Food and Agriculture Organization of the United Nations

Towards Improved Water Demand Management in Agriculture in the Syrian Arab Republic

Bazza, M. and Najib, R.

First National Symposium on Management and Rationalization of Water Resources Use in Agriculture
Organized by the University of Damascus
Damascus, Arab Republic of Syria
28-29 April 2003

A Towards Improved Water Demand Management in Agriculture in the Syrian Arab Republic

Bazza[1], M. and Najib[2], R.

---

1. Introduction

1.1. The global water crisis

Until recently, the prevailing perception was that of infinite fresh water on the planet, but the assumption is tragically false. Available fresh water amounts to less than one half of one percent of all the water on earth. The rest is seawater or is frozen in the polar ice. Fresh water is renewable only by rainfall, at the rate of 40-50,000 cubic km per year. Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. According to the United Nations, more than one billion people on earth already lack access to fresh drinking water. If the current trend persists, by 2025 the demand for fresh water is expected to rise by 56 percent more than is currently available.

In spite of the hard work and progress, the number of people without access to water supply in developing countries remained practically the same throughout the 1990s. According to the Global Water Supply and Sanitation Assessment 2000 Report, the majority of the world's population without access to improved water supply lives in Africa and Asia. The Population Council predicts that world population will grow to 7.8 billion over the next 25 years, with most of the increase in urban areas. The urban population will roughly double to 4.5 billion. After 2020, all population growth and most poverty in the developing world will occur in urban areas, as the rural population declines. Universal water supply coverage by 2023 will mean that in urban areas an additional 1.9 billion people will need water supply (Damme, 2001).

At the same time and according to FAO estimates, 70-80% of the increase in food demand between 2000 and 2030 will have to be covered by irrigation. This means that competition for water will continue to grow with growing population and increased needs for food, drinking water supply, industrial goods, recreational facilities, safe environment, etc. At present, water use in agriculture represents around 70% of the total worldwide, the largest share, but agriculture is also the most vulnerable sector because of its vulnerability and lower priority with respect to most other sectors.

---

[1] Senior Irrigation and Water Resources Officer. FAO Regional Office for the Near East. P.O. Box 2223, Cairo, Egypt. Mohamed.Bazza@fao.org

[2] FAO Consultant. FAO Regional Office for the Near East. Reza.Najib@fao.org

Globally speaking, there are still ample amounts of water to cover all needs of the world. However, it is not evenly partitioned over the planet, with several regions at the brink of crisis.

1.2. Current Situation and Recent Development in MENA Region:

With the rising populations, domestic pollution and expansion in agriculture and industry, the per capita water availability in the Middle East has become the lowest in the world, representing only 1/3 of Asian and 15% of African levels. While representing 5% of the total world population, the Middle East and North Africa (MENA) region contains only 0.9% of the global water resources. The number of water-scarce countries in the Middle East and North Africa has risen from 3 in 1990 (Bahrain, Jordan, and Kuwait) to 11 by 1995 (with the inclusion of Algeria, Israel and the Occupied Territories, Qatar, Saudi Arabia, Somalia , Tunisia, the United Arab Emirates and Yemen). Another 7 are anticipated to join the list by 2005 (Egypt, Ethiopia, Iran, Libya, Morocco, Oman and Syria).(Berman & Wihbey, 1999). At the same time, water remains vital for the economy of most countries of the region that depend essentially on agriculture, particularly irrigation.

In addition to its scarcity, much of the Middle Eastern water stems from three major waterways: The Tigris-Euphrates, the Nile and the Jordan River Systems. Mutual reliance on these resources has made water a catalyst for conflict. The constraints for improvement are neither financial nor technical; they are therefore, political, social and managerial

The crisis over water in the Middle East is escalating. Despite existing agreements, dwindling resources that are increasingly affected by pollution, agricultural/industrial initiatives and population growth, have elevated the strategic importance of water in the Region.

The fact that irrigated agriculture consumes by far the largest share of water resource use in most of the middle East and North Africa Region, emphasizes the importance and need for better water management in the agricultural sector, and more specifically, for improved irrigation efficiency. While progressive agricultural methods such as drip irrigation exist, they have, as a result of inappropriate policies and other reasons, been implemented by only a handful of states. Nor have current desalination efforts in the region proven capable of meeting growing demand.

The use of modern irrigation techniques like drip irrigation, micro-sprinklers, and other water saving devices has become widespread in some countries of the region, leading to substantial water savings. The careful implementation of a variety of on-farm irrigation management practices has also resulted in extensive water savings. However, substantial research is still needed to develop improved irrigation techniques, particularly those adapted for the use of marginal waters, in addition to associated technology transfer activities, which will be essential to further increase irrigation efficiency. There is also a need to determine the socioeconomic and environmental impacts of these new techniques, and to assess the social and political impacts of diverting agricultural water to municipal and industrial uses and to assure the adequacy of water quality if irrigation water is to be replaced with treated wastewater.

Better water management is not an option in the MENA region. It is a necessity, particularly in irrigation, which uses the greatest part of the region's overall water resources, as much as 87% according to the World Bank. In nearly all countries of the region, the most promising means for further water development activities involves real conservation and water basin-wide system efficiency enhancement, where a considerable number of programs have already been undertaken. In Jordan, they are working on improving water quality by reducing its salinity and pollution. Turkey has conducted research on water resource exploitation and, as in countries that are self-

sufficient in water, is studying ways to improve water storage facilities as well as water demand management practices.

In Tunisia, they are encouraging the participation of the private sector in introducing modern techniques by rewarding it by ample subsidies of 60% of the cost. It is important to recall that less than five percent of the world's people have their domestic supply of water provided by the private sector, despite the fact that such water is regarded as a valuable commodity that can be sold relatively easily. Irrigation water is much more difficult to sell for various reasons. Accordingly, global experience with private operation of irrigation systems is very limited. In Tunisia, wastewater reuse is also practiced.

