quality management and pollution control plan is to establish well functioning water quality monitoring net work. Recently, a monitoring network only for surface water quality (rivers, lakes, reservoirs, and sea coast) was established by Department of Pollution Control (DPC) of MOI and comprises 162 measuring and sampling locations (See Annex 1, Table A.16). No monitoring sites exist along the agricultural drains; however, some sites along the rivers coincide with some of the drain outlets. Monitoring of ground water quality is occasional and carried out on an ad-hoc basis. The main parameters monitored are temperature, electric conductivity, pH, ammonia, dissolved oxygen, chloride and BOD.

2.48 The DPC is responsible for monitoring the quality of industrial wastewater too. Inspections are carried out once per year at the outlet of the discharge pipes. In the Damascus area, there are about 500 industrial plants including over 250 private tanneries many of which discharge untreated industrial wastewater. In the absence of a tight pollution control framework with sufficient regulatory and legal power this region remains one of the most serious black spots of the country. Similar situations may also exist near big industrial centers as in Aleppo.

2.49 The DPC has the authority to: *enter, sample, monitor and advise*. It has no enforcement authority and limited monitoring and analytic capacity. The Head Office of the DPC consists of two Divisions; one for monitoring and the other one for studies. Water samples for quality analyses are collected by the field staff of the Irrigation Departments in the river basins and then transferred to Damascus for analysis. The Directorate faces a major operational and staffing problems. This is evident, for example, in the fact that it has no gas chromatograph (essential for identifying many pollutants) and only two atomic absorption machines available for analyzing pollutants within the entire country. There is also no provision for heavy metal and pesticide analysis. In addition, it has only 15 professional staff for monitoring all industrial pollution in the Damascus area as well as analysis and water quality studies for the whole country. Capacity for monitoring seems less than adequate in terms of number of personnel involved, training,

equipment, data recording and reporting. The main weakness exists in the lack of trained staff and incentives to retain qualified personnel.

2.50 The treatment plants at Damascus and Homs have been commissioned during the past two years and the construction of the rest will expectedly continue until 2010. However, many of the smaller communities with more than 70% of the population will remain without wastewater services. It will be necessary to provide sewerage as well adequate treatment facilities to these communities in small towns and rural areas which are the primary source of the current pollution in Barada and Awaj upstream of Damascus.

Recommendations

2.51 The capacity of the DPC in terms of organization, staffing and equipment needs immediate strengthening. In addition, DPC needs to be invested with real enforcement authority in order to carry out an effective pollution abatement mandate. Cooperation with the Ministry of Environment would also be essential in order to identify major polluters and critical hot spots. A well-functioning water quality monitoring network for both surface and groundwater is a prerequisite for any comprehensive water quality management program.

2.52 The institutional aspects of treated waste water reuse still needs attention through better organization and regulation on the basis of well defined standards and specifications and practical guidelines and operational rules. Currently, no comprehensive regulatory framework exists for treated wastewater reuse. While acknowledging the progress made through treatment, the risks involved should not be minimized. The environmental and health implications of treated wastewater reuse need to be disseminated to farmers who also need more training on measures to minimize adverse effects. Developing cost-effective technologies for collecting, treating and disposing/reusing of wastewater in small-towns and rural areas is the need of the hour. In this regard, two ongoing efforts are noteworthy: a UNDP-supported project on treated wastewater reuse in the Damascus and Aleppo areas has just got under way on a pilot basis[32]. Two experimental sites of about 20,000 m2 will be established, one near Damascus, and the other near Aleppo city and will be equipped to carry out long-term multi-disciplinary research on the use of secondary effluent on soil fertility and crop productivity as well as on health and environmental aspects. Training of farmers and government officials in the management of irrigated agriculture using treated sewage effluent and agricultural drainage water is also envisaged. The World Bank has also made available to the Government of Syria through the Ministry of Housing and Utilities (MHU) a Japanese Policy and Human Resources Development (PHRD) grant that will be partly used to finance the Wastewater Strategic Planning and Priority Investment Study in two areas of Barada and Ghouta Gharbiyah of the Damascus Rif area surrounding the city of Damascus that is not served by the recently completed Damascus wastewater treatment plant. The objectives of the study are to identify and prepare a strategic plan for provision of wastewater management services (collection and treatment) in the project area (Barada and Ghouta Gharbiyah) and to identify and prepare to the feasibility stage, a priority package of works that will comprise a wastewater component for financing under the World Bank-proposed Greater Damascus Water and Sewerage Project.

[32] 1/2000-12/2002; total project cost ~ U.S$800,000.

3. INSTITUTIONAL FRAMEWORK AND SECTOR ORGANIZATION

A. General

3.01 Any discussion on the institutional issues in water management in Syria must start with recognition of the sensitive nature of the topic. Water issues are of fundamental economic, social and political importance to Syria. This translates into limitations on the flow of information. From an institutional perspective, the politically sensitive nature of the issue of water resources management may represent a critical challenge in developing effective partnerships and solving its water management needs. Most institutional analyses now emphasize the fundamental role of information, models and analyses in creating the shared understanding necessary to develop effective management strategies. This is true whether the dialogue is at a local level – between groups of farmers, cities and government entities – or at higher levels. Shared understanding is the "institutional glue" that enables groups to reach agreement regarding the nature of problems and the best avenues to address them. It is the catalyst that ensures all parties will actually devote human, social, financial and political capital to achieving what are often extremely difficult objectives.

3.02 Syria as a country is at an historic juncture. Until recently, substantial water resources remained undeveloped. Now, according to the MOI, most surface water resources have been developed. The groundwater balance in all basins (except the Coastal and Steppe basins) is negative. Furthermore, both surface and groundwater resources are threatened by pollution. *Government organizations need, as a result, to make a transition from a water development to a water management focused role.* This transition necessitates the building of management institutions and capacities within the government and local user populations.

B. Sector Organization

3.03 The overall institutional framework for water management in Syria is hierarchically organized. The apex policy making body is the Supreme Agricultural Council. This is headed by the Prime Minister and has members from the major water related ministries,[33] the leading political party and the head of the Farmers' Union. This council has parallel regional councils in each governorate with a similar makeup headed by the governor. Both the Supreme Agricultural Council and its equivalent in each governorate appear designed to ensure that the perspectives of critical political and user stakeholder groups are represented. Ministerial and political representatives reflect government perspectives. Representatives from the Farmers Union, a separate structure composed of village level, regional and national farmer committees or cooperatives, provide representation for user perspectives.

3.04 Government Organizations: The key government organizations involved in water management on a day to day basis are the Ministry of Irrigation and Ministry of Agriculture and Agrarian Reform along with their local directorates, the Mohafazats and the Farmers Unions. (See Organogram 1). In addition, the Ministry of Housing and Utilities is responsible for the water supply and sewerage sector. Each of these organizations plan, implements and conducts O&M separately. According to the JICA report, the level of feedback among the organizations is

[33] Ministry of Irrigation, Ministry of Agriculture, Ministry of Housing, Ministry of Environment, Ministry of Electricity, Ministry of State Planning Commission, etc...

limited and the responsibility and accountability of different organizations are sometimes blurred. There is little coordination and cooperation among related ministries and organizations.

Ministry of Irrigation (See Organogram 1)

3.05 The Ministry of Irrigation is the organization with the greatest direct responsibility for water resources related activities. Established in 1982, the MOI is formally responsible for management of water in the country in terms of: a) policy formulation and research / studies regarding the water resources development including water quantity and quality and allocation among sectors, b) issuing water permits both for surface and groundwater, and c) planning, construction, and O&M of most of the hydraulic facilities, such as dams, canals, and pumping stations. The country's seven hydrological basins are managed on decentralized basis by the Central Directorate and six General Directorates (GD) which include Divisions for Irrigation and Water Resources and Divisions for Operation and Maintenance for each basin. The Establishment of Land Reclamation is based in the Euphrates Basin and is responsible for land reclamation and irrigation and drainage in this basin where the largest area irrigated with surface water exists. The General Company for Water Studies was established in 1983 to carry out all investigations, studies and designs of irrigation and land reclamation including drainage schemes where artificial drainage is necessary. The private sector gets involved in design or construction of irrigation and drainage systems only when the state owned companies are unable to do so due to work overload. The MOI has a variety of specialized directorates, including the Directorate of Pollution Control, the Water Research Center, the Water Resources Department, the Dams Department and so on. To carry out its water resources management mandate, MOI is responsible for hydrological and hydro-geological monitoring of river flow, dam storage volume, groundwater level, water abstraction, etc. including water quality indexes, through its General Directorates. It is also responsible for collecting most of the basic water resources data, water resource assessment and planning. The functions of the MOI, its specialized Directorates and its relation to other related agencies for water resources development is shown in Organogram 2.

3.06 The General Directorate (GD) of MOI in each basin through the Mohafazat office reviews any new water right application submitted by the executing agencies/users along with an annual plan of water use including the amount of water and location. The General Directorate examines the application reviewing the available water resources in the basin based on the hydrological monitoring data and assessment. The Farmers' Unions also prepare annual operation plans including the irrigation schedules and water demands compiled from farmers' requests and submit them to General Directorates through the Mohafazat offices. The GD offices review the requested irrigation water demands considering rainfall and evaporation, crop water requirements, available water volume in reservoirs for approval with the aid of computer programs. The Mohafazat offices are also in charge of controlling the actual irrigation turns at farm gates with agricultural cooperatives. This water distribution system seems to be enforced well according to MOI officials who report no conflicts in water allocation even during dry years. However, this has not been confirmed through independent verification with farmers. In addition to surface water, MOI is responsible for groundwater management, reviewing the application for new wells based on the basin water balances.

3.07 Planning and Design of Water Resources Facilities: The irrigation projects covering dams, canals, pumping stations up to farm gates are under the jurisdiction of the General Directorates of MOI in terms of planning, design, and O&M. Feasibility studies of small-scale irrigation projects are carried out by the Irrigation Divisions of General Directorates and then reviewed by the Central Directorate of Water Resources and Irrigation of MOI. For the case of large-scale

irrigation projects, the General Directorates commission the studies to consulting companies through an international bidding process[34] while the Central Directorate plays a review function.

3.08 The investigation and feasibility studies of dams are under the authority of the Central Directorate of Dams of MOI. The design of small and medium-size dams (up to about 50 m usually) are prepared by General Directorate, which commissions the study to the General Company of Hydraulic Studies under MOI as well as some local private companies. The design of large-scale dams are commissioned to international consulting firms by General Directorate. The Dam Department reviews and examines the preparation process of large dams with the approval of a technical committee headed by Vice Minister of MOI. The technical standard of dams in Syria seems to have been derived from the former USSR and eastern European countries.

3.09 The MOI has roughly 15,000 staff. All directorates report directly to the Ministry of Irrigation. The Central Directorate has about 500 staff, of whom 20 percent are engineers. General Directorates are larger and staffing is heavily dominated by engineers with few economists, sociologists or lawyers. In addition, there is little opportunity for professional development and staff tend to stay on a narrow career path. It has no public relations section. Salary levels in MOI, as in other government Ministries, are very low. Overall, the MOI appears configured to support water resource development rather than management.

3.10 Water resources data are a particular arena where the MOI plays a lead role. In theory, data relevant to water are accumulated in the General Directorates and sent to the Central Directorates for filing and redistribution. (See organogram 3). In practice, data and publications are often not sent and important basic data and information may have been lost. Data availability is highly fragmented. There is no "one stop shopping" for data access. The meteorological record, hydrogeological record and groundwater withdrawal are separately observed by different organizations. The meteorological agency is, for example, part of the Ministry of Defense, and it collects rainfall data which are also collected by the Ministry of Agriculture and Agrarian Reform. Once collected by the MOI, documents and data are stored manually on a card catalogue system.

Ministry of Agriculture and Agrarian Reform

3.11 The Ministry of Agriculture and Agrarian Reform (MAAR) has 35,000 staff. This Ministry has directorates in all water basins. Its main water management activity appears to be through its advisory role on cropping patterns and on-farm water use. The MAAR instructs farmers to follow "a yearly cropping pattern to farmers through directorates and the Farmers' Union." According to officials, the MAAR control over cropping patterns has been declining in recent years and enforcement is now limited.

3.12 MAAR also provides basic extension and research services to farmers. The Department of Irrigation and Water Use (DIWU) of the MAAR carries out nationwide research work on crop water requirement, farm water management and irrigation methods and technologies. DIWU has seven research stations in the seven river basins which links its research program to the local water, soil, crops and climate conditions of the basin. A number of activities are being carried out in the areas of irrigation techniques and methods, and transfer of technology activities with the local Department of Extension including field days and seminars. In addition, joint research activities are being carried out with ICARDA, notably on supplementary irrigation (SI) at the Sirbaya research station of the DIWU in Aleppo. Research on drainage and reuse of drainage

[34] Companies from Russia, Bulgaria, and Romania are among the countries that have thus been contracted.

water is carried out at the Deir es Zor station in the Euphrates basin. The research station of DIWU in the capital recently established a computerized laboratory to test (at no charge) locally produced modern irrigation equipment (drip and sprinklers) but the testing process still needs to be formalized and linked to the mandatory role of the Ministry of Industry for standardization, and formal certification. Research has also been initiated on the reuse of treated wastewater in irrigation. However, there is little coordination between the research carried out by MOI and that of the MAAR.

Ministry of Housing and Utilities (MHU)

3.13 In addition to urban planning, mapping, and housing, this Ministry has primary responsibility for domestic water supply and sewerage. With the decentralization of 1981, 14 semi-autonomous water supply and sewerage (WS&S) authorities were created in each governorate. These are overseen by the MHU. Currently, the MHU is involved in the design of major drinking water supply projects including one to transfer water from the Coastal Basin to supply water for Damascus. From the point of view of overall water resources management, it would seem that MOI would be the more appropriate lead agency. However, MOI is not involved in this potentially critical project.

Mohafazats & Farmers Union

3.14 The primary role of the Mohafazats is to control the illegal digging of wells and canals. According to MOI officials, well closures can also be enforced by the police. *The MOI itself does not have any direct power to enforce well closures.* Beginning in the 1960s there have been numerous orders that prohibit well digging in different areas. These do not appear to have been effectively enforced. The Farmers' Union digs wells and canals and constructs small dams for irrigation and livestock. Wells are also constructed by private farmers on their own.

C. Institutional Capacities

3.15 From a management perspective, the MOI and the DIWU within the MAAR have clear capacity limitations with regard to water management. Although they are proposing various regulatory activities, they have little or no enforcement authority. They also lack staff skilled in the wide array of social, economic, and technical issues necessary for water management rather than development. Key areas where capacity appears to be lacking include:

- *Data Collection*: The government's ability to collect data in key areas, such as water quality, is clearly limited. As discussed earlier, the DPC within the MOI has extremely limited staff and analytical facilities in relation to the major pollution and water quality problems present in Syria. In addition, although they have not been reviewed in detail, groundwater monitoring systems appear weak (manual monitoring of a few parameters within a limited piezometer network). Strengthening data collection appears central to developing an accurate understanding of water management challenges and options.

- *Data Management and Analysis*: Computer capabilities within the government organizations appear weak, particularly in relation to water resource modeling, Geographic Information Systems and other forms of data processing and analysis. This represents a critical constraint on Syria's ability to analyze water resource concerns and to identify the strategic and institutional issues it may face. There is a clear need for new hydrogeological data that are needed for technical evaluation of water availability and flow and on the data bases and

systems required for storage and retrieval. It is equally important that these data be analyzed and communicated so that they assist in creating the social and political foundations for management. Close attention needs to be paid to the development of appropriate decision support systems, and the key users of data.

- *Outreach and Communication*: Government organizations appear to have a relatively limited capacity to communicate technical insights to local users or to work with them to develop effective management systems. This is a critical limitation because management implementation generally requires a high degree of understanding, support and involvement on the part of users. Understanding is also essential to building the political acceptance for what are often difficult, management alternatives. As MOI officials noted, *the building of political support for difficult management decisions is new for the organization.*

- *Economic, Legal and Social Analysis*: Water management depends heavily on detailed understanding of the social, legal and economic factors influencing the viability of different approaches and their effects on different user groups. At present, government departments appear to lack staff with the necessary educational background and training in such skills.

- *Integrated Water Resources Management:* The water resources management function appears to be fragmented between MHU, MOI, MAAR, and the Ministry of Defense. MOI's capacity for integrated water resources management in the context of new water supply options appears to be limited. MOI needs to strengthen its capacity for effective integrated water resources management including demand management, water resources protection, environmental and social impacts of large-scale inter-basin transfers, and so on.

3.16 In contrast to government departments, general impressions based on discussions with officials and observations suggest that farmers seem to have a key role in planning and management of the agricultural sector in Syria. They are involved in the political arena from the village level to the highest central levels. They already participate in determining the crop intensities and type of crops on the basis of the available water resources. Field visits suggest that strong water user associations are present, at least in some areas (See Annex 7). Although they may have no direct organized role in managing the irrigation water in large scale schemes, the present farmer organizations provide strong base for giving farmers more institutional and legal responsibilities in the participatory management of the irrigation and drainage schemes. Options for participation and user involvement in irrigation water management and the necessary regulatory and institutional framework are areas which need immediate consideration at the national and regional levels.

D. Water Laws

Current situation

3.17 The right to use surface or groundwater is acquired through the issuance of water use license by the MOI. Whoever installs a pump on public surface without having a license is subject to a nominal fine. The license can be withdrawn if the user does not comply with license conditions *or if they use the water for purposes other than those authorized.* At present, licenses specify discharge, well numbers and a maximum depth of 150m. They are issued for periods of either 1-3 years or 10 years. According to MOI officials, a very strong law banning new wells has been in place for three years. This law allows the repair of problematic wells but prohibits new construction. However, enforcement of this law is weak.

3.18 According to MOI officials, over 140 laws have been passed since 1924 that address water. Water use priorities have not, however, been set in any official legislation. There is, however, a widely accepted consensus among related ministries about priority of water usage. Drinking water has the top priority followed by agricultural water and industrial water." Prohibitions on well digging and groundwater pollution have been passed – but there are no clear mechanisms for enforcement.

3.19 According to MOI officials, disputes over water rights and other water management issues are currently resolved through the normal court system. This often involves a committee chaired by a judge and containing representatives from the MOI, local authorities and the Farmers' Union. Enforcement is, however, generally lacking. This is also the case in times of water scarcity. According to MAAR officials, when water is scarce the Supreme Agricultural Council bans summer crops. As an MAAR official stated, however, "unfortunately, there are many wells in irrigation projects. So if we cancel water for cotton, they grow it anyway."

3.20 Part of the above conflict may relate not just to governmental enforcement capabilities but to perceptions. As research by ICARDA found: "most farmers in the study area have a set of well-formed perceptions about the nature and origins of groundwater; and that these perceptions are such that the majority of them do not accept the official view that groundwater levels are declining solely because of excessive abstraction (ICARDA 1993). This suggests that effective strategies for enforcement may require substantial supporting activities (education and outreach) to "close the perception gap." Enforcement is always difficult in the absence of agreement over the nature of emerging problems.

Water Law Reforms

3.21 Given their highly fragmented nature, the MOI has drafted a new bill to supersede and replace existing water laws. A translation of this draft law is presented in Annex 8. This law is currently being considered by the Parliament. The justification for the proposed law is based on the fragmented nature of current laws and the absence of a comprehensive and unified water law that matches the development of irrigation and land reclamation projects.