Some other countries in the MENA region, particularly those with recent experience on Public-Private Partnerships (PPP) in the domestic water supply sector, such as Jordan and Morocco, are currently exploring possibilities of PPP pilot projects in the irrigation sector, but this experience is still at its infancy, since at this stage, such experience is limited to about five years in the domestic water supply and wastewater sector (mainly in Morocco and Jordan), with no apparent experience in the irrigation sector.

Estimates of population growth rate and minimum water requirement (MWR) in some of the Middle Eastern Countries, for the years 2000 and 2020, are shown in Table 1.

Table (1) Estimates of population, growth rate and MWR in selected countries (Asheesh, 2000)

	Population in 2000 (million)	Population in 2020 (million)	Water resource potential (Mm^3/yr)	Water per capita per year in 2000 (m^3)	Water per capita per year in 2020 (m^3)	Total MWR in 2020 (Mm^3/Yr)	Excess or shortage (Mm^3/yr)	Growth rate (%)
Jordan	**4.7**	**9.9**	**1100**	**234**	**111**	**1239**	**-139**	**3.8**
Palestine	**2.6**	**5.1**	**300**	**115**	**59**	**634**	**-334**	**3.4**
Syria	**14.9**	**25.9**	**10500**	**705**	**406**	**3236**	**7264**	**2.8**
Lebanon	**3.3**	**4.4**	**3700**	**1121**	**849**	**545**	**3155**	**1.4**
Turkey	**61.9**	**83.4**	**105000**	**1696**	**1259**	**10421**	**94579**	**1.5**
Egypt	**64.3**	**120.7**	**60000**	**933**	**497**	**15091**	**44909**	**3.2**

The available information clearly indicates that groundwater over-abstraction and quality degradation are the major emerging problems in the Near East. In several areas of the region, over-abstraction is severe and water levels are declining at rates that range from 1-3 meters per year. From the supply side, valuable natural water sources are still unexplored or insufficiently evaluated in the region. The following are some of the available supply and demand management options that can enhance the situation of water availability:

- Deep groundwater reservoirs,
- Geomorphologic drainage basins and wadi flows,
- Inter-basin transfer,
- Artificial recharge of groundwater reservoirs,
- Rain-fed irrigation,
- Water import (direct and virtual water) and transfer of icebergs, and

– Non-conventional water resources: reuse if agricultural drainage water, treatment and reuse of sanitary wastewater, desalination of salty and brackish water, use of brackish water in agriculture, use of sea water in agriculture, and rain seeding.

The last option is finding its way in the region. Reuse of agricultural drainage water is practiced in the countries with drainage systems, like Egypt, Syria and Iraq. Desalination of both sea and brackish water is used mainly in the Gulf Countries for household water supply. Sanitary and industrial wastewater that undergoes prior treatment before reuse in agriculture is widely used in Jordan, Tunisia, Egypt, etc. Other countries have started the process, such as Morocco, Syria, Yemen, etc.

The greatest potential and most promising option however remains the improvement of demand management in all sectors, particularly agriculture.

2.Current situation in Syria

2.1. Climate and Geography

Syria's climate is Mediterranean with continental influence: cool winters and warm dry summers with relatively short spring and autumn seasons (FAO, 1997a). The country is exposed to high variability in daily temperatures. The climate varies from the humid Mediterranean in the coastal areas to semi-arid in Damascus, Homs, Hama, and Aleppo in land areas to arid in the Badia Region, in the east. The Terrain is primarily semiarid and desert plateau; narrow coastal plain; and mountains in the west.

2.2. Role and importance of the agriculture sector

Agriculture in the Syrian Arab Republic (SAR) is a dominant economic sector; it accounts for 28 percent of the Gross Domestic Production (GDP) and 60 percent of the non-oil exports. In recent years, agricultural production has increased substantially; it supports the livelihood of half the rural population and provides employment to 27% of the total manpower in the country. Food security through increased crop production is among the highest priorities of the Government which accords a high attention to the issue and provides support to the expansion of agriculture and rural development, particularly in the densely populated areas.

In recent years, low rainfall and successive drought waves have jeopardized national efforts to boost agricultural production. To overcome these constraints, the strategy has been to rely on irrigation as a buffer against climatic variability and water shortage. Therefore, irrigation forms the backbone of sustainable agricultural development and national food security. It is also a means of increasing economic returns from agriculture and reducing production risks

The national policy to increase the irrigated area was implemented by subsidizing irrigation equipment and according favourable credits to farmers, in addition to free access to water. This policy encouraged public and private investment in the sector, leading to a continuous increase of the irrigated area, particularly during the last three decades. The total area under perennial irrigation increased steadily from just over 540 000 hectares in 1970 to nearly 1 250 000 hectares in the year 2001. About 60% of this total area, or 700 000 hectares, are irrigated from groundwater and the rest from surface water.

The predominant method of irrigation is the conventional surface technique with an overall efficiency below 50%. Modern and potentially high efficient methods are limited to only around

80000 hectares for sprinkler and to some 4000 hectares under trickle and other localized methods. The overall losses of water associated with the traditional irrigation methods are very high as they represent half of the amounts applied by farmers. Although part of this loss returns to groundwater through infiltration, this proportion is low (15 to 20% of the total loss); in addition, it results in higher pumping costs for farmers and induces pollution of aquifers.

The situation as described, associated with traditional irrigation practices and on-farm water management, created favourable conditions for the application of amounts of water far in excess of the crop needs. In addition to low technical know-how of farmers, traditional irrigation methods and practices normally have a low potential efficiency. Farm sizes in the area irrigated from groundwater are generally small and range from 0.5 hectare in the coastal region to about 2-5 hectares in the other provinces. With the inheritance mode, even small farms are divided into smaller plots that are often too small for allowing irrigation without large losses. They also result in the multiplication of wells, as each heir tends to dig his own.

The increase in the irrigated area and the loss of large quantities of water through mostly low efficiency, traditional methods of application have led to an overall shortage of water resources and particularly an alarming decrease of groundwater level. Groundwater draw-down started to be felt in the late eighties-early nineties and reached large figures in the mid-nineties.