3.22 Provisions for screening of water rights cover five pages in the draft law. The process is to be based on land, not water. The law confirms established rights on public water but gives the government the authority to nullify them and requires compensation if this is to be done. It states that "no rights traditional or otherwise can be nullified without payment of compensation as defined in this law." The value of a right is based on the difference between the pre and post-development value of the land (i.e. the land with and without the water). The law states that "compensation should not exceed the difference between its value on a rainfed basis and its value as irrigated land". The MOI expects to issue a decree in parallel with the new law to define water duties in each basin, establish separate licenses for pumps based on their capacity and establish fees for irrigating lands from wells, and the licensing of wells and pumps.

3.23 The proposed new water law would, if enacted, establish a highly centralized system for regulating and managing water resources, including groundwater. This is reflected in the large array of key management decisions that would be made at the ministerial level and in the absence of any detailed mention of either regional or local management organizations. It is also evident in the high degree of centralization for enforcement actions. Under Articles 48 and 49 having to do with pollution control, for example, cancellation of licenses in the case of pollution by an industry

is a ministerial decision. This leaves local officials with little power to enforce pollution control standards.

3.24 The potential gaps created by allocating management decisions to higher levels are well illustrated by the case of well spacing. Under Article 3 of the proposed new law, the "haram" (private or restricted) area around wells would be set and modified via a rule promulgated at the ministerial level. Well spacing regulations are a common strategy in many countries for managing groundwater extraction and well interference. The appropriate spacing depends heavily on hydrological characteristics, the nature of the well and the nature and type of other uses. Since all these factors are tend to vary on a sub-regional (or even case-specific) basis, spacing regulations set at a national-level are likely to be ineffective. Even more importantly, virtually all types of water use regulations depend for their effectiveness on the willingness of user populations (farmers, domestic users, industries, etc...) to respect and obey them. Unless most users are supportive of regulations, enforcement is generally complex if not impossible.

3.25 The new water law also includes sections about water pollution control and legal actions in case of violations. The enforcement of the law when approved will certainly help in pollution control but this would be insufficient unless it is done within a comprehensive framework which includes strengthening of the monitoring capacity, treatment of wastewater, improved water quality management, adequate standards and specifications for waste water treatment and disposal, wide involvement of all stakeholders and sufficient awareness of the whole community about the danger of continuing with the status quo. Section 7 of the proposed water law is devoted to the protection of public water from pollution. It prohibits disposal of wastes which may cause pollution from any source into any public waterway. The law gives the Minister in charge to issue the necessary decrees with the necessary technical specifications and arrangements for storage or handling any substance which may cause pollution. The proposed law specifies the legal steps, conditions, inspection and monitoring requirements, analysis to be followed when licensing outlets from sources that may cause contamination of the public water. The same legislation applies to disposal of wastewater into the sea. In section 8, the law provides details of fines and penalties on polluters. The proposal is an important step forward but it should be carefully reviewed before enactment to avoid gaps and ambiguities, and inconveniences. For example, in clause 56 of section 8.9, the penalty specified is the same for individual, household and large industrial facility. The determination of the costs of cleaning polluted waterways is also not specified.

3.26 It is unclear how the new legislation of the type proposed by the MOI would change the poor compliance with existing laws. The new legislation does include an array of financial and, in some cases, additional sanctions if regulations are violated – but *it contains no indication of how they would be implemented nor does it specify who (which organization) would have responsibility for enforcement.*

Recommendations

3.27 At present, the capacity of government organizations to support water management (as opposed to water development) appears limited. Organizations appear structured and staffed primarily for the development of large water supply schemes. Component organizations dealing with data, pollution control, enforcement and other functions essential for management appear weak. Earlier reviews emphasized the importance of investments in farm-level irrigation, research and farmer education (World Bank 1987). Capacities in these areas are still limited and need to be strengthened.

3.28 User-based organizations (the Farmers' Union) may be quite strong and well represented in high-level policy as well as at the implementation level. There may be significant opportunity for the development of user-based approaches to water management in general, and groundwater management in particular. Developing the necessary regulatory framework and the institutional arrangements are immediate priorities.

4. FUTURE STRATEGY AND POTENTIAL FOR BANK COOPERATION

A. Government Priorities

4.01 Insofar as the specific strategies of the Syrian government pertaining to irrigation and water use in the agriculture sector are concerned, the following key areas have been identified for priority actions and investments to achieve the overall objective of improving water use efficiency in the sector. (A complete list is provided in Annex 10):

Water-use efficiency and land productivity:

- Efficient use of all available water resources "*each drop of water*", particularly in the Steppe Basin through water harvesting where possible.
- Rehabilitation and modernization of old irrigation schemes to realize improved conveyance efficiency through use of canal lining, pipeline networks and to be supplemented with modern field irrigation systems for increasing irrigation efficiency.
- Control of waterlogging and salinity in irrigated areas particularly in the Euphrates Basin, and construction of adequate drainage systems.

Groundwater management:

- Developing ground water irrigation management projects on the basis of group operation of well fields within a basin for decreasing the number of wells to realize efficient use of the resource and minimize the cost of operation.
- Absolute banning of any further drilling of ground water wells within basins suffering overdraft and declaring these basins as "*closed basins*".

Water quality:

- Monitoring surface and ground water quantity and quality all over the country.
- Control of waterlogging and salinity in irrigated lands, particularly in the Euphrates Basin and construction of adequate drainage systems;
- Developing a comprehensive plan to collect and treat all domestic and industrial waste water and reuse of the treated waste water and agricultural drainage water in irrigation within each basin to increase the water available for irrigation and to control pollution.

4.02 According to MOI officials, their main strategic plan for addressing both surface water needs and overdraft problems in the future focuses on the development of more small dams, consolidated groundwater management, the development of large irrigation projects along the Tigris, and development of a plan and treatment facilities to reduce pollution.[35] Rehabilitation of existing irrigation projects and increasing the efficiency of irrigation networks through the use of buried and pressurized pipes is also proposed.

4.03 Currently, more than 150 dams are operational with a total storage of more than 15 billion cubic meters. The government plans to supplement this by building more small dams for water harvesting. The Government (MHU) is also considering an expensive interbasin transfer project

[35] A brief strategic outline provided for the May 2000 mission focused on: 1) water harvesting; 2) rehabilitation of projects, 3) expansion of irrigation networks; 3) use of non-conventional water; 4) development of the Tigris river along the Turkish borders; 5) consolidation of wells where feasible; 6) monitoring and evaluation of all water; 7) conducting comprehensive regional studies; and 8) automating MOI activities. Water quality was also mentioned as a major strategy concern.

to meet the future needs of the Damascus region. A simple analysis reveals that for the Barada-Awaj region, this option is the most expensive compared to other options such as compensating farmers for reduction in irrigation, introduction of modernized irrigation systems, and construction of new dams in the Orontes and Coastal basins. The estimated water savings also are not as high as some of the other options. (Details in Annex 9).

4.04 MOI and the MAAR are also proposing well consolidation to address the groundwater management challenge. According to official sources, this approach has been approved by the Supreme Council for Agriculture and is supported by the Farmers' Union. However, this is extremely complex to implement and the institutional and regulatory framework for O&M of the consolidated well fields remain unclear. Beneficiary participation at all levels of the project cycle is essential. The World Bank's experience with deep tubewells in Nepal is illustrative in this regard (See Box 3).

4.05 The emphasis of the MOI on construction of more small dams and the specific projects put forward for consideration are unlikely to address most emerging water supply concerns. Water use efficiency is a major focus of the DIWU which has a substantial program focused on irrigation efficiency and the promotion of private sector companies to provide efficient technologies, such as drip irrigation systems.[36]

4.06 Irrigation is already by far the dominant water use and key water basins are suffering overdraft. Declining groundwater tables are a serious concern in several parts of the country. Overall, expansion of irrigated agriculture in the absence of clear new sources of supply is likely to undermine Syria's food and economic security over the intermediate to long-term. Improvements in water use efficiency through both irrigation efficiency improvements and encouraging the growth of high value crops appear to be the primary short-term avenue for increasing water availability for all uses, including agriculture. Overall there appears to be a large potential for irrigation efficiency projects. Irrigation efficiency improvements could increase yields and possibly reduce overall agricultural water demands.

[36] The Department has encouraged the development of companies for supplying drip irrigation – 20 of which are now in operation. They are also advocating the formation of companies to promote land leveling.

Box 4: Nepal: Bhairawa Lumbini Groundwater Irrigation Project

The World-Bank supported Bhairawa Lumbini Groundwater Irrigation Project was carried out in three stages: Stage 1 from 1978-84, Stage 2 from 1983-91, and Stage 3 from 1992-99. The original Stage 1 project comprised 64 tubewell systems, and Stage 2 project comprised 38 tubewell systems with each system irrigating about 120 ha with an average depth of more than 120m. Completion of Stages I and II before 1990 was based on a supply-driven principle with the entire burden for planning, construction, O&M on the Government's limited financial resources. The average cost recovery was only about 10% of the targeted amount and O&M funding continues to be inadequate. Turnover has not been completely successful. Lessons learned from Stages I and II included:

- lack of ownership by farmers in site selection, design, and distribution inhibited the collection of water charges since the farmers believed that the system belonged to the Government;
- farmers experienced difficulties with managing command areas greater than 60 ha with unlined open channels;
- lack of coordination and cooperation among users;
- unwillingness to pay for electricity charges incurred during pumping.

Stage III of the project however, was designed in accordance with the Government's new Irrigation Policy which was based on the principles of participatory irrigation development and management by beneficiary farmers. The 79 tubewells planned under Stage III followed the "demand-driven" principle right from its inception. Farmer groups are required to: (i) request their deep well facility; (ii) be involved in the early stages of planning, design, and implementation; (iii) commit to from a WUA; (iv) contribute to construction costs in cash and/or labor, and (v) take over responsibility for the system O&M on completion. Stage III has seen higher irrigation efficiencies, conservation of energy, and improved cropping intensities and yields compared to its predecessors.

Source: World Bank, Third Bhairawa Lumbini Groundwater Irrigation III Project, Implementation Completion Report, 1999.

B. Towards a Water Sector Strategy

4.07 From all available accounts, it is indubitable that Syria would benefit by undertaking a comprehensive initiative to develop an integrated water resources management strategy. Existing reports clearly indicate the fragmented nature of water management institutions, information and management capacities. However, Syria has the advantage of already having in place, an effective basis for decentralized management through its seven regional Basin Directorates. Available studies also emphasize the magnitude of the emerging pollution, groundwater overdraft and general water scarcity problems Syria faces. If these are to be addressed, Syria will need a comprehensive, well-informed and effective strategy for managing its water resources. The earlier the development of such a strategy can be initiated, the greater the likelihood that effective policies can be implemented before problems become intractable. Any future strategy in irrigation or water resources management will need to be closely linked with reforms in agricultural policy. The progress made in irrigation development has been remarkable. However, the Government will need to recognize that achieving food security with respect to wheat and other cereals in the short-term as well as the policy for promoting cotton production appear to be undermining Syria's security over the long-term by depleting available groundwater resources. *The transformation of existing irrigation systems will need to be achieved within the context of a more diversified agricultural production system.* In the long-term, crop prices will need to become more aligned with international market prices in order to provide the right incentives to farmers. Cropping patterns will need to shift towards more high-value[37] crops and more research on improving irrigation water use on different cropping systems will be imperative. These structural reforms will require a long-term planning perspective and will need a sufficiently long period of adjustment over 10-20 years.

4.08 The urgent need for a clear country strategy with respect to water does not imply that this needs to be undertaken prior to the implementation of specific projects where a clear need exists. Given the basic data that has already been collected through the various studies by JICA, efforts to collate basic data within Syria may be less important than in many other cases and need not be a pre-condition for the Government to proceed.[38] Water strategy work supported by the World Bank has followed different courses in India, Jordan, Nepal, Tunisia, and Yemen – countries where there is also a high reliance on groundwater in many areas. Each of these courses has different characteristics. This has, in turn, influenced the effectiveness of the strategy development exercise. Syria might, as a result, wish to review the approaches taken by a cross section of countries before designing and ultimately initiating its own water sector strategy work. Reviewing the strategies other countries have developed could create a basis for dialogue and joint understanding while respecting the sensitivity of Syria to water resource issues. In this regard, the recommendations contained in the World Bank's Urban Water and Sanitation Sector Note (1999) appear fully warranted. These include suggestions to develop a comprehensive policy framework for efficient water allocation and use, introduce charges for irrigation water that better reflect the cost of supply, and encourage growth of higher-value crops and/or less water intensive crops.

C. Potential Areas of World Bank and Donor Cooperation

4.09 Based on the priorities of the Government, the results of the May 2000 mission, and the analysis presented in this note, proposed project interventions could be classified into three levels as shown below. The World Bank could assist the Government of Syria in securing financing - either through the Bank itself and/or through mobilizing other donors and cofinanciers - for

---

[37] Per unit of water consumed.

[38] This should be confirmed in discussions with the MOI and JICA before any decisions are made.

financing entire package of interventions, partly or wholly, based on Government priorities. The proposed project interventions are described in the following paragraphs:

Level I

IA- Integrated Basin Management

- *Hydro-geological monitoring and assessment*
- *Demand Management*
- *Supply Management*
- *Conjunctive Use*
- *Water Quality Management*
- *Participatory Groundwater Management*

IB - Institutional Strengthening in WRM

- *Data Collection and Management*
- *Capacity Building and Training*

Level II

IIA - Irrigation System Improvement

- *Rehabilitation and modernization of existing irrigation systems*
- *Improved on-farm water management (incl. participatory management)*

IIB- Drainage and Water Quality Improvement

- *Drainage improvements in the Euphrates and other basins*
- *Development of a comprehensive water quality management framework and action plan*

Level III

Pilot Projects

- *Participatory groundwater management projects*
- *Appropriate technologies for treatment of wastewater and reuse in agriculture in rural communities*

Level I envisages an integrated, cross-cutting approach as follows:

I. A. Integrated Basin Management

Integrated water resources management is a cross-cutting approach for addressing the complicated and critical issues of both surface and groundwater including the water quality aspect. The Barada-Awaj and Aleppo basins would be priority basins for the implementation of this approach considering the magnitude of their water scarcity and pollution problems. The major components would be: i) basin-wide hydro-geological monitoring and assessment, ii) demand management (irrigation efficiency improvement coordinated with urban water supply efficiency improvement, which would be addressed by a different project), iii) supply management (water harvesting / recharge dams, treated wastewater reuse for irrigation, potential inter-basin water transfer to be studied, iv) conjunctive use of surface and groundwater; v) water quality management (small-scale rural sanitation system in upper basins and intensive water quality monitoring), vi) Capacity enhancement of hydro-geological monitoring and computerized decision support systems as well as legislative / institutional mechanisms for improved water resources management; and vii) promotion of community-based approaches to groundwater management. For the case of Barada-Awaj basin, close coordination would be ensured with the proposed Greater Damascus Water and Sewerage Project, preparation of which is being supported by the World Bank through a Japanese PHRD grant to the MHU. The project objectives are be to improve the quality and increase the efficiency of

water supply and sanitation services through rehabilitation of existing infrastructure; expansion of networks; modernization of operation and management systems; and provision of satisfactory wastewater collection and treatment. In particular, the recommendations of the ongoing Wastewater Strategic Planning and Priority Investment Study in Barada and Ghouta Gharbiyah area will be incorporated in any future project in the Barada/Awaj basin.

I. B Institutional Strengthening in Water Resources Management:

This could include the following elements:

(i) Data collection and management:
Establishing a national program for the monitoring necessary for integrated surface and ground water resources management (quantity and quality) and strengthening the capacity of the Pollution Control and Basins Departments of the MOI for field and laboratory measurements, data analysis, quality assurance and control of data, data bases and reporting. This should be a part of developing a comprehensive frame work for pollution control and integrated water resources management at the national scale.

(ii) Capacity building:
This would include capacity building and training in the Water Research Center (MOI) and the Department of Irrigation and Water Use (MAAR) to strengthen their capacity to carry out research for improved water management, modern irrigation and drainage systems and practices, water quality and other related issues. Strengthening the Irrigation and Water Resources Department and the Planning and Follow-up Department (MOI) to carry out water resources and project planning using modern concepts and tools of planning such as interactive data bases, management information systems(MIS), geographical information systems (GIS) and decision support systems (DSS) would also be necessary. Governmental capacity in regard to education, community outreach and stakeholder participation also needs to be strengthened. Government capacity in legal, economic, social science, and management skills will also need to be addressed.

Level II outlines specific areas where well-defined programs or projects can be implemented in selected basins or representative project sites as follows:

II. A. Irrigation System Improvement:

This could be implemented within a broader framework of the development of a major agricultural demand side management program in Syria. This would focus on irrigation efficiency improvements at both the system and end-use levels. It would include the rehabilitation of existing irrigation and drainage systems in selected basin(s), modernization works, and improved on-farm management (including participatory management) to achieve savings in water use and improving overall irrigation efficiency. It should also address the institutional and other incentives necessary to create incentives for efficient use. As with specific groundwater management projects, review of the proposed water law and investigation of opportunities for strengthening it should also be a central part of preparation for any demand side management project.

II. Drainage Improvement and Water Quality Management:

Syria has made good progress in meeting the *drainage needs in the irrigated agriculture* during the last quarter of the 20th century. However, to keep pace with the agricultural development and to increase the productivity of the irrigated agriculture and to ensure its

sustainability, the implementation of new drainage projects must be accelerated. The Bank can support a program similar to that in Egypt and Pakistan to implement new drainage schemes, reduce waterlogging, and rehabilitate existing networks. Such program could be separate or combined with an irrigation improvement program as required. This would be mainly in the Euphrates basin, and to a lesser extent in the lower Orontes and Coastal basins.

A major area of possible cooperation is the development of a *comprehensive water quality management* and institutional framework and action plan. The World Bank as a knowledge base could provide the necessary expertise for planning, best practices and capacity building. The establishing of national surface and ground water quality monitoring program (monitoring network, analytical capabilities, data processing and information system) is a priority requirement. The Bank could support upgrading the research capability in water quality management, pollution control and re-use practices.

Level III envisages pilot schemes which could be prepared to test innovative approaches in the following areas:

III. Pilot Projects:

(i) Development of groundwater management projects in areas around Damascus, Homs and possibly Ras al Ain in the Khabour basin on either a pilot or, if appropriate, implementation basis. These projects should combine initiatives to address both overdraft and pollution/quality problems. Further investigation of both project possibilities is important. In addition to specific sites, this investigation should involve a detailed review of existing water user associations and the Farmers' Unions with respect to the role they could play as focal organizations for management. Review of the proposed water law and investigation of opportunities for strengthening it should also be a central part of preparation for any project. Any proposal for collective groundwater management should be carefully evaluated in light of local/international experiences and must be combined with the introduction of the advanced on-farm irrigation systems to ensure the sustainability of the system. A careful social assessment would also be required.

(ii) Effective use and appropriate management of treated wastewater reuse in irrigation including cost-effective options for treatment of domestic wastewater of small communities in rural areas (e.g., in the Barada-Awaj basin). Pilot projects for testing different technologies and practices and integrated management practices is recommended specially for the re-use of effluent from the new municipal waste water treatment plants (as in Damascus) or agricultural drainage water as in Maskana Gharb. This would be closely linked to the outcome of the ongoing World Bank-supported Wastewater Strategic Planning and Priority Investment Study in Barada and Ghouta Gharbiyah.