Conscious of these issues and of the need to sustain agricultural production and rural income, especially for small farmers, through the sustainable management and optimal utilization of the natural resources, the Ministry of Agriculture and Agrarian Reform (MAAR) adopted a strategy aimed at, among other objectives:

- Sustainable water resources and irrigation development to meet the growing water demand from agriculture and other water user sectors.
- Efficient and optimal utilization and conservation of water resources in irrigation as a priority for national food security, through the introduction of improved irrigation methods and water control and management tools.

2.2. Water Resources

The water resources of Syria are very limited compared to the needs, and estimations show that available resources amount to 16 059 million m^3/year as total uses reach 19 164 million m^3/year. In consequence, the water balance is in deficit of 3 105 million m^3/year varying across basins. The biggest deficit concerns al Khabour basin due to the expansion of the irrigated area, a disproportionate and often uncontrolled development of wells and the severe drought witnessed by Syria (FAO, 2002a). The water economy of the SAR depends mainly on rivers. There are 16 main rivers and tributaries in the Country of which 6 are most important international ones.

- El-Kebir with sources in Syria and Lebanon and which forms the border between them before flowing to the sea.
- Tigris, which forms the border between Syria and Turkey in the extreme north-eastern part.
- Euphrates (Al Furat), which is Syria's largest river. It comes from Turkey and flows to Iraq. Its total length is 2 330 km, of which 680 km are in Syria;
- Afrin in the north-western part of the country, which comes from Turkey, crosses Syria and flows back to Turkey;
- Orontes (El-Assi) in the western part of the country, which comes from Lebanon and flows into Turkey;

- Yarmouk in the south-western part of the country with sources in Syria and Jordan and which forms the border between these two countries before flowing into the Jordan river. Table 2 shows the main rivers in SAR (FAO, 2003a)

Table 2: The Main Rivers in SAR

Rivers	Source	Termination out or within SAR	Length (km)		Long term term average flow (Mm^3/yr)
			Total	Within SAR	
Euphrates	Armenia hill	Iraq	2880	680	31400
Tigris	Tourous & Zagross	Iraq	1718	44	18800
Al-Khabour	Tourous	Euphrates	442	442	1261
Orontes	Hermel	Med. Sea	485	336	813
Afrin	Kerdag	Med. Sea	149	68	227
Queiq	Tourous	Aleppo	126	98	95
Sajour	Tourous	Euphrates	108	48	132.4
Al-Balikh	Tourous	Euphrates	202	202	138.7
Jaghiagh	Tourous	Khabour	124	100	227
Al-Kabir North	Aqra'a	Med. Sea	96	96	208.1
Al-Kabir South	Lattakia Mou	Med. Sea	75	65	252.3
Sinn		Med. Sea	6	6	312.2
Barada	Anti Lebanon Mountains	Atibeh lake	81	81	315
Awag	Haramoon	Hujaneh Lake	70	70	47
Al-Yarmouk	Shikh & Al-Arab Mount	Jordan Valley	60	50	189
Sybarani	Haramoon	Atibeh Lake	22	22	22.07
Banyas	Shikh Mount.		1	1	15.7

There are 155 dams in SAR distributed per basin, three of them, namely Fourat, Tichreen and Al-Rostan, represent about 90% of the total storage capacity. The largest one is the Fourat or Euphrates, with a storage capacity of 14,000 Mm^3. Water resources per water basin are shown in Table 3 (FAO, 2001a). As shown in the table, 90% of the total volume is for the Coastal Al Khabour basins, Tigris, Orontes and Euphrates basins

According to the Ministry of Environment, the total annual renewable water resource in Syria amounts to only 9,977 MCM, of which 81% is used by Agriculture, 6.5% by domestic users, 2.5% by industry and 10% lost by evaporation (Syria Water Quality Management Country report, 2001). The Irrigation Sector Report prepared by the World Bank in 2001 indicates that the total estimated volume of water use is about 15 billion m^3 per year of which 87% is used for irrigation, 9% for domestic use, and 4% for industrial use. The surface and groundwater shares of total irrigated area are respectively about 40% and 60% in average. The share of groundwater is highest in the Barada/Awaj basin and lowest in the coastal basins (Syria Water Quality Management Country report, 2001)

Table 3: Main Basins in SAR

	Unit	Barada - & Awag	Yarmouk	Al Badia	Orontes	Coastal	Al Khabour	Euphrates and Tigris	Total
Area	km^2	8630	6742	70787	21624	5049	9129	63219	185180
Rainfall (average)	%	59	49	30	60	80	40	100-40	
Water resources (surface)	Mm^3	12	88	49	666	1246	315	6818	9194
Water resources (undergroun d)	Mm^3	490	131	54	964	622	640	2494	5395
Water resources (total)	Mm^3	502	219	103	1630	1868	955	9312	14589
Utilization rate	%	0,90	0,85	0,60	0,85	0,65	0,95	0,98	-
Actually availability	Mm^3	452	186	62	1386	1214	907	9126	13332
Domestic & Industrial waste water	Mm^3	257	50	8	214	0	36	130	695
Agricultural drainage	Mm^3	568	36	-	231	43	428	725	2031
Total available for use	Mm^3	1277	272	70	1831	1257	1371	9981	16058

2.3. Water Issues

Water scarcity in Syria is becoming an increasingly serious concern for public authorities as future demand for water is surpassing available resources. Agriculture is the largest consumer of water since it consumes up to 85% of all available hydraulic resources in the country and the economy of the country depends directly on it (30% of GDP). Therefore, the need to increase water use efficiency in agriculture is at the center of the nation's water policy discussions, which are designed to combine the expansion of irrigation and to attain a sustainable use of water by increasing technical efficiency and by reducing future consumption (FAO, 2001a).

Irrigated agriculture has increased steadily in Syria over the last decades, almost doubling since 1985; a fact that has responded to the nation's food security policy objectives to satisfy the food production needs of an increasing population that features one of the largest growth rates in the world (3,50% in 1985 and still 2,54% from 1995-2000) (FAO-MAAR, 1999, 2001).