ANNEX 1: DATA TABLES

Table A.1: Structure of Gross Domestic Product by Sector

(at constant 1995 prices: share in %)

Sector	1975	1980	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998[39]
Agriculture	31	32	27	30	29	31	29	29	28	30	29	33
Mining and manufacturing	9	7	8	13	13	12	13	12	14	16	18	17
Building and construction	5	8	10	4		4	4	4	4	4	4	4
Wholesale and retail trade	27	26	27	24	25	27	26	27	26	23	21	20
Transport and communication	8	7	8	10	10	9	10	11	11	12	13	12
Finance and insurance	6	6	4	4	4	4	5	5	5	4	4	4
Social and personal services	2	3	3	2	2	2	2	2	3	2	2	2
Govt. services	12	12	13	12	13	11	11	10	9	9	9	8
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100

[39] Provisional.

Table A.2. Value of agricultural production: 1994-1998 (at constant 1995 prices; mill. S.P)

Index numbers based on 1995=100

		1994			1995			1996			1997			1998 *		
		Value	Share	Index	Value	Share	Index	Value	Share	Index	Value	Share	Index	Value	Share	Index
Plant Production	Cereals	51156.9	23.0	88	59931.4	25.2	100	59026.9	21.7	98	43359.4	17.2	71	54330.6	17.9	89
	Industrial crops	21097.4	9.5	90	22977.2	9.7	100	25536.2	9.4	112	32026	12.7	140	32159	10.6	141
	Fruits	36791.8	16.5	113	33771.5	14.2	100	49401.9	18.1	144	36539.2	14.5	110	57091.5	18.8	167
	Vegetables	18953.4	8.5	91	20008.2	8.4	100	18652.5	6.9	95	15791.9	6.3	78	20574.4	6.8	102
	Dry legumes	3487.6	1.6	70	5097.1	2.1	100	4721.1	1.7	91	4005.8	1.6	72	6179	2.0	119
	Pastorals	1643.8	0.7	123	1339.3	0.6	100	12877.9	4.7	962	11047.9	4.4	825	10544.1	3.5	-
	Rural industries	1458	0.7	166	878.1	0.4	100	1270.5	0.5	145	987.6	0.4	113	1007.4	0.3	-
	Seed	3444.8	1.5	96	3584.9	1.5	100	3954.8	1.5	110	3460.6	1.4	97	4245.3	1.4	-
	Plants	643.2	0.3	203	316.3	0.1	100	338.4	0.1	107	348.6	0.1	110	355.5	0.1	-
	Ginning of cotton	14172.9	6.4	96	14789.2	6.2	100	15767.7	5.8	107	20227	8.0	123	25094.2	8.3	-
	Others	4259.5	1.9	123	2834.2	1.2	100	2626.8	1.0	106	3977.5	1.6	96	5276.8	1.7	135
	Sub-total	157109.3	70.5	96	165527.4	69.6	100	194174.7	71.3	110	171771.5	68.2	94	216857.8	71.5	120
Animal production	Milk & products	28756	12.9	89	29819	12.5	100	32254.1	11.8	109	34441.1	13.7	121	38417.8	12.7	129
	Livestock	27769.8	12.5	84	33486.9	14.1	100	36360.3	13.4	109	37598.7	14.9	111	39497.7	13.0	116
	Eggs	5877.4	2.6	96	5321.3	2.2	100	5272.1	1.9	104	5375.9	2.1	106	5270.2	1.7	104
	Wool	1545	0.7	86	1798.3	0.8	100	1953.7	0.7	109	1890.5	0.8	112	1009.4	0.3	129
	Animal hair	32.9	0.0	218	15.1	0.0	100	15.5	0.0	103	15.7	0.0	104	42.2	0.0	-
	Skin	558.8	0.3	130	431.4	0.2	100	497.9	0.2	115		0.0	118		0.0	-
	Fisheries	828.4	0.4	76	1088.2	0.5	100	1134	0.4	104	113.3	0.0	104	1355	0.4	-
	Silk cocoons	13.1	0.0	80	16.4	0.0	100	7.7	0.0	47	4.9	0.0	62	9.7	0.0	-
	Honey	341.9	0.2	87	394	0.2	100	558.4	0.2	142	592.1	0.2	150	653.3	0.2	-
	Honey wax	19.7	0.0	43	46.1	0.0	100	49.4	0.0	107	24.3	0.0	153	87.4	0.0	-
	Sub-total	65743	29.5	87	72416.7	30.4	100	78103.1	28.7	109	80056.5	31.8	114	86342.7	28.5	120
Total taxable value of production		222852.3	100.0		237944.1	100.0	100	272277.8	100.0		251828	100.0		303200.5	100.0	
Customs		3050			3564			4069			4104			5107		
Total Production Value		225902			241508			276347			255932			308308		
Annual growth rate					6.9			14.4			-7.4			20.5		
* provisional estimates																

Table A.3 Land Use: 1989-98

Year	Cultivable land (ha) Irrigated	Rainfed	Tot.cropped	Fallow	Tot.cultivated area	Uncult.land	Forest	Steppe/pasture	Other/a	Total land
1989	670134	4725690	5395824	107115	5502939	526312	718388	7988669	3781633	18517941
1990	692977	4773054	5466031	159981	5626012	523202	722708	7869350	3776699	18517971
1991	788331	4065043	4853374	722806	5576180	502516	731412	7935707	3772156	18517971
1992	906283	4215068	5121351	432868	5554219	491100	654516	8059482	3758654	18517971
1993	1013273	3925397	4938670	486982	5425652	513395	585287	8216557	3777080	18517971
1994	1082107	3787180	4869287	617433	5486720	484033	486900	8298888	3761430	18517971
1995	1088891	3892730	4981621	520156	5501777	477218	492926	8286831	3759219	18517971
1996	1126096	3515963	4642059	827708	5469767	478651	509744	8319909	3739900	18517971
1997	1167633	3635486	4803119	718064	5521183	465178	521525	8283041	3727044	18517971
1998	1213108	3655071	4868179	615851	5484030	497381	536836	8269841	3729883	18517971

/a includes rocky and sandy land, rivers and lakes, buildings and public roads.

Table A.4 Cropping Intensity and Area Irrigated by Source: 1989-98

Year	Total Cultivated Area	Total Irrigated Area	Groundwater Irrigated Area	Surface irrigated area (pumped from rivers)	Gravity irrigated area (from rivers)	Total Cropped Area by Irrigation	Irrigation Cropping Intensity (%)
1989	5,502,939	670,134	313,925	206,037	150,172	778,127	116
1990	5,626,012	692,977	341,951	216,886	134,140	831,063	120
1991	5,576,180	788,331	420,802	222,484	145,045	929,590	118
1992	5,554,219	906,283	530,884	236,054	139,345	1,079,028	119
1993	5,425,652	1,013,273	610,057	228,004	175,212	1,169,652	115
1994	5,486,720	1,082,107	693,621	232,712	155,774	1,222,673	113
1995	5,501,777	1,088,891	685,497	227,942	175,452	1,254,421	115
1996	5,469,767	1,126,096	683,773	236,111	206,212	1,258,991	112
1997	5,521,183	1,167,633	701,634	237,854	228,145	1,327,934	114
1998	5,484,030	1,213,108	723,696	214,828	274,584	1,360,839	112

Source: Agriculture Statistical Abstract in 1998

Table A.5 Self-sufficiency/* ratios: 1989-1997

Commodity	1989	1990	1991	1992	1993	1994	1995	1996	1997
Wheat									
Production	1020	2069	2350	3045	3626	3703	4184	4080	3031
Imports	1002	945	1107	89	79				
Exports	11	10	0	34	7	11	59	278	885
Ratio	**0.51**	**0.69**	**0.68**	**0.98**	**0.98**	**1.00**	**1.01**	**1.07**	**1.41**
Barley									
Production	271	846	1000	1091	1553	1482	1705	1653	983
Imports			208	82					
Exports					156	379	594	556	297
Ratio	**1.00**	**1.00**	**0.83**	**0.93**	**1.11**	**1.34**	**1.53**	**1.51**	**1.43**
Maize									
Production	116	180	225	215	200	203	199	250	303
Imports	126	249	262	104	347	400	317	279	597
Exports									
Ratio	**0.48**	**0.42**	**0.46**	**0.67**	**0.37**	**0.34**	**0.39**	**0.47**	**0.34**
Sorghum									
Production	3	3	6	8	6	4	5	6	3
Imports									
Exports									
Ratio	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
All Cereals	**0.83**	**0.81**	**0.76**	**0.87**	**0.83**	**0.89**	**0.97**	**0.99**	**0.92**
Sugarbeet									
Production	187	422	653	1365	1237	1452	1405	974	1126
Imports									
Exports									
Ratio	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Tobacco									
Production	13	13	16	23	15	14	23	22	23
Imports									
Exports	0.5	6	6	1	2	2	4	2	3
Ratio	**1.04**	**1.86**	**1.60**	**1.05**	**1.15**	**1.17**	**1.21**	**1.10**	**1.15**
Cotton fibre									
Production	164	164	205	255	396	198	216	264	367
Imports									
Exports	59	66	81	136	159	150	124	13	156
Ratio	**1.56**	**1.67**	**1.65**	**2.14**	**1.67**	**4.13**	**2.35**	**1.05**	**1.74**
Dairy									
Production	1288	1331	1370	1351	1244	1226	1414	1508	1610
Imports									
Exports									
Ratio	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Livestock/^									
Production	15826	16294	16928	16382	11840	13013	13913	15011	15786
Imports	0.5	181	1113	1807	2363	1969	1089	1223	846
Exports	1	1003	1230	1259	1177	970	956	589	484
Ratio	**1.00**	**1.05**	**1.01**	**0.97**	**0.91**	**0.93**	**0.99**	**0.96**	**0.98**
Eggs									
Production	1378	1519	1611	1981	2026	2049	2060	2229	2273
Imports		18		1.2		2			
Exports	85	84	73	18	96	75	25	47	74
Ratio	**1.07**	**1.05**	**1.05**	**1.01**	**1.05**	**1.04**	**1.01**	**1.02**	**1.03**

/* defined as production/consumption where consumption = production + imports - exports
/^ includes goats, sheep, cattle (1000 heads)

Table A.6 Area, Yield, and Production of Major Crops: 1989-1998

Cereals

Wheat

Year	Irrigated			Non-irrigated			Total		
	Area '000 ha	Prod. '000 t	Yield tons/ha	Area '000 ha	Prod. '000 t	Yield tons/ ha	Area '000 ha	Prod. '000 t	Yield tons/h a
1989	237.3	586.6	2.5	1002.7	433.6	0.4	1240	1020.2	0.8
1990	274.2	915.1	3.3	1066.4	1154.7	1.1	1340.6	2069.8	1.5
1991	369.5	1234.3	3.3	899.1	1116.4	1.2	1268.6	2350.6	1.9
1992	435.3	1733.2	4.0	945.4	1312.4	1.4	1380.8	3045.6	2.2
1993	551.0	2179.5	4.0	834.2	1447	1.7	1385.1	3626.5	2.6
1994	619.7	2236.9	3.6	933.7	1446.1	1.6	1553.4	3703	2.4
1995	624.7	2439.9	3.9	1019	1744.2	1.7	1643.6	4184.1	2.5
1996	625.5	2314.5	3.7	993.7	1765.9	1.8	1619.2	4080.4	2.5
1997	684.8	2020.1	2.9	1076	1011	0.9	1760.8	3031.1	1.7
1998	689.9	2478.4	3.6	1031.5	1633.2	1.6	1721.4	4111.6	2.4

Barley

Year	Irrigated			Non-irrigated			Total		
	Area ha	Prod. '000 t	Yield tons/ha	Area '000 ha	Prod. '000 t	Yield tons/ ha	Area '000 ha	Prod. '000 t	Yield tons/h a
1989	16086	17.6	1.1	2875.6	433.6	0.09	2891.7	271.1	0.09
1990	4581	10.3	2.3	2724.8	1154.7	0.30	2729.4	846.2	0.31
1991	11155	20.63	1.8	2222	1116.4	0.44	2233.1	999.6	0.45
1992	14934	31.4	2.1	2251.5	1312.4	0.47	2266.5	1091.4	0.48
1993	8298	25.4	3.1	2160.6	1447	0.71	2168.9	1553.4	0.72
1994	8735	15.6	1.8	1885.3	1446.1	0.78	1894.1	1481.7	0.78
1995	8361	18.3	2.2	1954.9	1744.2	0.86	1963.2	1705.1	0.87
1996	5831	16.9	2.9	1543.9	1765.9	1.06	1549.8	1653.0	1.07
1997	3741	8.8	2.4	1568.5	1011	0.62	1572.2	982.7	0.63
1998	3903	11.7	3.0	1538.7	1633.2	0.56	1542.6	868.8	0.56

Legumes:

Lentils

Year	Irrigated			Non-irrigated			Total		
	Area ha	Prod. t	Yield tons/ha	Area '000 ha	Prod. '000 t	Yield tons/ ha	Area '000 ha	Prod. '000 t	Yield tons/h a
1989	1952	1562	0.8	2875.6	433.6	0.09	2891.7	271.1	0.09
1990	939	1405	1.5	2724.8	1154.7	0.30	2729.4	846.2	0.31
1991	452	370	0.8	2222	1116.4	0.44	2233.1	999.6	0.45
1992	83	144	1.7	2251.5	1312.4	0.47	2266.5	1091.4	0.48
1993	116	123	1.1	2160.6	1447	0.71	2168.9	1553.4	0.72
1994	313	468	1.5	1885.3	1446.1	0.78	1894.1	1481.7	0.78
1995	11	19	1.7	1954.9	1744.2	0.86	1963.2	1705.1	0.87
1996	116	198	1.7	1543.9	1765.9	1.06	1549.8	1653.0	1.07
1997	1	1	1.0	1568.5	1011	0.62	1572.2	982.7	0.63
1998	94	102	1.1	1538.7	1633.2	0.56	1542.6	868.8	0.56

Chickpeas

Year	Irrigated			Non-irrigated			Total		
	Area ha	Prod. tons	Yield tons/ha	Area '000 ha	Prod. '000 t	Yield tons/ ha	Area '000 ha	Prod. '000 t	Yield tons/h a
1989	126	126	1.0	33.5	13.2	0.40	33.7	13.3	0.40
1990	64	38	0.6	69.6	36.2	0.52	69.7	36.2	0.52
1991	603	936	1.6	42.8	26.7	0.62	43.4	27.6	0.64
1992	249	469	1.8	81.9	73.3	0.90	82.2	73.8	0.90
1993	107	214	2.0	80.2	55.0	0.51	80.3	55.2	0.69
1994	184	258	1.4	48.8	24.9	0.69	49.0	25.2	0.51
1995	115	171	1.5	76.9	53.3	0.69	77.1	53.5	0.70
1996	169	278	1.6	66.3	45.5	0.69	66.5	45.7	0.69
1997	212	268	1.3	94.3	58.6	0.62	94.5	58.9	0.62
1998	153	301	1.9	107.9	84.3	0.78	108.0	84.6	0.78

Industrial crops

Cotton

Year	Irrigated			Non-irrigated			Total		
	Area '000 ha	Prod. '000 tons	Yield tons/ha	Area '000 ha	Prod. '000 t	Yield tons/ ha	Area '000 ha	Prod. '000 t	Yield t/ha
1989	158.1	430.7	2.7	-	-	-	158.1	430.7	2.7
1990	156.4	441.2	2.8	-	-	-	156.4	441.2	2.8
1991	170.4	555.1	3.3	-	-	-	170.4	555.1	3.3
1992	211.8	688.6	3.3	-	-	-	211.8	688.6	3.3
1993	196.5	639	3.3	-	-	-	196.5	639	3.3
1994	189.4	535.4	2.8	-	-	-	189.4	535.4	2.8
1995	204.3	600	2.9	-	-	-	204.3	600	2.9
1996	219.5	760	3.5	-	-	-	219.5	760	3.5
1997	250.6	1047.4	4.2	-	-	-	250.6	1047.4	4.2
1998	274.6	1017.8	3.7	-	-	-	274.6	1017.8	3.7

Sugarbeet

Year	Irrigated			Non-irrigated			Total		
	Area ha	Prod. '000 tons	Yield tons/ha	Area '000 ha	Prod. '000 t	Yield tons/ ha	Area '000 ha	Prod. '000 t	Yield tons/h a
1989	20,033	384.2	19.2	1537	27,365	17.8	21,570	411.6	19.1
1990	21,444	421.8	19.7	-	-	-	21,444	421.8	19.7
1991	19,688	652.6	33.1	-	-	-	19,688	652.6	33.1
1992	29,917	1364.9	45.6	-	-	-	29,917	1364.9	45.6
1993	31,857	1236.8	38.8	-	-	-	31,857	1236.8	38.8
1994	33,459	1451.9	43.4	-	-	-	33,459	1451.9	43.4
1995	31,309	1406.1	44.9	-	-	-	31,309	1406.1	44.9
1996	22,425	974.2	43.4	-	-	-	22,425	974.2	43.4
1997	26,647	1126.4	42.3	-	-	-	26,647	1126.4	42.3
1998	28,663	1202.2	41.9	-	-	-	28,663	1202.2	41.9

Tobacco

Year	Irrigated			Non-irrigated			Total		
	Area ha	Prod. tons	Yield tons/ha	Area ha	Prod. tons	Yield tons/ ha	Area ha	Prod. tons	Yield t/ha
1989	3595	6721	1.9	10,609	6329	0.60	14,204	13,050	0.92
1990	2881	6571	2.3	9885	6542	0.66	12,766	13,113	1.03
1991	3447	7683	2.2	10,954	8518	0.78	14,401	16,201	1.13
1992	4594	11,379	2.5	13,216	12,916	0.92	17,810	23,575	1.32
1993	3134	8684	2.8	8686	5924	0.68	11,820	14,608	1.24
1994	3273	9242	2.8	8758	5056	0.58	12,031	14,298	1.19
1995	4397	14,861	3.4	9445	8500	0.90	13,842	23,361	1.69
1996	5113	12,766	2.5	9089	9338	1.03	14,202	22,104	1.56
1997	4531	12,163	2.7	10,434	10,768	1.03	14,965	22,931	1.53
1998	4892	12,266	2.5	10,130	10,848	1.07	15,022	23,114	1.54

Table A.7 Landholding sizes

Irrigated (non-Government)	15 ha	Ghouta oasis (south of Damascus)
	20 ha	Coastal region
	25 ha	Bteiha area
	35 ha	in pump-irrigated areas
	40 ha	in areas irrigated from Euphrates, Khabour, and Tigris rivers
	45 ha	in areas irrigated from wells in Al-Hasakeh, Deir-es-Zor, and Al Rakka governorates
Tree Crops	30 ha	Latakia and Tartous governorates
	35 ha	Other governorates
Rainfed Areas	55 ha	if annual rainfall > 500mm
	85 ha	350 mm < annual rainfall < 500 mm
	140 ha	annual rainfall < 350 mm

Table A.8 Main Imports & Exports, 1998

Main Imports (cif)

Item	**$USm**	**% of total**
Machinery & transport equipment	916	23.5
of which:		
Transport equipment	336	8.6
Food, live animals & beverages	629	16.2
Metal & metal products	618	15.9
Chemicals & chemical products	501	12.9
Textiles	372	9.6
Total incl others	**3,895**	**100.0**

Main Exports (fob)

Item	$USm	% of total
Crude oil and petroleum products	1,603	55.5
Food and live animals of which:	565	19.6
Fruit and vegetables		
Wheat	380	13.1
	95	3.3
Textiles & textile fibers	366	12.7
Raw cotton	273	9.4
Total incl others	**3,135**	**100.0**

Source: Central Bureau of Statistics, Statistical Abstract

Table A.9. Govt. support prices for wheat: 1995-98

Price ($/t)	1995	1996	1997	1998
World price[40]	179	210	161	126
Govt. support price	214	224	224	224

Table A.10: Annual Budget of Ministry of Irrigation

Year	General Directorates of Water Basins and Central Directorate	Euphrates Basin	Unit: Million S.P. ($US million in parentheses) Total
1993	4766 (95)	4132 (83)	8898 (178)
1994	4550 (91)	4600 (92)	9150 (183)
1995	5947 (119)	4672 (93)	10619 (212)
1996	7232 (145)	6320 (126)	13552 (271)
1997	7427 (149)	8626 (173)	16053 (321)
1998	9662 (193)	8088 (162)	17750 (355)
1999	N.A.	N.A.	16900 (338)
2000	9225 (185)	7705 (154)	16930 (339)

Source: Annual Agricultural Statistical Abstract, MAAR; EIU Commodity Report

[40] U.S No. 2 hard winter.