Along the Tigris and Euphrates Rivers, Turkey and Syria are currently approaching a massive confrontation over water resources. Relations between the two countries, strained at best, have been aggravated since the 1980s by growing tensions over water. Despite the signing of a protocol ensuring Syria access to Euphrates in 1987, Turkish development efforts have increasingly threatened to marginalize Syrian access to water. Most notably, the southeast Anatolia (GAP) project has provided Turkey, situated at the headwaters of the Tigris and Euphrates River System, extensive control over the flow of Euphrates water. Turkish disruption of the flow of the Euphrates in January 1990 to fill water reservoirs in front of the Attaturk dam highlighted Syrian vulnerability to Turkish control over upstream water resources.

Pollution is another issue that has reached alarming levels for both surface and groundwater and threatens their sustainability. The Assi river and groundwater in Barada/Awaj Basin and around Aleppo are examples of this situation.

2.4. Risks and Constraints

Syria seems to be engaged mostly in water resource exploitation activities. The country has ample potential for additional water use and groundwater extraction. However, it needs to consider its stream flow and environmental needs, as well as the possibility that water resource development in neighboring countries may considerably reduce the volume of Euphrates River water available to it. This may require a greater focus on Water Demand Management and conservation activities.

The current policy which lacks instruments to prevent excessive quantities of water from being lost, expanding water contamination and inadequate demand management measures, has led to critical issues in the water sector including supply-demand imbalance, quality degradation and competition between users.

Due to delays in surface water supply projects and the lack of new supplies, intensive agricultural practices relying on ground water spread quickly in most areas in the last ten years; a fact that has threatened the water-table and lowered drastically springs discharge.

The high growth of population and the economy and the competition between agriculture and industry for limited water supplies have been limiting development efforts in many parts of the country like Damascus, Homs and Hama, causing even more problems and difficulties in the regions.

Syria faces problems of both quality and quantity of water. In Damascus, for example, a water-supply system designed for a population of one million is servicing a population of four million that is still growing at eight per cent annually. To compensate for the excess demand, ground water sources are being exploited unsustainably. Until recently, wastewater treatment was virtually nonexistent, with sewage dumped untreated into surface water in many Syrian cities. In addition, Syria faces surface water sharing issues with all its neighbors that are either unresolved or only partly resolved. The most prominent of these is its dispute with Turkey over the flow of the Euphrates and, to a lesser extent, the Orontes and Tigris rivers. Some degree of controversy also applies in its sharing of the Yarmouk waters with Jordan and the Litani waters with Lebanon.

The monitoring activities of the different institutions involved show that both the groundwater and surface waters are polluted with domestic and industrial wastes across the entire country, near all major settlements (WB/UNDP, 1999). The main sources of pollution are: (1) urban domestic wastewater, (2) rural domestic wastewater, (3) industrial pollution, (4) agricultural drainage water, and (5) salt water intrusion.

The lack of wastewater treatment facilities in many cities and villages means there is a substantial opportunity in this sector in most of the major urban centers. The government has already taken steps to address this problem in Homs, Aleppo, Hama, and Damascus. Improvements to system efficiency as well as re-use of wastewater will be essential in Syria's future water needs. Large scale conveyances for Euphrates water may be possible in the future. Solid waste sector, other than a pilot landfill for Damascus, has been rather neglected. This is likely to present opportunities in the future, ranging from landfill design and construction through hazardous and medical waste disposal technologies. Environmental Consulting Syria is at an early stage of developing its environmental awareness and establishing a governmental structure for monitoring

and protecting the environment. As such, there may be opportunities for working with donor funding and specialized organizations to help build capacity in this area.

2.5. Groundwater for irrigation

Groundwater management in SAR is an issue of great concern to water policy makers, planners and legislators, not only regarding pollution, but also with respect to resources. Syria has important groundwater resources estimated at 5395 Million m^3 which represents 37% of the total water resources of the country. The important aquifers concentrate in the western and northern regions but most of theses aquifers have been overexploited, except for the coastal and Al Badia basins. (FAO, 2001b)

In 2000, it was estimated that 715 508 ha (56% of the equipped area) was irrigated from groundwater and 560 559 ha or 44% from surface water (gravity-fed and pumped from the rivers and lakes). Of the total area of 560 559 ha irrigated by surface water, 396 518 ha or 71% are considered as public irrigation where the government is involved and 80% of this area is also equipped for drainage. The remaining 164 041 ha or 21% is considered as private irrigation. (FAO, 2000).

Since pumped water is free and the only investment expense required is the well and a suitable pump, the use of groundwater for irrigation has been rapidly expanding. Farmers obtain credit at preferential rates of interest to purchase fuel and imported pumps at subsidized prices. Also the large number of farmers with small size of holdings explains the increase in irrigation from groundwater. Since most of them want secure and independent access to water supply they often dig their own wells. The number of wells in 1999 reached a total of 201 259, of which 25% were not licensed. This fact has caused the issuing of special decree stating the obligation of licensing all wells by 2001. Furthermore, several decisions were taken by the Government to halt the expansion of wells, such as Decision no 13/1999 banning wells drilling and renewal licenses in replacement of dried-up wells, Decision no 6/2001 forbidding the establishment of wells in the cretassic layer, unless for drinking purposes (FAO, 2003a). Table 4 shows the number of wells and related irrigated area.

Table 4: Number of Wells and related Irrigated Area

Basin	Number of wells	Irrigated area (ha)
Euphrates	34 898	190 694
Coastal	30 000	12 996
Togris and Al Khabour	35 000	314 050
Al Yarmouk	5 000	10 637
Orontos and Al Badia	46 225	129 377
Barad and Awag	50 136	57 755
Total	201,259	715,509

Considering that the total renewable ground water in Syria represents only less than 7% of the total available water resources, one may notice the irrational and unbalanced policy of using water resources in the country.

According to FAO guidelines on water quality for irrigation, a severe restriction for irrigation is indicated when the electrical conductivity of water exceeds 3ds/m. Water samples from three

wells north of Deir El-Zor within the steppe area have been analyzed and found to have EC values ranging between 7 and 10 ds/m (Syrian National Report, 2002). Furthermore the guidelines indicate limits for specific ion toxicity. In the analyzed samples sodium and chloride were found to be the dominant cations and anions respectively. A severe restriction degree is given in the guidelines when the concentration and the composition of these salts are considered in the analyzed samples and these waters are not suitable for irrigation.