Table A.11: Irrigation Water Use Crops and by Basin
Unit: million m3/year

Basins	Total Irrigation Water Use	Summer Crops					Winter Crops				Fruit Trees				
		Total Summer Crops	Cotton	Maize	Other Crops	Vegetables	Total Winter Crops	Wheat	Other Crops	Vegetables	Total Fruit trees	Olive	Citrus	Apple	Other Fruit Trees
Yarmouk	359	145	1	10	30	103	63	43	11	9	151	80	3	13	55
Aleppo	780	558	330	91	68	69	125	103	12	10	96	21	1	13	61
Orontis	2,235	1,154	634	89	162	270	630	501	93	36	450	110	10	83	247
Barada/Awaj	920	133	30	7	43	53	162	85	48	29	625	86	0	189	350
Coastal	957	430	5	6	179	240	52	40	2	10	475	8	390	45	32
Steppe	341	142	71	16	18	37	104	84	13	8	95	22	1	18	54
Euphrates	7,157	4,215	3,002	933	116	163	2,688	2,500	146	43	255	94	1	19	141
Total	12,749	6,777	4,072	1,152	617	936	3,825	3,357	324	145	2,146	422	406	378	940

Notes:
1) The figures are estimated based on the Agricultural Statistical Abstract in 1998, JICA Phase I Study, and other sources.
2) Water use efficiency is assumed to be 60 % including delivery and field application losses.

Table A.12 Licensed and Non-licensed Wells by Basin

	Non-licensed Wells (unit)	Licensed Wells (unit)	Total Wells (unit)	Share of non-licensed wells (%)
Yarmouk	1,282	1,889	3,171	40.4
Aleppo	3,460	6,374	9,835	35.2
Orontis	13,306	17,545	30,851	43.1
Barada\Awaj	22,169	3,315	25,483	87.0
Coastal	12,948	13,569	26,517	48.8
Steppe	2,737	2,480	5,218	52.5
Euphrates	10,218	28,606	38,824	26.3
Total	66,120	73,779	139,899	47.3

Source: Adapted from Agricultural Statistical Abstract in 1998

Table A.13. Gross margins (S.P/ha.) for different crops in zones 1-5 for season winter 1998/1999 and summer 1998

Zone/Crop	Irrigation	1	2	3	4	5
Beans	FI		155,610.00			
Cotton	FI	29,751.00	34,288.00	29,109.75	10,700.00	18,091.26
Cucumber	FI	43,365.00	82,702.91			
Barley	RF	2,500.00	2,300.00	2,100.00	1,750.00	
Wheat	RF	4,500.00	3,200.00	2,500.00	2,050.00	
Barley	SI			2,031.00		
Faba bean	SI	25,819.67	16,743.20			
Wheat	SI	9,074.70	18,135.98	10,502.97	5,300.00	7,353.25

RF= rainfed
FI= Full irrigation
SI= Supplementary irrigation
Source: ICARDA, personal communication, May 2000.

Table A. 14. Loans for Irrigation Wells by the Cooperative Agricultural Bank: 1988-99

Year	Value of Loans ('000 S.P)	Value of loans (cumulative) ('000 S.P)	Area benefited (ha.)	Area benefited (cumulative) ha.	No. of beneficiaries	No. of beneficiaries (cumulative)
1988	202,569	202,569	9183	918	2538	2538
1989	512,690	715,259	23,231	32,414	n.a	n.a
1990	1,115,492	1,830,751	46,532	78,947	n.a	n.a
1991	2,143,989	3,974,740	87,560	166,507	11,471	14,009
1992	2,400,069	6,374,809	101,742	268,249	13,038	27,047
1993	1,079,179	7,453,988	61,128	329,377	10,395	37,442
1994	933,855	8,387,843	21,142	350,520	6824	44,266
1995	650,127	9,037,970	19,286	369,806	5746	50,012
1996	500,999	9,538,969	11,587	381,394	4307	54,319
1997	294,427	9,833,396	6779	388,173	2061	56,380
1998	285,292	10,118,688	6972	395,145	3003	59,383
1999	208,890	103,275,578	5451	400,596	2044	61,427

Table A.15: Groundwater Irrigation Area per Well (by Basin)

Name of basin	Area fed by motor wells (ha)	Total Wells (unit)	Groundwater Irrigated area per well (ha / unit)
Yarmouk	11,942	3,171	3.8
Aleppo	44,343	9,835	4.5
Orontis	115,043	30,851	3.7
Barada/Awaj	47,463	25,483	1.9
Coastal	14,508	26,517	0.5
Steppe	18,397	5,218	3.5
Euphrates	472,001	38,824	12.2
Total	723,696	139,899	5.2

Source: Adapted from Agricultural Statistical Abstract, 1998

Table A.16. Numbers and Locations of Surface Water Quality Monitoring Sites

Location	Number of monitoring sites	Remarks
Barada River & Tributaries	36	
Awaj River	23	
Irrigation Channels	7	Treated Waste Water From Adra Treatment Plant
Orontes River	27	
Great Northern River	6	
Euphrates	13	
Khabbour River	14	
Gallab River	1	At the border with Turkey
Belegh River	2	At the border with Turkey and connection with Euphrates
Coastal zone	62	According to Barcelona agreement
Reservoirs	-	Occasionally

Table A.17. Drip and Sprinkler Irrigation Area, by Governorate:1998

Governorate	Area under drip (ha)	Area under sprinkler (ha)	Total area (ha)
Damascus	1227	893	2120
Quneitra	102	1	103
Dara'a	2045	1442	3487
Sweida	90	0	90
Homs	1288	3493	4781
Hama	137	21009	21146
Aleppo	375	11275	11650
Idleb	145	26300	26445
Tartous	2513	140	2653
Lattakia	447	55	501
Al-Raqqa	150	2500	2650
Deir Ezzor	5	377	382
Al-Hassakeh	25	12995	13020
Total	**8553**	**80480**	**89033**

Source: MAAR

ANNEX 2

THE NATIONAL FIVE-YEAR PLANS

The Planning Process

1. Five-year plans provide the guidelines for government decision making. These plans, which are annually evaluated and revised within the general goals of the plans, set out the economic and social objectives for the economy as a whole, and for each individual sector, and the general policy measures to achieve said objectives. The plans also set out the indicative investment program, and the quantitative production and input targets.

2. Preparation of the annual plan is a two-way exercise: top-down, general indicators and production targets, and bottom-up, a detailed production plan including cropping patterns and input needs from the sub-district level. The Supreme Agricultural Council (SAC), which is chaired by the Prime Minister, establishes broad objectives, provides production targets and investment indicators, and later makes the final decision on the production plan and a number of commodity prices. Among the fundamental objectives which have been established the highest priority is accorded to self-sufficiency in major food crops at the national level.

3. These guidelines are transmitted through the State Planning Commission (SPC) to the Ministry of Agriculture and Agrarian Reform (MAAR) and other sectoral ministries. SPC also performs an intersectoral coordinating role regarding investment requirements and physical infrastructure.

4. Two Directorates within MAAR, Planning and Statistics, and Agricultural Economics, have the major responsibility for defining the plan which will be implemented by other directorates. Plan targets are assessed relative to land and water resources available within the rainfall zones and the indicative aggregate production targets are then translated into provincial targets. At the provincial level, the district and sub-district committees chaired by MAAR staff and including representatives of the farmers (Farmers Union), the Ba'ath Party, the cooperatives, state farms, the Cooperative Agricultural Bank (CAB), and agroprocessing facilities within the region prepare the detailed sub-district, district, and provincial plans based on local information and the revised (if any) targets which go to the SAC. After approval by the Provincial Agricultural Council (chaired by the Governor), the revised targets are sent to the SAC for final approval.

THE 8th 5-YEAR PLAN FOR THE AGRICULTURE SECTOR
(The Agriculture, Forest, and Fishery Sector Plan for the period of 1996 to 2000)

1. The Overall Objectives

1.1 Irrigation and Land Reclamation

- Increasing the agriculture land by the horizontal expansion of new land reclamation and improving the existing irrigated lands without overexploitation of the national water resources.
- Construction new dams and groundwater storage to get the ultimate benefit from the flood, river, and generally surface waters and strengthening the winter irrigation.
- Rationalizing the water use and protecting it from the pollution hazards as well as forbidding the over-extraction of the groundwater.
- Encouraging the use of the modern irrigation technology and increasing the irrigation efficiency of all available water sources.

1.2 Agricultural and Animal Production

- Giving priority to the strategic crops to fulfill the national food security requirements.
- Preserving the agricultural soil from degradation or any probable water quality problems.
- Developing the tools of manufacturing the agriculture equipment based on the international standards.
- Facilitating the use of new technologies in water, agricultural and environmental research in order to maximize the benefit from the available land and animal resources.
- Saving the requirements of the agriculture and animal industry.
- Improving the quality of the crop and animal production to satisfy the international standards for export purposes.
- Expanding the cultivation of all kinds of fruit trees in the suitable soils to achieve the best production.
- Expanding the production of the animal fodder to fulfill the requirements of the animal resources.
- Protecting the natural dairy farms and semi-desert parks from deterioration hazards.
- Giving more attention to the animal resources by saving its requirements, improving the breed heritage of the animal, and protecting it from diseases.
- Encouraging the breeding of the good animal breeds especially the local kinds, which are familiar with the environment and weather (e.g., Shami cows and Shami Goats).

1.3 Forests

- Protecting forests and searching for new techniques to improve its production.
- Encouraging the economic investment in forestry.

1.4 Fisheries

- Expansion in saltwater fishery.
- Getting the ultimate benefit from the open water areas to improve the fishery production to help providing another source of food, under condition of using scientific rules.

1.5 Investment and Services

- Increasing the investment in agriculture through the different channels, e.g., governmental, collective, private and shared).
- Improving the role of the agricultural service centers to give the ideal and experienced advice to the farmer or the animal and small agricultural industry owners.

2. Production Targets

2.1 Total Local Production

- Increasing the value of total local production by an average annual rate of 5.86% during the plan period. The contributions of the public and the private sectors are 0.12% and 5.74% respectively.
- Increasing the value of total local production in the public and private sectors by average annual rates of 5.25% and 5.87% respectively.

2.2 Production Requirements

- Increasing the value of production requirements by an average annual rate of 4.78% during the plan period. The contributions of the public and private sectors are 0.09% and 4.69% respectively.
- Increasing the value of production requirements in the public and private sectors by average annual rates of 4.18% and 4.80% respectively.

2.3 Investments

The size of investment in the eighth 5-year plan for the agriculture and irrigation sector is 192,306 million Syrian pounds based on the categorization as follows:

Sector	Public Investments (million S.P)	Private Investments (million S.P)	Total investments (million S.P)
Irrigation	82,222	5000	87,222
Agriculture	22,943	82,141	105,084
Total	105,165	87,141	192,306

The distribution of the public sector investments in agriculture (105,165 million S.P) between rehabilitation, transfer, and new projects are as follows:

Sector	Rehabilitation Projects (million S.P)	Transferred Projects (million S.P)	New Projects (million S.P)	Total investments (million S.P)
Irrigation	6578	74,538	1106	82,222
Agriculture	522	20,136	2285	22,943
Total	7100	94,674	3391	105,165

2.4 Employees

- Increasing the number of employees from 1,180,000 employees in 1995 to 1,469,000 employees in 2000, with an average annual increase rate of 4.5%.
- Increasing the number of employees in the public agriculture sector from 29,000 employees in 1995 to 46,000 employee in 2000, with an average annual increase rate of 4.3%.
- Improving the education level among the employees in the public sector during the plan period according to the following:

Unit is employee

The educational level	Basis Year (1995)		Target Year (2000)	
	Count	%	Count	%
Universities	9,987	34.3	15,000	32.6
Intermediate institutes	2,568	8.8	5,301	11.5
High Schools	1,001	3.4	1,510	3.3
Technical Schools	4,078	14.0	6,203	13.5
Profissional Schools	1,793	6.2	3,100	6.7
Intermediate Schools	9,680	33.3	14,885	32.4
Total	**29107**	**100**	**45999**	**100**

Unit is 1,000 Hacters

Asspect	Basis Year (1995)	Target Year (2000)	Average Growth Rate (2000/1995)%
The Invested Lands	5,502	5,548	0.20
The Existing Cultivated Land	4,982	5,209	0.90
a. Surface Irrigated Land	1,089	1,268	3.60
b. Surface Irrigated Trees	125	136	1.70
c. groundwater Irrigated land	3,893	3,941	0.25
d.groundwater Irrigated Trees	587	695	3.50
Breeding and Dairy Farmd	8,287	8,304	0.04
Forestland	493	557	2.50

2.5 The Productive Aspects

2.5.1 Land-Use Balance

2.5.2 Irrigation and Land Reclamation

- Implementing irrigation and drainage networks through the land reclamation projects (area of *169,000 ha*).
- Constructing 35 large, medium, and small dams (total storage volume of 1,367,000,000 m^3).

2.5.3 Improving of the Important Crop Productions

Unit is 1,000 Ton

Asspect	Basis Year (1995)	Target Year (2000)	Average Growth Rate (2000/1995)%
Wheat	3,852	4,732	4.20
Rice	1,160	1,283	2.00
Lentil	112	124	2.00
Hommous	48	53	2.00
Cotton	614	825	6.10
Suger Beet	1,330	1,468	2.00
Yellow Corn	210	282	6.10
Yam	424	496	3.20
Olives	429	915	16.00
Apple	247	450	12.70
Citrus	577	979	11.20
Hallaby Pistachio	15	32	16.50

2.5.4 Improving the Important Animal Productions

Unit is 1,000 Ton

Asspect	Basis Year (1995)	Target Year (2000)	Average Growth Rate (2000/1995)%
Milk Production	1,432	1,826	4.99
Beef Meet Production	171	208	4.00
Chicken Meet Production	85	107	4.60
Egg Production (million)	2,136	2,838	5.80
Fish Production	11.7	12.9	2.09
Honey production	0.889	1.021	2.80

Unit is 1,000 Ton

Asspect	Unit	Basis Year (1995)	Target Year (2000)	Average Growth Rate (2000/1995)%
Surface Irrigated Wheat	kg/ha	3,824	4,099	1.40
Groundwater Irrigated Wheat	kg/ha	1,436	1,509	1.00
Groundwater Irrigated Rice	kg/ha	591	621	1.00
Groundwater Irrigated Lentil	kg/ha	889	934	1.00
Hommous	kg/ha	619	651	1.00
Cotton	kg/ha	3,005	3,318	2.00
Suger Beet	kg/ha	42,471	46,891	2.00
Yellow Corn	kg/ha	3,055	3,373	2.00
Citrus	kg/tree	90.8	100.2	2.00
Apple	kg/tree	31.7	36.7	2.00
Olives	kg/tree	16.91	17.25	0.40
Hallaby Pistachio	kg/tree	5.27	5.54	1.00
Foreign Cows	kg/cow	3,967	4,200	1.15
Shammy Cows	kg/cow	2,574	2,750	1.33
Improved Cows	kg/cow	2,501	2,650	1.16
Shammy Goats	kg/goat	325	335	0.60
Cheap	kg/cheap	60	65	1.60
Poultry	egg/chicken	232	240	0.68

2.5.5 Improving the Important Agricultural Crops

2.5.6 The Self-Sufficiency Percentage

Asspect	Basis Year (1995) %	Target Year (2000) %
Wheat	135	146
Beans	152	144
Cotton	263	254
Yellow Corn	46	46
Apple	133	177
Citrus	136	197
Olives	114	199
Beef Meat	93	94
Chicken Meat	107	109
Egg	105	116

2.5.7 The Most Important Indicators for the Ministry of Agriculture and Land Reclamation Projects to Develop Agricultural Production

The eighth 5-Year plan aims to strengthening the agricultural production process through a variety of the production and service indicators, as follows:

- Producing 60 million fruitful seeds.
- Producing 150 million other kinds of fruitful seeds.
- Producing 45 million fodder seeds.
- Reclaiming 130,000 hectare for the purpose of fruitful trees production.
- Reclaiming 20,000 hectare for the purpose of productive crops.
- Improving 120,000 hectare of land (50% of it are in new lands).
- Cultivating 85,000 hectare by the fodder shrubs and dispersing it in the Syrian semi-deserts to increase the crop cover.
- Increasing the number of invested wells from 145 well in 1995 to 210 well in 2000.
- Producing 2,300, 000 liter of the Azotic liquid.
- Implementing 2,300,000 artificial pollinations.
- Producing 37,000 modern wooden beehives.
- Producing 30,000 bees.
- Increasing the agricultural services and guidance units from 815 unit in 1995 to 885 units in 2000.
- Constructing agricultural service roads with length of 4,000 km to serve 450,000 hectare.
- Determining and resolving any problems regarding the 450,000-hectare of new agricultural land.

3. The Policies, Actions and Precautions

3.1 The Natural Agricultural Resources Aspects

3.1.1 The Agricultural Land and Soil

- Preserving the fertility of the soil by cultivating the suitable crops in the suitable soils, following the accurate crop cycles, which are based on technical and economical studies, and by using the appropriate nutrients and fertilizers.
- Protecting the agricultural soil from erosion problems by increasing the crop cover.
- Designing a comprehensive program for developing the Syrian semi-desert areas in the long-term in order to increase the animal resources and encouraging new communities to reside on it.

- Resolving the technical, social, or financial problems which pose obstacles to the development of the new reclaimed lands.
- Expansion in foresting the mountain and hill areas and growing citrus trees in the suitable areas.
- Transforming the non-irrigated lands to irrigated lands according to the available water resources.
- Developing the mechanism of counting and categorizing the soils, land-uses, and measuring the productivity of the soils to help putting the future investment plans.
- Resolving all problems relating to the possession of the new cultivated lands by 2000.

3.1.2 The Water Resources

- Preparing for a water plan depending on the Syrian water basin studies in order to get the ultimate exploitation of the water and land resources for irrigation, agriculture, industry, and domestic purposes.
- Establishing all the related works to determine the protected area of all water resources, structures, and facilities.
- Completing and following up the ongoing hydrologic studies.
- Establishing an annual program during the 5-year plan in order to encourage the farmer to use the newest techniques in irrigation, to reduce the water losses.
- Prohibiting the over-exploitation of the groundwater, which affect the reservoir storage and lead to depletion of the replenishment of the groundwater resources.
- Utilizing the information technology to develop the national water resources.
- Accelerating the time-schedule of the current irrigation projects as well as saving its supplies.
- Examining the performance of the construction companies, who are responsible for the implementation of the irrigation projects to make sure they are capable of finishing the construction works in the scheduled time.
- Utilizing the old Roman irrigation canals and doing the required renovation to use it in the winter irrigation projects.
- Minimizing the need of the foreign experts and attracting the well-qualified personnel to invest their expertise locally.
- Issuing the necessary laws and institutions to rationalize and organize the surface and subsurface water uses and protecting it from the pollution hazards.

3.1.3 The Forest Areas

- Protecting the forest from the fire by taking all the precautions to save the forest from any expected fire, training the firemen on the modern fire protection equipment, and by controlling all the violations.
- Utilizing the natural forest economically based on the accurate scientific basis.
- Expansion in producing the good quality seeds.
- Constructing the required roads in the forest areas to facilitate the investment purposes.

3.1.4 The Fishery Resources

- Expansion in the fishery industry by utilizing the new technology.
- Expansion in using the artificial fish generation impoundment.
- Preventing the forbidden fishing methods by establishing an efficient control system.
- Establishing a suitable investment plans regarding the fishery production.
- Preventing the use of groundwater in fishery production.

3.2 The Agriculture Production Supplies

- Saving the agriculture production supplies in the determined times through:
  - Enlarging the base of saving the agriculture production supplies through the public and private sectors as well as strengthening the role of the public sector in the quality control process.
  - Encouraging the establishment of the agriculture production equipment locally according to the international manufacturing standards.
  - Encouraging the establishment of the agricultural nutrients, fertilizers, fodder, and veterinary medicines.
  - Establishing the specification for the supplies and equipment, which are locally manufactured, provided that, it has the same quality and standards of the similar international supplies and equipment.
- Selecting the appropriate dosage and application schedule of nutrient and fertilizers based on the soil analysis and scientific research.
- Expansion in using the improved seeds to maximize the agriculture production.
- Rationalizing the use of pesticides in agriculture protection and using biological protection instead.
- Expansion in cultivation and producing the animal fodder to ensure the integration between the development in the agriculture and animal sectors.
- Expansion in producing the veterinary medicines and encouraging the establishment of the medicine factories in all sectors.
- Encouraging the manufacturing of the medicine containers to serve in all sectors and based on the international standards.
- Allowing the most important agriculture production supplies import to get the benefit from the agriculture goodies export return.

3.3 The Agriculture Services which Help in the Agriculture Production Process

- Expansion in the scientific research as well as connecting it to the currently discussed issues regarding the development of the agriculture production.
- Providing the scientific research with the required technical equipment.
- Managing the channel and flow of communications between the scientific research sector and the agriculture production sector.
- Developing the work mechanism of the agriculture guidance units and saving their supplies to play a more effective role in the agriculture production process.
- Improving the local animal progenies and expanding the artificial insemination in order to enhance the animal resources.
- Strengthening the veterinary services and increasing its effective role.
- Expansion in using the agriculture mechanism to compensate the expected agriculture production requirements.
- Training and qualifying the technical personnel to contribute more effectively in the agriculture production process.
- Enabling and facilitation the agriculture loans with long term payments and low interest values.

3.4 The Pricing Process

- Continuing the country's policy in using the subjective and scientific basis in determining the agriculture production prices.
- Granting profit incentive to the agriculture producers to guarantee reasonable income to them equivalent to the average national income, through:
  - Maintain the review of the criteria which control the pricing process.
  - Adjusting the profit margins of the main crops in order to comply with the national economic requirements.

- Announcing the prices of the strategic crops by the Supreme Agricultural Council before the cultivation season of each.
- Pricing the agriculture supplies with minor profit margin.

3.5 The Marketing

- Continuing the use of the strategic crops marketing policies in the public sector.
- Establishing the specifications and standards for the agriculture production, especially which are prepared for export purposes.
- Organizing the wholesale markets as well as encouraging the retail market channels.
- Giving the chance for the agriculture production units to market their agricultural produce, especially those produce which are not marketed by the public sector through reasonable marketing channels, even locally or nationally.
- Encouraging the private sector to establish qualified companies in internal and external marketing of the agricultural production.
- Opening loan channels to finance the storing, freezing, transporting the agricultural production.
- Encouraging the establishment of the collective companies for transporting of agricultural production.

3.6 Landholding and Investment Aspects

- Encouraging the establishment of agriculture cooperative companies to construct integrated agricultural projects with reasonable areas.
- Determining rules for investing the non-used public landholdings and non-cultivated areas.
- Completing and issuing the modified agriculture laws, which control the agricultural relations and contain all the illustrative explanation and examples.
- Prohibiting the fragmentation of agricultural landholdings which mitigates against its economic use.
- Modifying the law No. 13 for 1974, regarding enforcing the punishments against the semi-desert protection and organizing the animal production violations.

ANNEX 3: MAJOR ON-GOING AND PROPOSED PROJECTS IN SYRIA

Purpose	Project	Water source	Main Features	Current Situation	Size	Costs
Barada / Awaj Basin						
Domestic water	Inter-basin water transfer from Coast	water transfer from coastal basin	a pipeline system over 300 km for 100 MCM/ year	Feasibility study is to be commissioned.	100 million m3 / year	SP 15,000 million
Industrial water	Re-allocation of groundwater from irrigation to industry	re-allocation of groundwater				
Irrigation	Expansion of irrigation network for treated wastewater reuse	treated wastewater	177 MCM at Adra in 1997 and other 297 MCM is proposed for reuse	about 18,000 ha is to be completed soon.	29,000 ha	SP 29,000 million
Irrigation	Reuse of drainage water from irrigation areas	irrigation return flow	Improvement of existing drainage system (55,900 ha). Drainage water volume is estimated at about 255 MCM.		55,900 ha	SP 110 million
Irrigation	Rehabilitation of existing irrigation canal	surface water	Concrete lining for main and secondary canals of the existing system in about 26,000 ha	8 canals completed, 4 canals to be completed in 1998, 2 canals under contract and planned to be extended to remaining canals.	26,000 ha	SP 1,800 million
Orontes Basin						
Domestic water	Zeita Dam project	surface water	effective storage 76 million m3	to be completed in 1998		
Domestic water	water supply source development	re-allocation of surface and groundwater	276 million m3	no additional surface water is available after on-going projects finished.		
Industrial water	Re-allocation of surface water from irrigation to industry	re-allocation of surface water				
Irrigation	Reclamation of existing irrigation area			new irrigation method is provided in Afamia, Al Zieala, GI schemes and Aafrin irrigation schemes.		
Irrigation	Irrigation network development for treated wastewater reuse	treated wastewater	74 million m3 from Hama and Homs stations and other 260 million m3 in the basin is to be re-used.	pilot scheme is going on at Selamiyeh.		
Irrigation	Reuse of drainage water from irrigation areas	irrigation return flow	improvement of existing drainage system (192,000 ha) including groundwater irrigation area. Drainage water volume is estimated at about 941 MCM.		192,000 ha	SP 380 million

Purpose	Project	Water source	Main Features	Current Situation	Size	Costs
Orontes Basin (Contd.)						
Irrigation	Kastoum and Zezoun dam and irrigation schemes	surface water	effective storage 98 million m3	dams are completed in 1996 and the irrigation system is to be completed in 1997.		
Irrigation	Afamia Dama and irrigation schemes	surface water	effective storage volume of 87 million m3	to be completed in 1997		
Irrigation	April 17th Dam and irrigation project	surface water in Aafrin river	effective storage volume of 172 million m3	the dam is scheduled to be completed in 1997, but a new irrigation area of 30,000 ha is subject to financing.		
Irrigation	Al Rouj Irrigation schemes	surface water, spring, and groundwater, drainage water	Al Baala reservoir (12.6 mcm), groundwater (21.5 mcm), drainage water (6.8 mcm), spring and Orontis (62.6 mcm)	Irrigation of 10,855 ha, comprised of the existing system of 3,000 ha and other new area, is under construction.		
Irrigation	Homs Dam project	surface water	gross storage volume of 60 million m3	Project aims to reduce evaporation loss (20 million m3) from the surface of Qatineh Lake, subject to approval for undertaking feasibility study from the MOI.	60 million m3	SP 480 million
Irrigation	Wadi Abiad Dam and irrigation scheme	surface water	effective storage volume of 80 million m3 with an irrigation area of 10,500 ha, being finalized by the detailed design.	the detailed design is being executed.	80 million m3	SP 640 million
Irrigation	Development of new dams under study	surface and drainage water	water amount of 573 mcm is required to be developed to meet the future water demand, but the available surplus water is limited to 89 mcm in 2000.	reservoirs with small to middle scale such as Kafer Hind, Holamiat, Al Rabeea, Al Sayadiya, Bahor, Al Nweha and Abou Homama reservoirs have been identified.		
Coastal Basin						
Domestic water supply and irrigation	Al Sakhabe Dam scheme	spring and surface flow	effective storage volume of 58 million m3	on-going for water supply to Latakia, Banyas, Tartous and small towns, including heightening of the Al-Houyes dam, and to be completed in 2001.		
Irrigation	Al Thawra Dam	surface water	effective storage volume of 90 million m3	dam structure is completed in 1997 and an irrigation area of 9600 ha was completed in 1995.		

Purpose	Project	Water source	Main Features	Current Situation	Size	Costs
Irrigation	Bassesl Assad Dam and irrigation scheme	surface water	effective storage volume of 99.5 million m3	dam structure is completed in 1997 and an irrigation area of 101,600 ha was completed in 1996.		
Irrigation	Tal Hosh Dam and irrigation	surface water	effective storage volume of 48 million m3	dam structure and an irrigation area of 6,820 ha was completed in 1997.		
Irrigation	Mzeineh Dam and irrigation scheme	surface water	effective storage volume of 18 million m3	scheduled to be completed in 2000		
Irrigation	Al Baida scheme	surface water (November 16th dam)		irrigation development with an area of 5000 ha which is going on by MOI		
Irrigation	Groundwater irrigation (2138 ha project)	groundwater	exploitation of 20 million m3 per year	scheduled to be completed in 2000		
Irrigation	Al Houssain Dam and Irrigation scheme	surface water	gross storage volume of 100 million m3	proposed to be completed in 2005	100 million m3	SP 700 million
					4,600 ha	SP 4,600 million
Irrigation	development of groundwater	groundwater	exploitation of 345 million m3 per year in 2015	it requires; 1) establishment of monitoring system including investigation and planning, 2) observation for 3 to 5 years, 3) study on potential of water resources	345 million / year	SP 1,028 million
Irrigation	New small multipurpose dam schemes	surface water	gross storage volume of 21.8 million m3 is expected. Water amount of 200 million m3 is required to be developed until 2000.	Jobar, Bait Al Marj, Al Sourani, Abou Thekra, draikish, Kenseba and Bait Sorak reservoirs have been identified.		
Aleppo Basin						
Domestic water supply and irrigation	water supply in rural area	groundwater	additional water amount of 60 million m3 is required to be developed.		60 million	SP 180 million
Industrial water supply	inter-basin water conveyance		192 million m3 is required to support industrialization in Aleppo, mainly using groundwater	no additional surface water is available, and other water sources need to be found outside the basin.		
Irrigation	further development of irrigation network for re-use of treated wastewater	wastewater in Aleppo	93 million m3 in 1998 and other 274 million m3 in the basin is proposed to be treated and utilized.	on-going by MOI, but still under study.		
Irrigation	irrigation development in Aleppo land	surface water in the Euphrates river	water amount of 507 million m3 is required to be developed for 20 years until 2015.	on-going by MOI		

Purpose	Project	Water source	Main Features	Current Situation	Size	Costs
flood control	flood control in Madgh area to be included in irrigation development in Aleppo land.	flood control volume of 60 million m3 is proposed to be provided for the envisaged Khan Toman reservoir.	It is essential to improve water quality of the Quwayq river, especially to manage water quality of industrial sewage.			
Steppe Basin						
Domestic livestock and irrigation uses	development of groundwater	groundwater	all the available water is necessary to be utilized for domestic, water supply, irrigation use and pasture growth. To stabilize domestic water supply, identification of fresh groundwater resource of 63 million m3 is desired to be carried out in the Steppe basin.	on-going by MAARA and proposed to be further developed.		
Livestock grazing and pasture growth	development of water spreading structure and small reservoirs	flood water		Expansion of water harvesting project which currently carried out by MAARA and MOI.		
Domestic, livestock and irrigation uses	effective use of existing dams and reservoirs	surface water		appropriate outlet facilities for the several existing dams are required to be provided for water supply.		
Industrial water supply	development of groundwater	groundwater	11 million m3 is required to be developed.			
Irrigation	further development of irrigation network for re-use of treated wastewater	treated wastewater	60 million m3 is required to be treated and utilized for the existing irrigation area.			
Note: All the information is based on JICA Phase I report.						

ANNEX 4. IRRIGATION AND DRAINAGE RESEARCH

1. Among the Government's proposed development plans are expansion of agricultural land, maximizing the use of the conventional and unconventional water resources, and improving the performance of the existing irrigation and drainage systems. It is recognized that these objectives could lead to worsening water quality problems. Therefore, the control and monitoring of the water quality in the irrigation and drainage networks are equally important considerations in the Government's irrigation development plans.

2. The Syrian government established the Water Research Center in 1992 to carry out research work related to water resources development and management as well as irrigation and drainage. This Center is already engaged in important research work such as artificial ground water recharge but it still needs strengthening of its capacity to expand its research to more areas. The Department of Irrigation and Water Use (DIWU) of the MAAR also carries out nationwide research work on crop water requirement, farm water management and irrigation methods and technologies. DIWU has seven research stations in each basin which links its research program to the local water, soil, crops and climate conditions of the basin. At the Sirbaya research station of the DIWU in Aleppo, a number of activities are being carried out in the areas of supplementary irrigation, irrigation techniques and methods, and transfer of technology activities with the local Department of Extension including field days and seminars. In addition, joint research activities are being carried out with ICARDA, notably on supplementary irrigation (SI). The research station of DIWU in the capital recently established a computerized laboratory to test (at no charge) locally produced modern irrigation equipment (drip and sprinklers) but the testing process still needs to be formalized and linked to the mandatory role of the Ministry of Industry for standardization, and formal certification.

3. Drainage Research is mainly carried out in the Euphrates basin by DIWU in their regional experimental farm at Deir El Zur. A well organized research program is being implemented on drainage for salinity control as well as impact of drainage on soils and crops. DIWU carried out research on using brackish water for irrigation. The MOI also carries out research on vertical drainage combined with sprinkler irrigation at the 7th of Nisan experimental farm in the same area. The data and research results of both stations provide a wealth of information that could support the future development of drainage in the area. However, much of the research is still carried out at the experimental stations only. An assessment of drainage systems performance in farmers fields is still needed in order to evaluate their effectiveness under field operational conditions in controlling water logging and salinity and the adequacy of the O&M programs. Research on the reuse of drainage water in irrigation is also limited. There appears to be little coordination between research carried out by MAAR and MOI.

ANNEX 5. DRAINAGE PROJECTS AND DRAINAGE NEEDS

5-1. Lower Euphrates

Project Name	Open Drains (Ha)	Pipe Drains (Ha)	Vertical Drains (Ha)	Area need Rehab. (Ha)	Non-drained Area(Ha)	Total Area (Ha)	Remarks
3rd Sector	-	-	15,000	-	-	15,000	Designed by the French Consultants Jursard
5th Sector	-	-	5,000	-	-	5,000	Designed by the French Consultants Jursard
7th Sector	-	-	10,000	-	-	10,000	Designed by the French Consultants Jursard
	-	1,600	-	-	-	1,600	Vertical drainage is not feasible
	-	-	-	-	93,400	93,400	
Total	-	1,600	30,000	-	93,400	125,000	

5-2 Central Euphrates

Project Name	Open Drains (Ha)	Pipe Drains (Ha)	Vertical Drains (Ha)	Area need Rehab. (Ha)	Non-drained Area(Ha)	Total Area (Ha)	Remarks
Pilot Project	13,200	2,400	-	5,800	-	21,200	Developed in 73 and 8000 went out of production
Central Euprat Valley	27,000	-	-	-	-	27,000	
Beer El-Hashm	10,000	-	-	-	-	10,000	
Baleigh - I	10,000	-	-	-	-	10,000	
Baleigh - II	-	-	-	-	6,000	6,000	Currently under study , expected as pipe drains
Baleigh - III	-	-	-	-	17,000	17,000	Currently under study , expected as pipe drains
Baleigh - III - West	-	-	-	-	2,510	2,510	Subject to Initial studies
Baleigh - IV	-	-	-	-	14,670	14,670	Only initial studies
Baleigh - V	-	-	-	-	40,000	40,000	Only initial studies
Rasafa	-	-	-	-	25,000	25,000	Initial study and currently subject to detailed study
Total	60,200	2,400	-	5,800	105,180	173,380	

5-3 Upper Euphrates

Project Name	Open Drains (Ha)	Pipe Drains (Ha)	Vertical Drains (Ha)	Area needs Rehab. (Ha)	Non-drained Area(Ha)	Total Area (Ha)	Remarks
West Maskana	0	50000	0	0	0	50000	
East Maskana	0	17600	0	0	0	17600	
Asad Establishment	0	24000		0	0	24000	
State Farm	3400	0	0	0		3400	Little drainage in the area
North Aleppo	0	0	0	0	55000	55000	Subject to study
South Aleppo	0	0	0	0	82000	82000	Subject to study
Total	3400	91600	0	0	137000	232000	

ANNEX 6

WATER MANAGEMENT: SOME INTERNATIONAL EXPERIENCES

As Syria begins to evaluate options for addressing the combination of overdraft and pollution problems that threaten groundwater resources within the country, a detailed review of international experiences could contribute to identification of effective strategies. Several experiences are particularly relevant given the approaches indicated as currently under consideration by MOI officials. These relate to:

1. The ability of highly centralized approaches to respond to the diverse groundwater conditions and management needs that are generally encountered within a country or region.

2. Experiences with user-group operation and management of community irrigation wells.

Overall, it is highly recommended that Syria undertake a detailed review of international water management experiences as it considers alternative approaches to legislation, the design of water management institutions and other similar issues.

CENTRALIZED VERSUS DECENTRALIZED APPROACHES

Debates over centralized versus decentralized approaches to groundwater management are common. In India, model legislation for establishing government groundwater management authorities at the state level was proposed by the Central Ground Water Board in the mid-1970s. In most states, however, no legislation was passed until very recently. This was due: 1) to opposition from users; 2) the lack of any clear avenue for enforcing any regulation the state-level board might impose. This second factor makes many groundwater officials working in state governments uncertain regarding the value of any legislation. Furthermore, experiences in states that did attempt to regulate groundwater extraction (by imposing bans on wells and through credit limitations) clearly showed the reality of enforcement problems. Legislation, wherever it was passed, has been difficult and often impossible to implement.

The difficulties of centralized regulation in India stand in sharp contrast to the local level initiatives undertaken by NGOs and villages. In many arid sections of India, a wide variety of water harvesting and groundwater recharge activities are being undertaken by local communities. These generally involve attempts to increase supply along with, in a few cases, attempts to limit water intensive crops. While these initiatives are limited in scope, they represent the main "active" attempts to address groundwater problems.