The increase in the irrigated area and the loss of adequate quantities of water due to inefficient and, in most cases, traditional methods of irrigation, have led to an overall shortage of water resources and, in particular, an alarming drop in groundwater. Groundwater drawdown began in the late 1980s and early 1990s and became serious in the mid 1990s. The province of Homs was the most affected area with an average decline of 12-35 m/yr, followed by that of Hama, where the decline reached 10 m/yr. The regions of Aleppo and Idlib were also affected, with an average drawdown of 1.0-1.5 m/yr. Such overdraft depresses the water table and increases pumping lifts and the costs of installation and abstraction. It may also induce recharge of aquifers with low quality drainage water or cause seawater intrusion in the coastal aquifers, as it is the case in the area of Lattakia and Tartous. The continued trend began to have negative effects on agricultural productivity. Unless it is stopped, it will result in the depletion of aquifers, with severe consequences to the environment, the national economy and the social conditions of the rural areas.

3. Potential for improvement

3.1. On policy issues

Since the year 2000, the government strategy has concentrated on the adoption of the so-called "modern" irrigation, as a measure to reduce water losses. A resolution was issued in August 2000, for generalizing the adoption of modern irrigation technology to all the irrigated area, within a period of four years. The resolution also regulates the mandatory licensing of existing wells, in addition to the introduction of water meters, and forbids the drilling of new ones, except for drinking purposes. These measures are very relevant, encouraging and ambitious. They are also essential first steps, but substantial efforts are still needed to achieve their effective implementation. As the following step, the country needs a clear national policy on water resources, targeting the sustainable management of these resources with the full participation of farmers. At present, even with the high level of subsidy provided by the Government, farmers are not fully convinced of the need for adopting the modern technology and saving water. This will also necessitate the training of farmers and require the importation of some crop commodities to maintain food security.

It is now widely recognized that wastewater reuse represents an important and integral component of a comprehensive water management programme. Although the quantity of wastewater available will account for only a small fraction of the total irrigation water requirements, its appropriate treatment and reuse can overcome water pollution problems and alleviate the water shortage mainly around cities. Therefore, wastewater reuse must continue to be given full attention and to be an integral part of the overall water resources policy and strategy in Syria.

As treatment and reuse of wastewater is new in Syria, all possible problems and constraints are common including the lack of policy, the absence of standards and regulations, and low technical and managerial capacity. Some of these problems are currently being addressed including through assistance from UNDP and FAO. A strategy for wastewater treatment and reuse is under preparation for the Damascus area and is expected to serve as a model for other cities. National

standards as well as a monitoring programme for the Damascus area are also under elaboration. (FAO, 2002b)

The development of new water resources seems very limited considering that Syria has developed a fair number of dams and reservoirs. An alternative would be to invest in improving the efficiency of existing irrigation systems and to provide incentives to private investments. As most of the aquifers are over-exploited, expansion of irrigated area should take place essentially in basis where the water balance is positive, i.e. Euphrates and Tigris and Coastal Basins. In particular, such expansion can take place if favorable agreements are reached with Turkey regarding the flows to be released in the Euphrates and the Tigris rivers.

A new Water Law and an Environment Law are under consideration by the government. The new water law addresses the protection of the public water from pollution in several articles and identifies sanctions to be applied in case of violating the conditions of protecting water quality and/or using polluted water for irrigation.

Table 5 shows the policy matrix for irrigation water in Syria (FAO, 2001b) and summarizes the policies related to irrigation water including policy objectives, policy strategies, policy measures and government departments involved and the legal documents enacted. Syria is trying, through the legal regulations developed, to respond to specific policy objectives that are namely: (1) conservation of water resources, (2) Food Security and Food production targets, (3) Settlement of nomad population.

Table 5: Policy Matrix for Irrigation Water in Syria (i)

POLICY OBJECTIVES	POLICY STRATEGIES	MEASURES	GOVERNMENT DEPARTMENTS	LEGAL DOCUMENT
CONSERVATION OF WATER RESOURCES (i)	Sustainable use of groundwater aquifers	• Well drilling is banned in the cretassic layer • Only public Ministries are allowed to drill wells in the cretassic layer for domestic water use	SAC	Decision nº 6 (17/2/2001)
		• Forbidding cultivation of summer crops in the steppe areas to preserve unrenewable groundwater reserves	MAAR MI	Decision nº 30 (21/10/2000)
		• Obligation to license all unlicensed wells by July 1 2001 ➔ In titled lands owned by individuals or groups properly documented ➔ In untitled lands proving ownership by certificate of MAAR ➔ In State lands when the farmer is a tenant proven by MAAR ➔ In private lands when the farmer is a tenant or sharecropper	SAC MAAR MI	Decision nº 22 (30/4/2001)
		• Well drilling licensing is banned • Licenses renewal for drilling new wells to replace dried-out wells is banned • Well deepening licenses are subject to the conditions determined by the irrigation department of the Governorate concerned • Pumping system installation is not permitted unless renewable water is available	MI	Circular nº 13 (31-8-1999) Circular nº 31 (3-6-2000)
		• Installation of flow meters in wells • Grant irrigation license to farmers investing in the installation of flow meters	MI MAAR	Decision nº 31 (21/10/2000)
	Cost recovery in public irrigation schemes of surface waters	• Establish an irrigation fee of 3500 SP/ha for permanent irrigation and 600 SP/ha for winter irrigation (recovery of O&M costs) • Establish a land reclamation fee from 2000 – 7000 SP/ha (recovery of capital costs)	SAC	Decision nº 5 (21/12/1999)

Table 5: Policy Matrix for Irrigation Water in Syria (ii) (cont)