The western U.S. and some other countries follow more decentralized approaches to water management than the one proposed in the draft legislation in Syria. In the U.S. case, most groundwater management occurs through local "districts." These are quasi-governmental in nature – though their specific characteristics and legal structures varies greatly between states. They are often governed by a locally elected board of directors and run through staff hired for the purpose. Their operations are often supported by a combination of user fees or local taxes. Because they are local entities, they are often able to develop water management approaches (including regulations) that are tailored to match management needs within their area. In addition, they are often able to build support for that management because the districts are governed by the very users that are affected by management problems.

Some analysts view water management in the U.S. as "fragmented." The district approach can respond flexibly to local problems and can help build political support for difficult management decisions. At the same time, in the absence of any central framework, the effectiveness of management is highly variable. Recognizing the tension between local and centralized approaches, other countries are developing "nested" frameworks that allocate substantial responsibility to local levels while at the same time encouraging the development of management capacity at higher levels in the government. This is, for example, the case in Mexico and appears to be the direction Tunisia is intending to proceed.

Overall, Syria may benefit from a careful review of international experiences with regard to institutional designs for water management, including groundwater management, and the degree to which the country relies on centralized versus decentralized strategies. Particularly in the groundwater case, it should be recognized that no single set of "best practices" has yet been identified. In most countries, groundwater management and the development of institutions for it is a relatively recent process. A wide variety of relevant experiences do, however, exist and these should be harvested before Syria finalizes its own approach.

USER GROUP OPERATION OF COMMUNITY WELLS

This element is highlighted here because of the proposals, discussed by MOI officials with the mission, to manage groundwater by closing existing private wells and shifting users to high-capacity group wells.

Experiences with high capacity group wells are mixed. In India during the 1980s, the governments of several states attempted to establish high-capacity deep tubewells (each serving approximately 100 ha via underground pipeline systems) as a major mechanism to increase groundwater irrigation. Most of these wells were, at least initially, owned, operated and controlled by the state irrigation departments. These group wells tended to be highly inefficient. Cost recovery was generally low and breakdowns were common. As a result, programs were initiated to turn the wells over to the users. At least in Gujarat, well turnover programs have been unsuccessful. In most cases, farmers are not interested in taking over the operation and management of group wells that were initially established by the government. A significant number of such wells have, as a result, been abandoned. In contrast to group wells established by the government, many high-capacity wells are owned and operated by private groups of users in Gujarat. These appear to be widely successful in terms of their operational efficiency and cost recovery. The primary difference between them and the government wells is institutional – the successful wells were drilled and operated by users.

Review of the experiences other countries have had with group wells could provide important insights as Syria considers well consolidation proposals. The Uttar Pradesh Deep Tubewell project illustrates some of the problems Syria may encounter with this type of approach. There is also substantial research by Dr. Tushaar Shah (Director of the Institutions and Governance Program at the International Water Management Institute, Sri Lanka) on the private tubewell companies of Gujarat and on the problems encountered in turning over government wells to user groups.

ANNEX 7

NABAK AND DEIR ATTIA: GROUNDWATER PARTICIPATORY MANAGEMENT

Sites visited by the Bank mission in May 2000 near Nabak and Deir Attia in rural Damascus were indicative of the existing community-based approaches to groundwater management. The area used to depend on irrigation through ancient underground channels "qanats[41]" which intercept water from the shallow ground water resulting from the snow melt and winter rain on the surrounding hills. During the recent years the water table dropped far below the levels of the canals. In the Nabk village (population 40,000), the farmers on their own initiative have organized Water User Association (WUA) which raised funds to dig four community wells (instead of many individual private wells) to pump deep groundwater into the ancient underground channels to distribute water to their farms (400-500 ha). In the Nabak site, a local leader and other members of the community (essentially a water user's association) refurbished a qanat that had dried up by drilling wells and supplying water from them to the qanat channel. This local organization is managed by an committee of eight selected by the governor from an initial list of 25 supplied by the original initiator. In the Deir Attia site, the qanat was refurbished by the government but is run by a locally elected committee. The Nabak organization is indicative of the investment and involvement by farmers in water supply. There, the local user organization hired a private consultant to carry out hydro-geological investigations and subsequently, drilled eight wells, three for current supply, one reserve but operational, and four capped as backup. Water appears to be supplied on a relatively equitable basis. Those who participated in the construction of the wells pay SP 2/m^3 while those who did not pay SP 4/m^3. A five-minute right to the flow every 12 days costs SP 1000. Water is distributed on the basis of 12 days rotation for irrigating trees only. Charges are doubled if farmers irrigate other crops than trees. Two "sheikh adan" are appointed to operate the system on rotation with a salary of SP 4000/month. The organization pays all its O&M costs and has generated sufficient revenues to pay for the capital costs of new wells. Similar practices are followed in Deir Attia (population 15,000) but in this case the government provided about one third of the initial investment cost. Water is pumped first to drinking water tank and the surplus flows to a concrete surface reservoir before it is discharged into the qanats for irrigation. The elected WUA in Deir Attia is in charge of administrating the local municipality.

Overall, the case of qanats is indicative of both the strength and limitation of existing farmer organizations. In the Nabak area, the association does not supply water intensive crops, such as vegetables. It is, as a result, promoting water conservation though crop type limitations. At the same time, it doesn't have the ability to actually control overall water use because a number of farmers have private wells and don't want to join the user group.

[41] Traditional underground irrigation systems of the Islamic world.

ANNEX 8

THE NEW DRAFT WATER LAW

Agriculture is considered one of the corner stones in the Syrian national economy. The surface and subsurface irrigation systems are the major source for irrigation. The expansion in land reclamation, using the new technology in the exploitation of the water resources, and enforcing new water law to regulate the aspects of rational use of water resources become an inevitable demand to fulfill the future food and fiber requirements and to face the expected regional water shortage and depletion of the groundwater aquifer.

Currently, there is no clear water regulation law that can either organize the water use aspects or work efficiently with the prospected development projects on the nationwide. The existing group of regulations that were issued in 1925, 1926 and 1958, included some general water use rules which didn't constitute a harmonic national water regulation law.

Therefore, the Syrian Ministry of Irrigation realized the need to issue a new water regulation law that can guarantee avoiding all the deficits in the existing group of regulations. The new water regulation law aims to achieve the following aspects:

1. Regulations associated with the general water use.
2. Regulations associated with problems resolving regarding the individual rights of public water possession.
3. Improving the public water networks.
4. Subsidizing the cost of well digging and pump installing.
5. Protecting the public water from the pollution hazard.
6. Confirming the adequate punishment and fin rules for committing any kind of hazard or deterioration actions towards the nation's water resources and the related public possessions.
7. Issuing a group of transition water regulations.

THE PROPOSED WATER REGULATION LAW

1. DEFINITIONS

Article (1): In this proposed water regulation law, the word "Ministry" means the Syrian Ministry of Irrigation and its relating agencies. Also, the word "Minister" means the Syrian Minister of Irrigation.

1. The water source is both the surface and groundwater water sources.
2. The surface water is the river water, the inner lakes, streams, falls, ponds, wetlands, marshes, and the unconventional water.
3. The groundwater is the shallow and deep wells water.
4. The water stream may be a river, tributary, canal, drain, or siphon.
5. The public water is any water source, water stream, or any water that can be considered as a public source for water use.
6. The ideal criteria mean the water ideal criteria.

Water Deterioration: the water deterioration can be defined as the existence of any substances or factors that might lead either directly or indirectly to altering the water physical or chemical or biological characteristics. Consequently, that might lead to harmful results on the public health or the designated water use.

Deterioration Cause: the deterioration cause can be defined as the normal or arbitrary cause either it is an individual person, public or private agency that commit deterioration to the water sources by any manner.

The water authority identity: refer to article 26

The Privacy Area: it is the determined area that is required to protect the water source and that is designed to satisfy the following specifications:

1. Maintaining the safety of the water source and protecting it from all kinds of damage or deterioration.
2. Constructing the maintenance and control routine works.

The Direct Privacy Area: it is the land surrounding the water source that enables the accessibility to the water source and doing the required maintenance, cleaning, and protection routine works.

The Indirect Privacy Area: it is the land strap surrounding the direct privacy area of the water source. The investment in that indirect privacy area is forbidden to keep the sufficient protection for the water source.

Dam: it is an artificial structure that is designed to restore water for exploitation in the drinking, irrigation, industry, energy generation, flood protection, scheduling the navigation, filtration, animal and fishing production, tourism recreational activities, and re-aeration purposes.
Irrigation Networks: it is a network that is designed in order to regulate the water allocation, distribution, and all other water uses.
The Main Canal: it is a closed or open water stream that is used to transport the water from the main water source to the different designated water uses.

The Secondary Canal: it is a branch from the main canal.

The Tributary: it is a sub-branch from the secondary canal.

The Water Allocation: it is the quantity of water (liter/sec) that is given to one hectare of the irrigated land in one irrigation cycle corresponding to a specified crop cycle.

2. THE PUBLIC WATER

Article (2): The following are considered part of the public water possessions:

1. The inner water, which include:
   a) The rivers and valleys of any shape till the water level and expansion in area specified at the highest flood time.
   b) The lakes, inner wetlands, small streams, ponds, marshes till the water level and expansion in area specified at the highest flood time.
   c) The water falls.
   d) The groundwater.
   e) The spring water (groundwater wells) of any kind.
   f) The water stored by dams.
   g) The dams that are constructed to store public water till the highest emergency designated water level.

h) The irrigation and drainage networks waters.
i) The drinking, industrial, and sewage networks waters.
j) The unconventional water

2. The inner water at the river outfalls and beaches where those waters interact with the sea water within the national water limits.

3. The direct privacy area of the water sources is determined as follows:

a) Regarding the water sources specified in (a, b, and c) of Article (1) of this law, the direct privacy area is 10 meters from the end border of the water sources aforementioned specified. The minister has the right to increase or decrease their direct privacy area if applicable.
b) Regarding the public groundwater wells and dams that are designated to be used for the irrigation and drinking water purposes, and for the national irrigation projects, the minister has the right to increase or decrease their direct privacy area if applicable.
c) Regarding the impoundment, lines, and tunnels of the drinking and sewage water networks, the direct privacy area is determined by written rule of the specified minister.
d) Regarding the irrigation and drainage buildings, the direct privacy areas are determined by written rule of the minister based on their designated uses.

Article (3):

1. The indirect privacy area is determined based on a written rule of the minister.
2. Any constructions and excavations within the indirect privacy area must be preceded based on a written rule of the minister.

3. RESOLVING THE PUBLIC WATER POSSESSION RIGHTS

Article (4): Resolving the public water possession rights is considered part of the public beneficial projects.

Article (5): The prime minister might issue a rule based on the suggestion of the minister including recommendation to resolve the possession right problems if necessary based on the following.

a) The urban zones plan drawings showing the private building that are influenced in the problem and the assigned water source.
b) The value of those rights is evaluated by a technical committee that is chosen by the minister. The decision of that committee is final and non-negotiable.

Article (6): The ministry has to inform the assigned administrative agency and the related real estate agencies by the resolution decision of the committee to do whatever applicable to implement that decision.

Article (7): The ministry has to announce the resolution of possession rights in the city hall, the location of the problem and in one of the local or national newspapers. Then, the ministry has to give a call for every person claiming a right of those included in the problem resolution decision in order to present his justifications and evidences within 60 days of the date of announcement. The person's information and his written rule must be attached to his claim. He should receive a recite too.

Article (8):

a) A technical committee must be chosen based on a written rule of the minister to study the justifications and evidences which are submitted by the involved persons to determine the size of possession rights and its preliminary values.
b) The value of those possession rights must be estimated according to the rules specified in the law No. 2405, year 1985 and its editions. That value should not exceed the difference between the land's value before and after its reclamation.
c) The ministry must inform each one of the involved persons by the preliminary estimated values of their possession rights. In the meantime, the ministry must announce for a general meeting to discuss the preliminary evaluation values within 15 days. That meeting must be announced according to Article (7) to ensure that, all the persons how didn't give their address information or how are located away of the area of the problem resolution most probably informed. Also, to inform the relatives of the died involved person in the resolution problem.

Article (9): All the involved persons in the possession problem have the right to negotiate the preliminary estimated values within 30 days from the following day of announcement. The estimated values witch are not claimed or negotiated during the previous specified period are considered final. The negotiation of one of the partners is considered negotiation of the right of all of them.

Article (10):

1. Another committee should be chosen to resolve the aforementioned negotiations. That committee is chosen as follows:

a) A jury (associate judge) that is nominated by the minister of justice, as a chairperson.
b) Representative for the general real estate agencies, as a committee member .
c) Representative for the ministry (with good experience in the constitutional laws) that is nominated by the minister, as a committee member.
d) A representative for the possession right person that is nominated by election, as a committee member.

That is according to the Article (23) of the real estate law No. 20, year 1983.

e) A stand-by person (substitution) for each of the committee members must be nominated to be ready to take over in case of original person would be absent or not able to attend the committee meetings.
f) The chairperson and the committee member have the right to give compensations to the claimed persons that are determined by a written rule of the minister.

2. The committee member must swear in front of the chairperson as follows:
   I swear by our great god that, I will do my job by the extreme loyalty and trust and I will never reveal any of the security information.
3. The committee has to stick to the Article (8-c) of this law when resolving the claimed negotiations.

3. The committee decisions must be issued either without any objection from the committee members or based on the majority of them. Their decisions must be final and confirmed and non-negotiable.

Article (11): The estimated values of the possession rights must be given to the claimed persons according to the Article (25) of the real estate law No. 20, year 1983, starting from the day of issuing the decision of the original or the second committee.

4. ESTABLISHING THE RULES FOR GAINED RIGHTS OF PUBLIC WATER

Article (12): The individuals, how have gained rights or any kind of benefits from the public water according to the followed traditions or according to official documents that had been issued before the consent No. 14 regarding the public real estate in Nov. 6, 1925, have to get equivalent compensation that can be determined according to this law.

Article (13): The commencement of establishing the rules for gained rights of public water is based on a written rule of the minister including the following:

1. Specifying the public water, which is involved in the establishment processes.
2. Specifying the location for submitting the claims and its deadline, which is at least 60 days starting from the day of announcing this rule.
3. That rule must be announced in one of the local or national newspapers. Also, it must be presented on the wall news board at the city hall, at the location of the negotiation, and at all the locations of the involved agricultural affirmatives.

Article (15):

1. The committee, how is responsible for establishing the rules for the gained rights of public water, is chosen by a written rule of the minister in every public irrigation directorate (district) nationwide, as follows:

a) Jury (associate judge) that is nominated by the minister of justice, as a chairperson.
b) Representative for the general real estate agencies (with good experience in the constitutional laws) that is nominated by the general director of the real estate, as a committee member.
c) Representative for the ministry that is nominated by the minister, as a committee member.
d) Representative for the general organization of farmers that is nominated by the president of general organization of farmers, as a committee member.
e) Representative of the province which has the location of negotiation, that is nominated by the minister, as a committee member.

A stand-by person (substitution) for each of the committee members must be nominated to be ready to take over in case of original person would be absent or not able to attend the committee meetings.

2. All the committee member must swear in front of the committee's chairperson, based on Article (10-2) of this law.
3. The chairperson and his committee member must decide the value of compensations based on the written rule of the minister.

Article (16): Every person, how claim that he has the right in the public water in his location, must to submit his claim authenticated by the official documents and evidences to the general irrigation directorate of his province during the specified deadline.

Article (17): The committee must to analyze the claims, the official documents and evidences. Then, the committee must to investigate the locations of negotiation and discuss each location with the involved associate persons and agencies how have good experience and reputations and how are able to give the illustrative comments and ideas.

Article (18): The committee have to prepare a preliminary report including table of the names of all the claimed persons, description of each case, and estimation the value of the claimed rights.

Article (19): The aforementioned table has to be presented in the main hall of the general irrigation directorate in the region for two months. Also, it is recommended to be announced in one of the local or national newspapers, if applicable, to let every person of how claiming a right in the public water informed.

Article (20): The claimed person has the right to give their comments on the announced table within 60 days of the day of announcing. Then, the committee has to discuss those comments and take the required action to put the table in its final shape in a period of 30 days.

Article (21): The final decisions of the committee must be recorded in the ministry's file.

Article (22): The implementation of the committee's final decision regarding establishing the rules of gained rights of the public water must follow the rules specified in this law.

Article (23): The prime minister has the right to give permission to temporary use and invest the public water possessions for a specified annual charge based on a written rule including the determined period of time specified for the use of the public water possessions.

4. THE GOVERNMENTAL WATER NETWORKS

Article (24): The governmental water networks consist of the lines for transporting and distributing and other lines for collecting the drainage water, which are constructed, supervised, and maintained by the government. Also, the structures, which are constructed to improve the water utilities and increase their efficiency, e.g., water pump station, treatment plants, dams, bridges, siphons, and culverts.

Article (25): The maintenance and renovation works for the irrigation and drainage networks are implemented every year according to the instructions, which are issued by the ministry, such as:

1. Estimating the water allocation based on the official crop cycle.
2. The starting and ending dates of irrigation cycles.
3. The instructions related to the maintenance and renovation works for the irrigation and drainage networks. As well as the instructions related to the water pump station, treatment plants, dams, bridges, siphons, and culverts.
4. The amount of drinking water required per capita can be determined based on the instructions of the involved ministry.

Article (26):

1. The technical specialist in the ministry has the official privileges in the issues related committing violations against this law. They are nominated by the ministry.
2. The aforementioned workers must swear in front of the province jury before starting their jobs, as follows:
   I swear by our great god that, I will do my job by the extreme loyalty and trust and I will ever work not for any thing but to preserve the public water and its related facilities.

Article (27): Lands, which get the benefit from the irrigation and drainage networks, can benefit from the water sources based on the distribution tables and instructions issued by the ministry.

Article (28): The beneficiaries from the governmental irrigation and drainage networks are responsible for moving out and maintaining the irrigation and drainage facilities on their expenses. Otherwise, the ministry might do those works and bill the beneficiaries of the estimated costs of moving out and maintaining the irrigation and drainage facilities, the procedure for collecting these money must be according to the public money collection law.

Article (29): Lands, which are used as conveyer of irrigation and drainage water, are considered part of the rights of the receiving downstream lands.

5. SUBSIDIZING THE WELL DIGGING AND PUMPING EQUIPMENT

Article (30): The ministry may grant well digging license to every beneficiary based on his request. Also, the ministry might provide the technical assistance and all the available water resources information that can be helpful for the beneficiary.

Article (31): The minister should issue the regulatory instructions which facilitate granting the public water investment licenses (e.g., irrigation, industry, tourism, drinking, animal and fish production) based on the arrangement with the other involved authorities.

Article (32): The well digging licenses are valid for one year and can be renewed for only one more year based on authenticated documents.

Article (33):

1. Investment of the public water for any purpose applies only after getting a valid license according to Article (32), provided that, the beneficiary must submit his request during the validity of the digging license.
2. The terms of conditions, application forms, license request, procedure, and the instructions for granting the licenses and its investment can be issues by a written rule of the ministry.
3. All the beneficiaries (e.g., individuals, authorities, agencies, corporations) have to submit copies of all the research information (e.g., the surveying report, visibility studies, mining, geotechnical investigation, sample analysis, geophysics, and hydrological reports) to the ministry to use it in the future research and development.

Article (34):

1. The person how applies for a license must be owner or beneficiary based on the terms of conditions of the agricultural reforming law. That person might be a representative of a group of owners, renters, or might be an authorized delegated actual or arbitrary person.
2. The majority is estimated based on the quorums.
3. It is possible to grant licenses to many wells in the same facility (or estate) if it is shared between different individuals. The minister has to estimate the maximum area assigned for each license based on the suggestions of the public irrigation authority regarding that basin.