POLICY OBJECTIVES	POLICY STRATEGIES	MEASURES	GOVERNMENT DEPARTMENTS	LEGAL DOCUMENT
CONSERVATION OF WATER RESOURCES (ii) **(cont)**	Irrigation rehabilitation and modernization	• Submit studies for adoption of pressurized pipe irrigation systems	MI	Decision nº 3 (3-5-2000)
		• Rehabilitation of public irrigation schemes within a specific schedule • Supply to farmers with the required equipment and inputs • Agricultural Credit Bank will finance modern irrigation networks and the installation of supplementary centrifugal pumping sets on licensed wells regardless of other loans obtained by the farmers	MI ACB	Decision nº 22 (30/4/2001)
		• Rehabilitation of the Al Manajeer irrigation projects in the Tigris and Al Khabour basins	MI	Decision nº 37 (21-10-2000)
		• Already implemented projects should be rehabilitated to adapt to modern irrigation techniques	MI	Decision nº 258 (22-1-2000)
	Adoption of modern irrigation technologies at farm level (i)	• Submit studies for adopting modern irrigation techniques for strategic crops according on water basins capacity • Allocate annual budgets and provide necessary loans • Quality control of equipment	MI MEFT MAAR MIN MSIT	Decision nº 3 (3-5-2000) Decision nº 21 (18-4-2001)
		• Conversion from traditional irrigation methods to modern irrigation techniques in 4 years • A committee is formed with all Ministries involved • Start conversion in public sector systems	SAC MAAR MEFT SPC, MI MHU	Decision nº 11 (5-7-2000)

Table 5: Policy Matrix for Irrigation Water in Syria (iii) (cont)

POLICY OBJECTIVES	POLICY STRATEGIES	MEASURES	GOVERNMENT DEPARTMENTS	LEGAL DOCUMENT
CONSERVATION OF WATER RESOURCES (iii) **(cont)**	Adoption of modern irrigation technologies at farm level (ii) (cont)	• Financing of adoption of modern irrigation by the Agriculture Cooperative Bank ➔ The Government will provide 40 000 million SP ➔ 7 years repayment period for individual projects ➔ 10 years repayment period for cooperative projects ➔ 5,5% interest rate for private farmers ➔ 4% interest rate for cooperatives ➔ 100000-85000 SP/ha for drip irrigation of field crops ➔ 45000-33000 SP/ha for drip irrigation in fruit trees ➔ 25000-20000 SP/ha for sprinkler irrigation ➔ Collateral of 85% of the loan is required • Give priority for financing the projects located in the water-deficit basins (Orantes, Al-Khabour, Barada and Al-Waj) • Licenses will be granted to unlicensed wells provided that modern irrigation equipment (sprinkler, drip) is installed	MAAR MI MIN MEN ACOB CFB GUP	Decision nº 17 (1-8-2000) Decision nº 29 (21-10-2000) Decision nº 25 (7-5-2001)
FOOD SECURITY **MEET FOOD PRODUCTION TARGETS**	Coordinate Agricultural Plan and strategic crops with irrigation water availability	• Establishment of crop rotations and cropping patterns according to the renewable water resources, dams and reservoirs allocated for irrigation	MAAR MI	Decision nº 3 (3-5-2000)
	Development of new irrigation areas	• Allow farmers in Al- Raqqa Governorate (Assilah and Al Kassair) to cultivate 1400 ha with summer crops and 2800 ha with winter crops in season 2000/2001 giving priority to barley and forage in winter crops	MAAR MI	Decision nº 30 (21-10-2000)
		• All irrigation and land reclamation projects should consider the adoption of modern irrigation techniques	MAAR MI	Decision nº 258 (22-1-2000)
SETTLEMENT OF NOMAD POPULATON	Development of new irrigation areas	• To ensure settlement of population in Jarwan, Arwaished and Abu Khashab it is permitted to cultivate pastoral shrubs and fodder barley not exceeding use of 1500 million m3/year for all uses, • summer crops are forbidden to preserve unrenewable ground water • investment in new irrigated lands by wells in the steppe trying to preserve water resources and ensure settlement of population	MAAR	Decision nº 30 (21-10-2000)

3.2. On Technical Issues

The construction of Dams was a crucial tool for food security in Syria. The three dams (Fourat, Tichreen, ald Al-Rostan) represent about 90% of the total storage capacity. The potential of increasing the volume of stored surface water still exists, but it is limited on one hand and requires high costs on the other.

The adoption of water-saving irrigation technologies and management tools constitute the most promising measures to balance supply and demand. Given the low performance of traditional irrigation, the potential of water conservation through the introduction of such measures is extremely high compared to all other options for solving the issue of water shortage. A recently implemented FAO project (see below) and other similar ones have demonstrated this potential, with high levels of water savings. Past programmes and projects provided only limited support to the improvement of irrigation methods and practices in the field, but the situation is slowly changing with the new policy.

The country has invested heavily in infrastructure (dams, water diversion works, pipes, wells, etc.), but these efforts have not been well balanced with sufficient institutional strengthening, training, managerial capacity, policies and regulations, extension, etc.; in addition to the lack of investment to improve on-farm water management. As a result, these investments are achieving only limited outputs in the short term and will be sustainable on the medium and long terms only if such a balance is achieved.

Procedures for the adequate design, installation and management of typical modern irrigation schemes have been developed under model projects, tested and proved to be reliable and well adapted to the conditions of Syria. In addition, training has been provided to national staff to raise their capabilities for implementing these technologies.

The adoption of the modern irrigation technologies will also require a disaggregated farm level analysis. The result can be substantially different in the large, medium and small farms evidencing that structural parameters and cropping patterns are determinant and hence regional characteristics. Across all farm types, the kind of water source whether surface or underground also determines the profitability of adopting modern irrigation techniques..

Capacity building of the technical manpower to handle improved irrigation technology and its management in an efficient manner is still highly needed. Implementation of the new policy by the Government to generalize this technology to all the irrigated area will require the filling of these gaps. Technical assistance from relevant organizations should focus on addressing this issue and a training component should be incorporated in all irrigation projects and programmes. The relevant institutions from the Ministry of Irrigation and that of Agriculture and Agrarian Reform and their decentralized units have a relatively high number of technical cadres with different fields of specialization. Although some of these are able to offer good technical services, most still need additional training on all aspects of modern irrigation techniques. In addition the available staff is not sufficient for implementing the new policy and responding to demand from all farmers in the country. The capacity building of technical manpower should be an integral part of the strategy to implement the new policy to switch from traditional to modern irrigation technology.

3.3. On institutional strengthening

The lack of coordination between ministries as well as between institutions within ministries hinders to a great extent the implementation of strategies and programmes. The establishment of co-ordination mechanisms between institutions, with clear mandates, responsibility and

accountability, are very much needed and would be very beneficial. In addition, the current level of investment and working means are below the needs.

According to other countries' experiences, farmers participation and the establishment of Water User Associations could provide an important inter-phase between the government and the farmers, particularly when severe measures are needed to reduce water abstraction.

The other aspect where additional attention is needed is the creation of awareness among farmers and their sensitization to the issue of water shortage and the potential benefit from improved technology and management tools, including through their participation to support the operation and maintenance costs of irrigation water. To complement such a campaign, reliable irrigation advisory services need to be established/reinforced and made operational, to cover the needs of the country for such services. At present, such services and overall extension on water use in agriculture are extremely limited and what exists is not operational for several reasons. Training of trainers and farmers is essential as properly designed irrigation systems may easily prove to be so poorly performing if they are operated in a wrong way.

The private sector should be encouraged to invest in the sectors parallel to irrigation such as the fabrication, import and marketing of repair parts, maintenance of irrigation equipment, etc. University graduates and technicians are more suitable for these tasks because of their technical background but they need special training as well as support opportunities through incentives and loans.

4. Cooperation between Syria and FAO in the field of water development and management:

The Food and Agriculture Organization of the United Nations (FAO) has the promotion of agricultural development and food security, while sustaining the natural resources base, among its priorities. To this end, it provides support to its member countries, in a variety of means, and depending on the needs. Co-operation between Syria and FAO, in the specific field of water development and management, materialized through a number of projects and activities having a direct impact on the water sub-sector. A brief review of the recent and on-going cooperation programme and its scope and achievements is summarized below.

Improved management of water resources for agricultural use (phase II).

Objectives:

- Establishment of adequate support services at national and regional levels to plan and introduce effective on-farm water management practices
- Introduction and dissemination of advanced irrigation methods to improve farm-level irrigation efficiencies.

Achievements

- Establishment of 11 equipped experimental stations
- Internal and external training of appointed staff
- Establishment of research and demonstration programme
- Creation and operation of a revolving fund facility to promote advanced irrigation methods
- Establishment of criteria for provision of credit for irrigation equipment
- Improved surface irrigation through laser controlled land levelling
- On-farm demonstrations on improved surface irrigation, sprinkler and localized irrigation methods
- Training in reclamation of saline soils.

Water control component of the special programme for food security

Objectives:

- Improve on-farm water management and the use of appropriate water efficient irrigation methods in selected water deficit areas
- Enhance capacity building in irrigated agriculture and water conservation

Achievements

- A total of 34 farms, covering an area of 91 ha in the regions of Aleppo, Hama, Homs, Idleb and Latakia, were equipped with modern irrigation networks
- Encouraging results showed an overall water savings of 20-50 %, improved crop productivity and quality, and substantial savings in irrigation labour, time and pumping costs
- Creation and operation of a revolving fund facility in the Agricultural Cooperative Bank
- Training farmers in the installation, operation and maintenance of irrigation networks
- Training staff in irrigation planning and design, monitoring and evaluation
- Raising awareness of stakeholders on the need to rationalize water use and at the same time increase productivity per unit area

Assistance in Agricultural planning, policy analysis and statistics.

This project focused on developing policy analysis capacity of the Department of Statistics and Planning of the MAAR. It was followed by a second phase (***Assistance in institutional strengthening and agricultural policy and Assistance for capacity building through enhancing operation of the National Agricultural Policy Center).***

Objectives:

- Institutional development
- Agricultural policy analysis and advice
- Training
- Statistical information for policy analysis

Achievements

- Restructuring of the MAAR
- Structuring and reviewing the functions and mandate of NAPC
- Establishment of the new, updated NAPC
- Enhancing the institutional capacity and the organizational and management capacities of the NAPC
- Studies on cross cutting agricultural issues, including water use in agriculture
- Studies on wider issues of relevance for agricultural policies covering among others, food security, environmental impacts of agricultural practices
- Strengthening links with regional and international institutions in establishing a permanent agricultural policy forum
- Basic training and specialized training including water resources policies, farm level policies analysis, food security and sustainable rural development
- Establishment of an electronic database for agricultural policy work including rainfall, land use and irrigation
- Production of a more user-friendly electronic interface to facilitate use of the database

Support to the development of national standards for locally manufactured modern irrigation equipment.

Objective : Assist MAAR in shifting from traditional to modern irrigation techniques, through the establishment and adoption of national standards of irrigation equipment, normalization and testing.

Achievements

- Development of national standards for locally manufactured modern irrigation equipment
- Identification of the requirements for verification tests
- Feasibility study for upgrading the quality of irrigation equipment

Strengthening capacity for the reuse of treated wastewater in irrigation (on-going)

The project falls along the lines of the strategy adopted by Syria regarding treatment and reuse of municipal wastewater and is intended to assist the Ministry of Irrigation for building its capacity to reuse treated municipal wastewater for irrigation. The project, which can be considered as pilot in the Ghouta region of Damascus, will address the issues of expanding the potential of water resources for irrigation, and reducing pollution hazards of groundwater by wastewater.

The issues created by water shortage for irrigation and the threats posed by municipal wastewater led the authorities to find solutions, notably through the use of these unconventional waters as an alternative for irrigation after their treatment. The opportunity materialized with the construction and operation of a plant for treating sewage water in the Adra region, in addition to construct of five irrigation canals with a total length of 60 km, dominating a potential area for irrigation of 18 000 hectares.

The treatment and safe use of the wastewater for irrigation is also intended to reduce environmental problems caused by these waters as well as the risks associated with them, in particular pollution of groundwater and population health. The safe use of treated wastewater for irrigation is the last stage of this big project that has received a high priority from the Syrian authorities. Expectations from this stage are also high, as irrigation would ensure greater food security and better management of the environment. To achieve these two objectives (safe environment and better agricultural production), the Ministry of Irrigation is facing serious problems associated with its current capacity to monitor and adequately use this water for irrigation; hence it requested support from FAO.