Article (35): The following must be issued based on a written rule of the minister:

1. The maximum water allocation that can be accepted for the license based on the available water resources in each basin. The amount of water extracted from each well can be modified based on the availability of the groundwater in the shallow and deep aquifers. The beneficiary has no right to claim any compensation for that change in the water quantity.
2. The limitations of using the groundwater, the extraction procedure, and the method of investment and protection of the groundwater based on the actual conditions of each basin and the proposed irrigation projects.

Article (36):

1. The pumping equipment license last for 10 years, renewable by the beneficiary's request and the decision of the minister. The license is considered valid starting from January of each year.
2. The ministry is responsible for carrying out the studies required to implement the collective irrigation well digging projects.

Article (37): The license is considered invalid in the following cases:

1. If the beneficiary gives up installing the licensed equipment within a year from its granting date, except during the emergency time.
2. If the beneficiary stops working in the site for a period exceeded 2 years.
3. If the beneficiary refused to pay the specified fees before the due dates.

Article (38): All kinds of licenses are considered cancelled without any compensation based on the decision of the license competent reference in the following cases:

1. If the licenses causes harmful effects to the public water (quantity and/or quality).
2. If the licenses causes harmful effects to the other beneficiaries or neighbors, provided that, that harmful effects can be proved by the authenticated documents.
3. If the beneficiary violate the terms and conditions in his license more than one time.
4. If the beneficiary changed the licensed designated use objective of the water.
5. If the land which has permission for irrigation is included by one of the governmental irrigation projects.
6. If the beneficiary ignores the decisions and instructions of the minister, which regulate the water investment using the pump equipment.

Article (39): All kinds of licenses are considered invalid without any compensation from the license competent reference to the beneficiaries, if any case of cheating or usage of unauthenticated documents is proven. The beneficiary will be committed to a crime and taken to the court.

Article (40): The granted license to certain owner, representative, renter, or delegated actual or arbitrary person will remain valid for the same facility (or estate), regardless of the identity of the person how receives the possession of the property.

Article (41):

1. A new license must be issued to the beneficiary when the original license expires or during replacing the original pump by a higher or lower capacity pump, or when changing the owner's name, or adding new properties in locations where the digging is permissible.

2. Irrigation fees apply for the land, which are irrigated using the groundwater extracted. These fees are determined by a decision of the prime minister and based on the suggestion of the minister of irrigation and minister of finance.

Article (42): A separate fee applies for the well digging and deepens processes, installing the pumping equipment. That fee is determined by a decision of the minister.

7. PROTECTING THE PUBLIC WATER FROM POLLUTION HAZARD

Article (43): It is prohibited to dispose any kind of wastes to the irrigation and drainage networks, since that will cause deterioration to the public water.

Article (44): The competent minister is responsible for issuing the required decisions to draw the standard and temporary specifications for the water resources before and after usage for any purpose.

Article (45): The procedure followed when storing or using any substances might cause any kind of pollution to the water source, even accidentally or intentionally, as well as determining the requited precautions and building the safety structures to protect from the pollution hazard, must be specified by a written rule of the minister.

Article (46):

1. Managing or storing any kind of pollution substance or wastes required an approved license. The beneficiary has no right to dispose any other kind or pollution that is not specified in his license. The instructions and conditions of that license, the pollution treatment unit construction specifications, and the required safety precautions must be issued by the competent minister.
2. If it is necessary to choose other location for storing the wastes than the one specified in the license, the beneficiary must apply in writing to the competent ministry to change the terms and conditions under his license. The competent ministry has the right to accept or refuse his request.
3. The beneficiary how has a unit for storing the wastes must record all the information required to control the water quality according to the samples and conditions specified by the competent ministry.
4. The beneficiary how is forced to store the wasters in a different location or by a different manner than the specified in his license under emergency conditions, must inform the ministry as soon as the occurrence of that accident, based on the terms of Article (58) of this law.

Article (47); Outfalls of the polluted water sources which flow into the public irrigation and drainage networks are subjected to the terms and conditions explained in this law. The license of such condition is granted with the coordination between the ministry and authority how is responsible for investing the sewage water treatment plant, if exists.

Article (48):

1. The authorized delegated representative of the ministry are eligible to investigate the industrial, trade, and agricultural, facilities, and any other property that might be a cause of water pollution. Also, they are eligible for taking water samples, doing the required to ensure the compliant with the water standard or temporary specifications, as well as reviewing the safety procedures and actions, and the pollution records, if exists.

2. The minister is eligible for canceling the license in case of discovering a violation. Also the minister has the right to take all actions and procedure to protect the irrigation and drainage facilities from the pollution hazard. If a sever hazard is proven, the whole location must be closed based on a written rule from the competent minister. The implementation of his decision is done by the administrative authorities.
3. The beneficiary has the right to request restarting for his license after removing the reasons of pollution and cleaning the site completely
4. The competent ministry is eligible for changing the terms and conditions of the license if there are scientific and technical justification for applying that change.

Article (49): The existing facilities, which are considered sources of pollution based on this law, must apply for a license within 3 months from the day of the notification. Otherwise, the facility will be closed by a written rule of the competent minister.

Article (50): The ministry must inform the existing facility which applies for a license about the required actions and procedure to remove the pollution hazard within a period of time specified based on the amount of work required to get rid of the pollution.

Article (51): The terms and conditions of this law apply in case of disposing the waste into the sea close to the public beaches, according to the articles of law No. 10 in 3/26/1972.

8. SANCTIONS

Article (52): In accordance with the stronger sanctions specified in sanction law or any other law:

1. Every individual how prevents the other individuals, vehicles, mechanical equipment, and all other transportation means from crossing the bridges, which are constructed by individuals over public water streams, which never considered as private property, must be punished by paying a file ranges from 3,000 to 5,000 Syrian Lira.
2. Every individual how constructs structures or causes damage or excavation within the privacy area of the public water resources or reclamation projects is punished by imprisoning for a period ranges from one month to one year, as well as a fine ranges from 10,000 to 20,000 Syrian Lira. Removing the violation is the responsibility of the violated individual.
3. Every individual how violate the terms and conditions of the license is punished by a file ranges from 4,000 to 10,000 Syrian Lira. Also, he must comply with the conditions of removing the violation and repairing any damage on his expenses.

Article (53):

1. Every individual how undertakes a violation, e.g., digging a well, installing a pump equipment, or applying any kind of investment means before getting the license, even if he is the landlord, renter, or representative, is subjected to an punishment of imprison for as period ranges from 2 months to 3 years and a fine of 20,000 Syrian Lira. The beneficiary is also responsible for removing the violation and repairing any damage on his expenses.
2. All the equipment, machinery, and tools related to the well digging and operation, that are available in the site, will be removed.

Article (54): Every individual how undertakes any kinds of damage, destruction to part or all of the public water facilities (e.g., bridges, dams, siphons, culverts, sprinkler, or drip irrigation systems, and subsurface irrigation or drainage systems) or any of their

related structures, or preventing the water from flowing, is subjected to a punishment of imprison for a period ranges from 2 months to three years and a fine of 10,000 Syrian Lira., besides compensating all how suffered from damage.

Article (55): Every individual how commits delay or obstruction to the public water investment in order to benefit from it or wasting it, is punished by imprisoning for a period ranges from one month to 6 months and a fine rages from 500 to 1,500 Syrian Lira.

Article (56): Every individual how violates the conditions of protecting the pollution which are specified by the granted licenses, according to the article under Chapter 7 of this law, is punished by imprisoning for a period not more than one year and by a fine ranges from 10,000 to 50,000 Syrian Lira, or by one of them.

Article (57): Every individual how uses the polluted water in the assigned water lines in irrigation purposes, is punished by imprisoning for a period not more than 6 months and by a fine not less than 10,000 to 50,000 Syrian Lira.

Article (58): If the license violation listed in chapter 6 of this law causes damages or harmful hazard to the animal, water, and agricultural resources, the individuals or agency committed that damage is subjected to paying reasonable compensations to the harmed individuals or agencies, based on a written rule of the minister and the suggestions of the committee formed by the minister, chaired by a representative of the ministry and the members are chosen from the ministries of industry, agriculture, land reclamation, and environment. The committee is allowed to associate with experts when apply.

Article (59): Removing the damage, reconstructing the affected structures, and cleaning the site are the responsibility of the individual (or agency) how commit the violation. If he refrains from doing his duty, the violation must be removed then, all the expenses must be paid by the violated individual (or agency).

Article (60):

1. Every individual how get more water benefit than the specified by the license granted to his, is subjected to a fine estimated by a written rule of the minister.
2. If the beneficiary refrains from removing the pump equipment after the expiration of his license by a maximum period of 10 days from the day he is informing by the expiration of his license, will be responsible for paying all the costs and charges. The water officer authority of the ministry will take over the removal process and they will keep the motor and the pump equipment.

9. GENERAL RULES

Article (61): The surface and subsurface water investments comply to instructions issued by the minister.

Article (62): The ownership, maintenance, operation and protection of the public water possessions is the authority of the ministry, except the possessions which comply to the ownership of other authority based on a special laws.

Article (63): All existing wells prior to the release of this law and which are operated in the permissible basins but without an approved license, must be reformed in the light

of the new law terms and conditions within a period of one year from the date of issuing this law and within the limitation of the safe extraction rates from the groundwater aquifer. It is mandatory for the beneficiaries of the existing wells to switch to using the new technology in irrigation to rationalize and capitalize the water use during the period specified by the minister.

Article (64): The minister must issue the required instructions to rationalize and capitalize the water uses for agricultural purposes. The beneficiaries of these waters must stick to those instructions. In case of committing a violation of waters wasting or violating the license instructions from the side of the beneficiaries, the minister has the right to prevent the water from the beneficiaries either the surface or the subsurface waters.

Article (65): The minister must issue the instructions to implement the terms and conditions of this law.

Article (66): The rule No. 320 in 5/26/1926 and its editions, and the law No. 165 in 9/28/1958, as well as, all the articles and terms in all existing or previous constitutions and laws that violate with the terms and conditions included in this law, must be cancelled and banned from application.

Article (67): This law must be published in the formal national newspaper.

ANNEX 9: ECONOMIC ANALYSIS OF VARIOUS OPTIONS

Costs for New Water Sources, 1999

Measures	Saved water volume(Mm3/year)	Investment cost (M US$)	Unit water cost (US$/m3)	Area (1,000 ha)	Note
Modern on-farm irrigation	85	34	0.074	Fruit Tree 10,000 ha and Sumer crops 3,000 ha	annualized investment and operation costs
Compensation for farmers	301	59	0.195	Fruit Tree 10,000 ha and Sumer crops 3,000 ha	annualized investment and operation costs
Water transfer from Coast to Barada	100	500	0.650		
Dam A (Orontes basin)	80	13	0.016		annualized investment and operation costs
Dam B (Coastal basin)	100	44	0.044		annualized investment and operation costs
Groundwater pumping (100 m deep)			0.026		operation costs only
Groundwater pumping (150 m deep)			0.042		operation costs only
Drinking water tariff (1 to 20 m3 / m)			0.052		
Drinking water tariff (21 to 30 m3 / m)			0.078		
Drinking water tariff (31 to 60 m3 / m)			0 226		

Data used in the table are derived from JICA (1998). The table only compares the costs of various hypothetical options Options like the intersectoral transfer of water from irrigation have not been assessed Thus, in the long-term basin transfer may be a feasible option.

Economic Analysis of Options

1. Modern On-Farm Irrigation System (a sample)

Crops	Irrigated Area	Applied Water Volume	Water Saving Rate	Water Saving Volume	Type	Unit Costs	Investment Costs	Annualized Investment Cost	Unit Water Cost	O&M Cost	Total cost
	(1,000 ha)	(MCM/year)	(%)	MCM/year		(US$/ha)	(M US$)	(M US$/year)	(US$/m3)	(US$/m3)	(US$/m3)
Fruit tree	10	250	30	75 0	drip	3000	30 0	3 94	0 053	0 020	**0.073**
Summer vegetable and crop	3	51	20	10.2	sprinkler	1300	3.9	0.51	0.050	0.030	**0.080**
Total				**85.2**			**33.9**				**0.074**

Note:
1) Barada / Awaj basin is assumed for applied water volume estimates
2) Around one third of the irrigated area for fruit trees and summer crops are assumed to be modernized in Barada / Awaj basin
3) The useful life of drip and sprinkler equipment is assumed to be 15 years
4) Micro point (drip) and travelling gun (sprinkler) type is assumed for investment and O&M cost estimates

Annualized investment cost calcuation

Number of years of useful life	15	50
Discount factor	10%	10%
Capital recovery factor	0 131	0 101

2. Typical dam and irrigation projects

	SP/m3	US$/m3	Mm3/year	M US$
1) basic projects (80 million m3)				
Unit water cost based on storage volume	8	0 160	80	13
Annualized over 50 years	0 81	**0.016**		
2) expensive dam projects (100 million m3)				
Unit water cost based on storage volume	22	0 440	100	44
Annualized over 50 years	2 22	**0.044**		

**Orontes and Coastal basin
** Dam reservoir volume can be filled up every year

3. Farmers' compensation for stopping irrigation (Barada / Awaj)

(JICA)	net income SP/m3	net income US$/m3	water use m3/ha	freed area ha	freed water Mm3	total compensation US$
Wheat	4 2	**0.08**	9500			
Vegetable	7 2	**0.14**	17000	3000	51	7 34
Fruit	10.3	**0.21**	25000	10000	250	51.50
Total (vege + fruit)		**0.195**	42000	13000	**301**	**58.84**

4. Interbasin Transfer

	SP/m3	US$/m3
Interbasin transfer from Coast to Damascus	32 5	**0.65**
(US$ 500 million investment and 100 Mm3/year)		

5. Groundwater pumping cost

(JICA)	SP/m3	US$/m3
100m	1 3	**0.026**
150m	2 1	**0.042**

6. Drinking water tariff 1997

water consumption per month

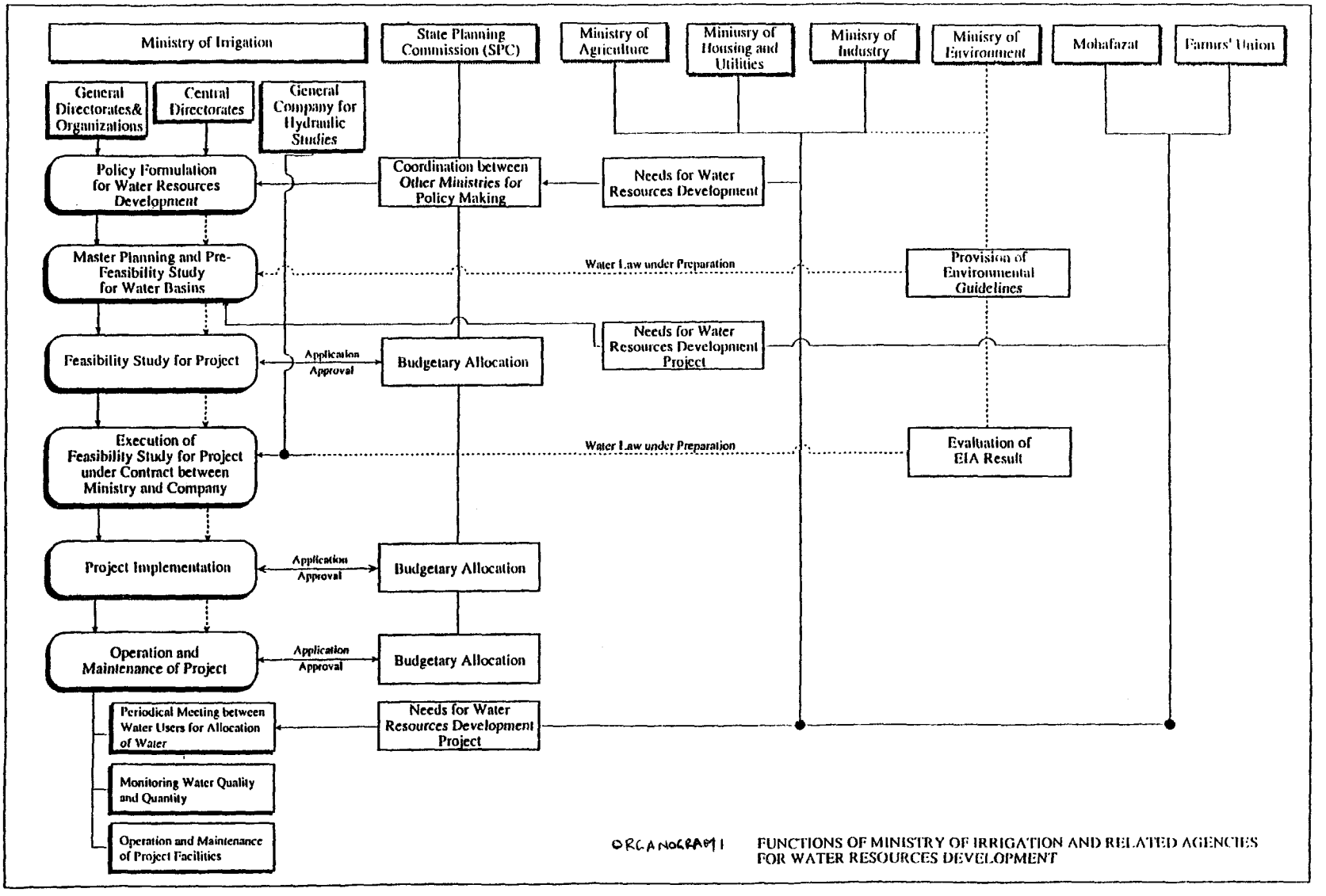
m3	SP/m3	US$/m3
1 to 20	2 6	**0.052**
21 to 30	3 9	**0.078**
31 to 60	11 3	**0.226**
61 and more	15 3	**0.306**
commercial	18 0	**0.360**
government	7 0	**0.140**