To improve irrigation techniques and management in the project area, about 15 hectares of pilot farms have been selected in a way that they represent the entire area. These farms serve as pilot where improved irrigation technology has been installed, including sprinkler and improved surface methods, to demonstrate appropriate irrigation management and practices. At present, these farms serve for field training of farmers as well as technicians from the Ministry of Irrigation. The monitoring program for quality control developed by FAO is also implemented in these farms, in addition to several points along the distribution canals and wells.

Objectives:

- Build the capacity of the Ministry of irrigation to analyze and monitor the quality of treated wastewater and to evaluate its suitability for reuse in irrigation
- Assess the supply of water resources and their demand management in Damascus Ghouta, and elaborate a strategy for the optimal use of these resources, including wastewater from the treatment plant
- Establish a pilot area for the safe and optimal use of treated wastewater in irrigation in the Ghouta region, with improved irrigation techniques and management tools, to be used for demonstration and training purposes
-

Achievements

- Draft standards for wastewater reuse for restricted and un-restricted irrigation
- Training engineers and technicians from the Ministry of Irrigation on quality control monitoring.
- Development of a comprehensive programme for water quality monitoring and evaluation in the project area
- Laboratory analysis for quality criteria
- Establishment of a pilot area irrigated with wastewater using modern irrigation techniques

5. Concluding Remarks

It is evident that the present water balance in Syria is negative and a fast growing population is putting additional pressure on the existing resources which are not enough to satisfy existing and future demands. The mobilization of additional water resources seems very limited considering that Syria has developed a fair number of dams and reservoirs and the fact that further investments in additional public-funded irrigation are extensively questioned worldwide due to increasing costs and environmental problems. Groundwater is over-exploited in several basins and this threatens the sustainability of vital aquifers.

An alternative solution is to invest in improving the efficiency of existing irrigation systems and to provide incentives to private investments which will conform to Syria's new trend in agricultural policies. This seems very crucial and on the whole, restoring a positive water balance in the future appears as an important policy objective in Syria that will require some drastic measures in some of the existing basins where the deficit has reached alarming proportions. Up till now, the nation-wide projected water policies have proven to be non-sustainable and a positive water balance will not be reached in the country, even less no in the critical high-deficits basins. Therefore, much of the present and future water policy will have to move towards action to focus on demand management and sustainability of the resources. The way is long and tedious, but the right solution is within reach.

References

- Asheesh, M., 2000. Management approach to Middle Eastern water resources and services. Institute of Environmental Engineering and Biotechnology, Tampere University of Technology, Finland.

- Bardaragoda, D. J. 1998. Needs for institutional impact assessment in planning irrigation system modernization. Research report 21. International Irrigation Management Institute, Colombo, Sri Lanka.

- Berman, I. & Wihbey, M., 1999. The New Water Politics of the Middle East. Tsrategic Review. Summer.

- Damme H.V., 2001. Overcoming Water Scarcity and Quality Constraints: Domestic Water Supply, Hygiene and Sanitation. 2020 Vision. October.

- Daoudy, M., 1999. Water Institutions and development in Syria: A downstream Perspective from the Euphrates and Tigris Syria. World Commission on Dams. December.

- FAO, 2003b. Review of World Water Resources by Country. Water Reports 23.

- FAO, 2003a. Water Resources Management in SAR with emphasis on non-conventional sources. TCP/SYR/0167. January.

- FAO, 2002c. Utilization of groundwater and treated wastewater in the Near East Region. Second Session of the Agriculture, Land and Water Use Commission for the Near East. March.

- FAO, 2002b. A comparative Assessment of Links Between Irrigation Water Pricing and Irrigation Performance in the Near East. Regional Office for the Near East. June.

- FAO, 2002a. Water Resources and Irrigation in Syria. Report for the World Food Day 2002. FAO Damascus, Syria. October.

- FAO, 2001b. The utilization of water resources for Agriculture: Analysis of current regime and policy. GCP/SYR/006/ITA.

- FAO, 2001a. Analysis of Irrigation Water Policies in Syria: Current Developments and Future Options. GCP/SYR/006/ITA.

- FAO, 1997. Seawater Intrusion in Coastal Aquifers: Guidelines for study, monitoring and control. Rome, Italy.

- FAO-MAAR, Ministry of Agriculture and Agrarian Reform of the Syrian Arab Republic, & Italian Cooperation. Country Profile: The State of Food and Agriculture in Syria. FAO Project GCP/SYR/006/ITA, 1999

- FAO-MAAR, Ministry of Agriculture and Agrarian Reform of the Syrian Arab Republic, & Italian Cooperation. Syria Database. FAO Project GCP/SYR/006/ITA, 2001

- National Technical Committee for Sustainable Development (NTCSD). The Syrian National Strategy Report for Sustainable Development. World Summit on Sustainable Development. Johannesburg, South Africa, 2002.

- Rosegrant, M., 1997. Water Resources in the twenty-first Century: Challenges and Implications for Action. Food, Agriculture and Environment Discussion Paper 20. IFPRI. Washington D.C.

- Rosegrant, M. & Svendsen, M., 1993. Asian Food Production in the 1990s. Irrigation Investment and Management Policy. Food Policy, 18:13-32.

- Seckler, D., 1996. The New Era of Water Resources Management: From “dry” to “wet” water savings. Research Report 1. International Irrigation Management Institute. Colombo, Sri Lanka.

- Syria National Report, 2002. (Compiled by W. Y. Ibrahim). Ministry of Agriculture and Agrarian Reform (MAAR), Soil Research Directorate, GIS Department.

- Anonymous, 2001. Syria Water Quality Management. Country Report on Water Quality Management and Potential METAP Interventions. Syria, November.

- WB/UNDP and Ministry of State for Environmental Affairs, 1999. National Environmental Action Plan. Final Report. January.

- World Water Council, 2001. Arab Countries Vision Consultations. September.