ANNEX 10

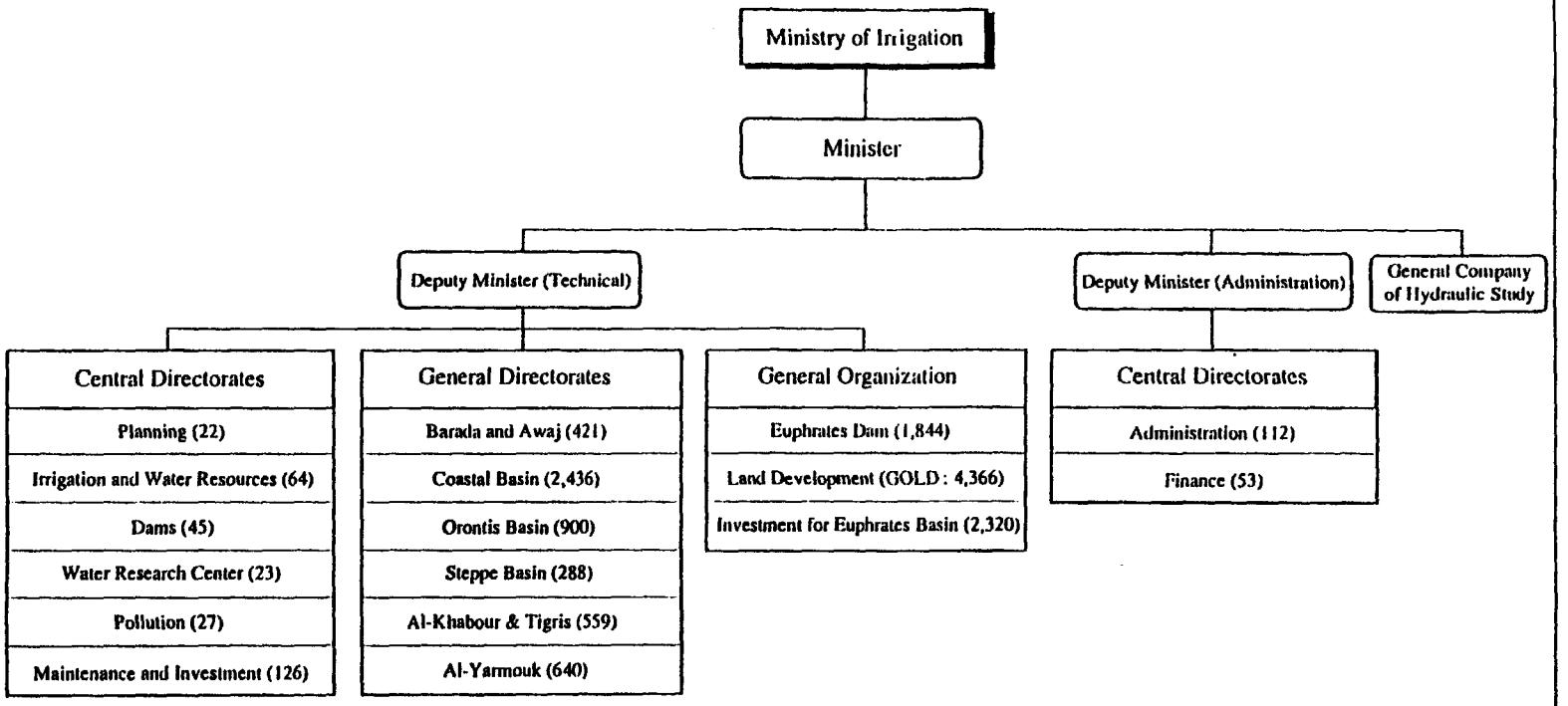
KEY ELEMENTS OF GOVERNMENT STRATEGY IN THE IRRIGATION SECTOR

Insofar as the specific strategies of the Syrian government pertaining to irrigation and water use in the agriculture sector are concerned, discussions with the officials of the SPC, MOI and MAAR, and the recent decisions of the Supreme Agricultural Council have indicated the following areas for priority actions and investments to achieve the overall objective of improving water use efficiency in the sector:

- Efficient use of all available water resources "*each drop of water*", particularly in the Steppe Basin through water harvesting where possible.
- Rehabilitation and modernization of old irrigation schemes to realize improved conveyance efficiency through use of canal lining, pipeline networks and to be supplemented with modern field irrigation systems for increasing irrigation efficiency.
- Planning the annual crop intensity, crop rotation, and crop pattern according to the available renewable groundwater and the surface water storage in each particular year.
- Using appropriate and suitable modern irrigation technologies for the agricultural crops and the type of water from different sources and according to the calculated water requirements.
- Reconsider the position of all non-licensed groundwater wells in light of the available renewable water resources.
- Developing ground water irrigated projects on the basis of group operation of well fields within a basin for decreasing the number of wells to realize efficient use of the resource and minimize the cost of operation.
- Absolute banning of any further drilling of ground water wells within basins suffering overdraft and declaring these basins as "*closed basins*".
- Developing a large scale integrated irrigation scheme from the Tigris River to supplement the flow of Khabour River in order to mitigate the insufficient low flow of Khabour aggravated by long droughts and cross-border over pumping of groundwater.
- Reversing the deficit in the water balance of the Upper Orontes and Khabour Basins.
- Defining the requirements and cost of rehabilitation and modernization of the irrigation schemes in order to cover the necessary cost in the annual government budget according to set priorities and to make available the necessary credits and foreign loans to cover the investments involved.
- Develop mechanisms and procedures for quality control and following appropriate standards in the production of irrigation equipment.
- Control of water logging and salinity in irrigated land particularly in Euphrates Basin and construction of adequate drainage systems.
- Monitoring surface and ground water quantity and quality all over the country.
- Developing a comprehensive plan to collect and treat domestic and industrial waste water and reuse of the treated waste water and agricultural drainage water in irrigation within each basin to increase the water available for irrigation and to control pollution.
- Implement a comprehensive study for treating waste water at the level of villages, small communities and industries within the Barada-Awaj Basin to protect surface and ground water from pollution.
- Building capacity within the MOI and MAAR for water quality monitoring and analyses.
- Automation of the data handling and processing within the Ministry of Irrigation and establishing computerized data basis and management information systems (MIS) and developing decision support systems (DSS).

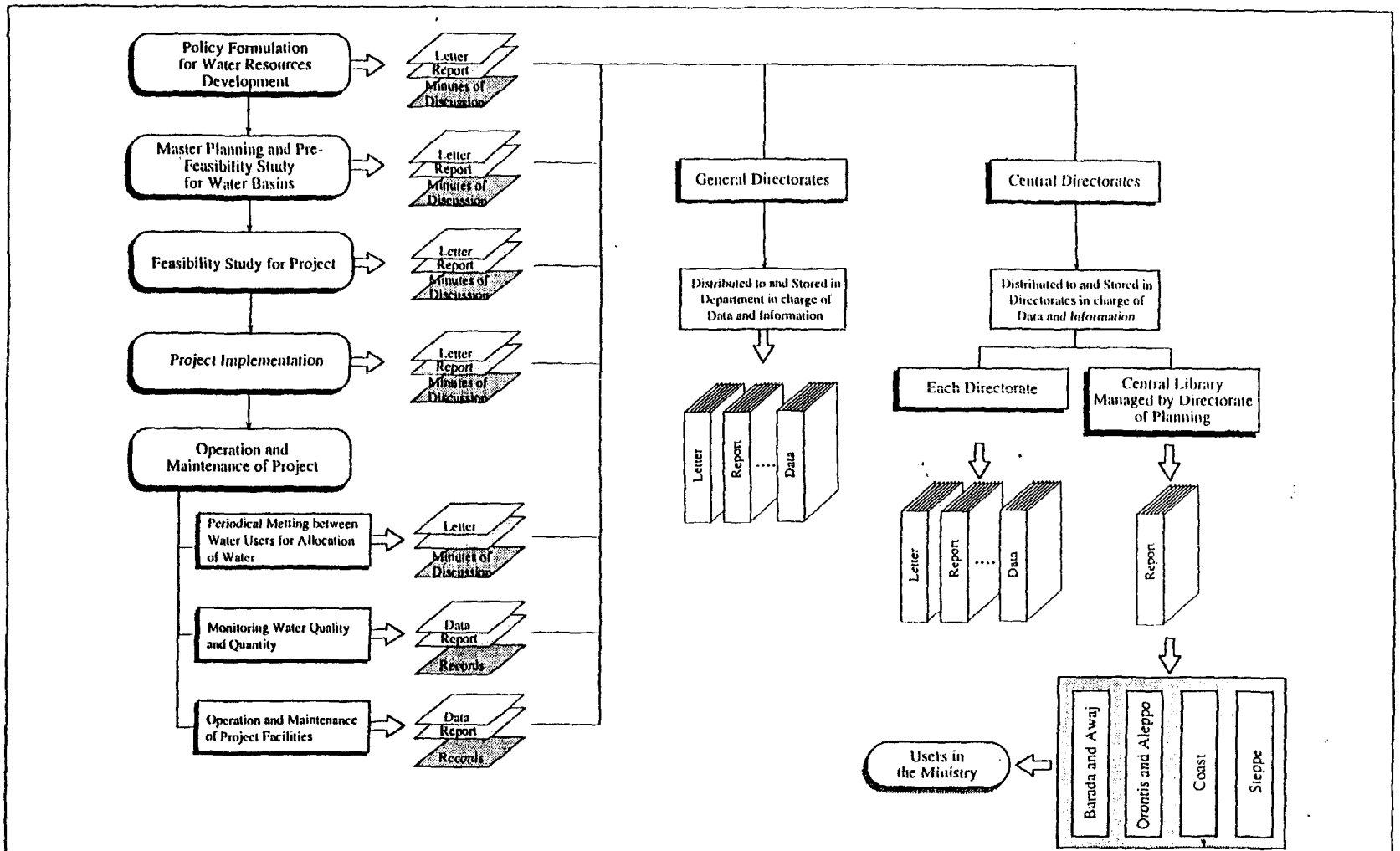


ORGANOGRAM I FUNCTIONS OF MINISTRY OF IRRIGATION AND RELATED AGENCIES FOR WATER RESOURCES DEVELOPMENT

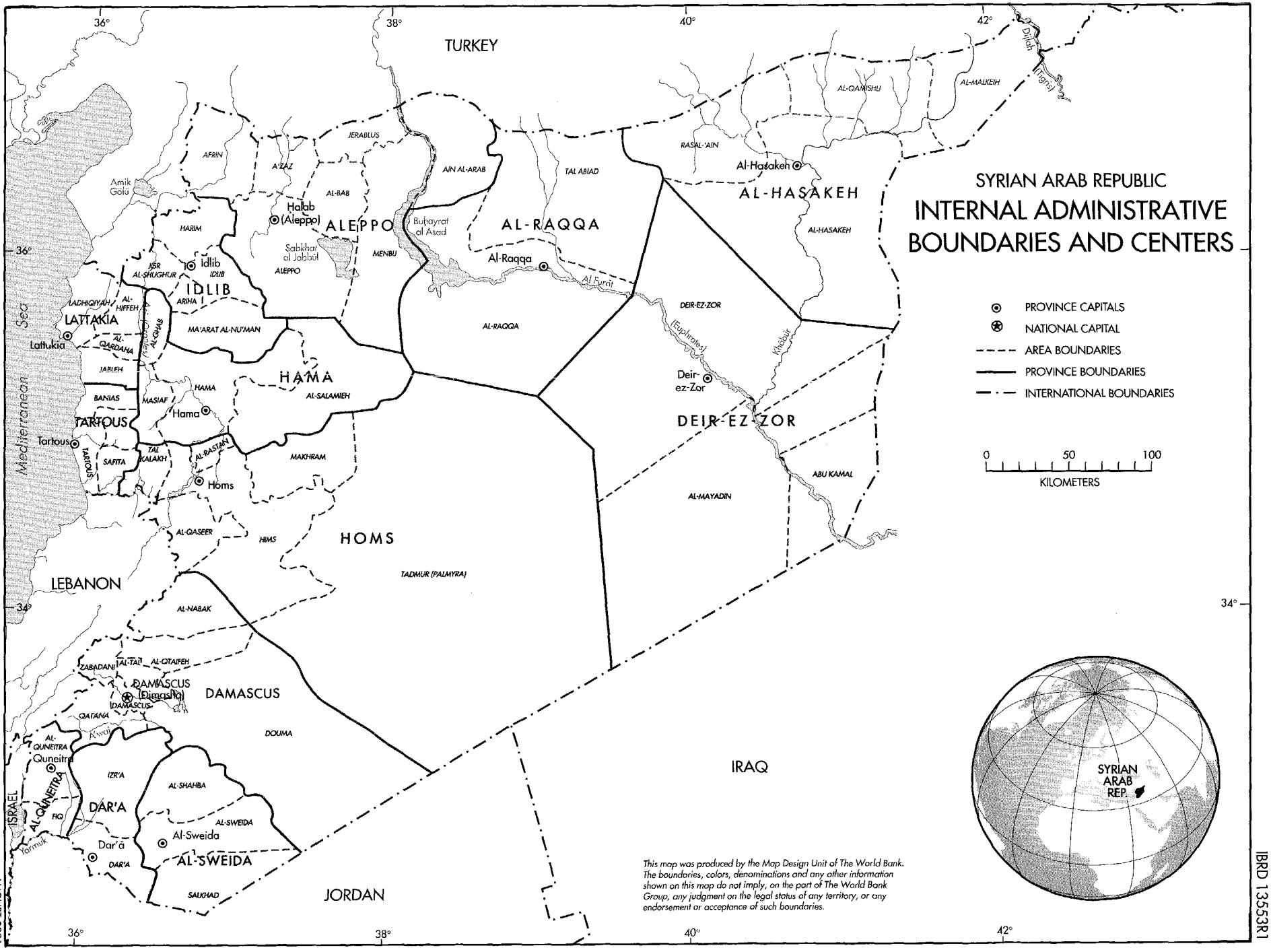


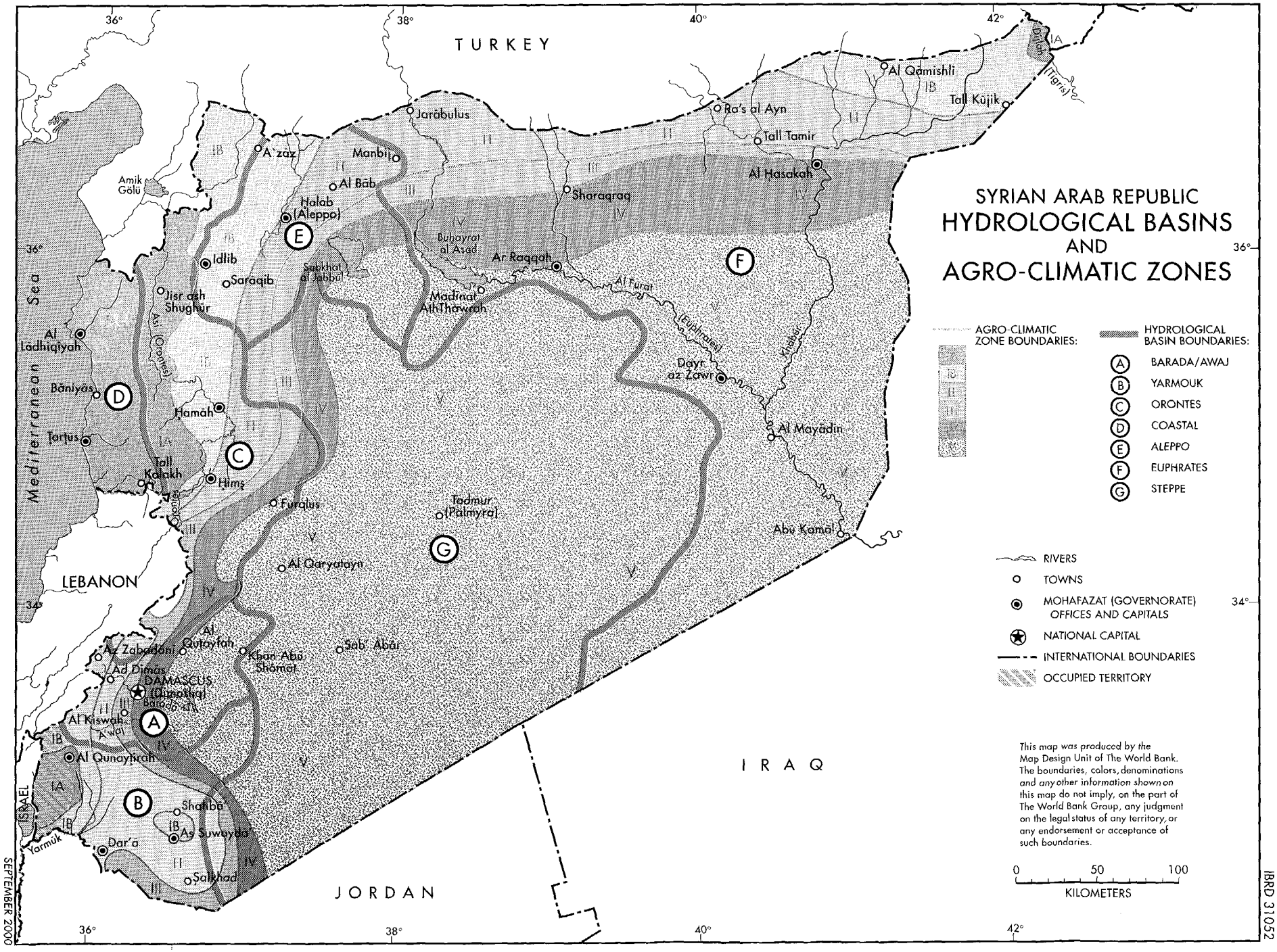
Note : Fiagures in parenthesis indicate number of staff in each directorate.

ORGANOGRAM 2 ORGANIZATION CHART OF MINISTRY OF IRRIGATION



ORGANOGRAM 3 CURRENT FLOW OF DATA AND INFORMATION IN THE MINISTRY OF IRRIGATION


SYRIAN ARAB REPUBLIC
INTERNAL ADMINISTRATIVE BOUNDARIES AND CENTERS
PROVINCE CAPITALS
NATIONAL CAPITAL
AREA BOUNDARIES
PROVINCE BOUNDARIES
INTERNATIONAL BOUNDARIES
0 50 100
KILOMETERS
TURKEY
LEBANON
ISRAEL
JORDAN
IRAQ
Mediterranean Sea
LATTAKIA
TARTOUS
IDLIB
ALEPPO
HAMA
HOMS
AL-RAQQA
DEIR-EZ-ZOR
AL-HASAKEH
DAMASCUS
DAR'A
AL-SWEIDA
Lattukia
Tartous
Idlib
Halab (Aleppo)
Hama
Homs
Al-Raqqa
Deir-ez-Zor
Al-Hasakeh
Damascus (Dimashq)
Quneitra
Dar'a
Al-Sweida
Euphrates
Tigris
Khabur
Orontes
Yarmuk
SYRIAN ARAB REP.
This map was produced by the Map Design Unit of The World Bank. The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of The World Bank Group, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.
AUGUST 2001
IBRD 13553R1


SYRIAN ARAB REPUBLIC
HYDROLOGICAL BASINS
AND
AGRO-CLIMATIC ZONES
AGRO-CLIMATIC ZONE BOUNDARIES:
HYDROLOGICAL BASIN BOUNDARIES:
A BARADA/AWAJ
B YARMOUK
C ORONTES
D COASTAL
E ALEPPO
F EUPHRATES
G STEPPE
RIVERS
TOWNS
MOHAFAZAT (GOVERNORATE) OFFICES AND CAPITALS
NATIONAL CAPITAL
INTERNATIONAL BOUNDARIES
OCCUPIED TERRITORY
This map was produced by the Map Design Unit of The World Bank. The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of The World Bank Group, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.
0 50 100
KILOMETERS
TURKEY
LEBANON
ISRAEL
JORDAN
IRAQ
Mediterranean Sea
Jarābulus
A'zaz
Manbij
Al Bab
Halab (Aleppo)
Amik Gölü
Idlib
Saraqib
Jisr ash Shughūr
Al Ladhiqiyah
Banīyas
Tartus
Hamāh
Tall Kalakh
Ḥimṣ
Furqlus
Al Qaryatayn
Tadmur (Palmyra)
Sabkhat al Jabbūl
Buḥayrat al Asad
Ar Raqqah
Madīnat ath Thawrah
Sharaqraq
Ra's al Ayn
Tall Tamir
Al Ḥasakah
Al Qamishli
Tall Kūjik
Dayr az Zawr
Al Mayadin
Abū Kamāl
Al Qutayfah
Az Zabadānī
Ad Dimās
DAMASCUS (Dimashq)
Khān Abū Shāmat
Sab' Abār
Al Kiswah
Al Qunaytirah
Shahbā'
As Suwaydā'
Dar'a
Salkhad
Yarmūk
Euphrates
Khabur
Tigris
Asi (Orontes)
SEPTEMBER 2000
IBRD 31052