Syrian Arab Republic country report

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SYRIAN ARAB REPUBLIC COUNTRY REPORT

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ABSTRACT – Growing population results in a great pressure on limited water resources (WRs) prone to depletion. As a result of the rising water demand by agriculture, industry and tourism, so it is necessary to cope with these circumstances by increasing water use rationalization. But this solution can't alone solve the problem for a long time, therefore we shouldn't use sewage water as a traditional source where treated wastewater reuse in agriculture became one of the most important solutions for providing irrigation water as a substitute for fresh water in irrigation. Accordingly, we should take several steps to avoid the adverse impacts of sewage water, select the appropriate irrigation methods, raise the awareness of farmers on health and environmental issues, and find standards for using this kind of water.

Key words: WRs, non-conventional water, drainage water, wastewater, treatment plants, utilization, pollution, environmental impacts, institutions, health

INTRODUCTION

The studies showed that the use of wastewater primarily started in Middle East region since more than two thousand years ago, particularly in Damascus (Syria) and Greece followed by Fas and Marakesh in Morocco in the eighth century, and in USA, Germany, Britain and other European countries a century ago.

Wastewater use, in the light of water resource shortage, can play a significant role in the sustainability of agricultural production in Syria. Additionally, treated wastewater reuse for irrigation can achieve several benefits, of which the most important is the irrigation of wide areas of agricultural lands.

Wastewater is considered a low cost resource. Experiments proved that there is a benefit from plant micro and macro-nutrients present in wastewater and in the solid matter resulting from treatment wastes used as soil conditioners particularly in desert lands and dry and arid zones, saving nitrogen and phosphate fertilizers.

The presence of wastewater is a reality, so its treatment is necessary in order to be used as profitable and as effective as possible. Safe and planned use of wastewater can reduce the health and environmental risks of traditional methods of disposal. The use of wastewater as a source besides its critical necessity in dry and semi-dry areas like the Syrian one, endanger consumers to health risk that shouldn't be disregarded when this water is used for irrigating crops and vegetables eaten raw (uncooked).

Disposal of untreated wastewater largely increased the concentration of contaminants, especially in Barda river and south Aleppo plains and outbreak of dysentery. Statistics showed that 75% of south-Aleppo and Damascus Ghouta's population is infected with dysentery.

Hence, the use of non-conventional water requires special management different from that of fresh water due to its physical nature and chemical composition. The impact of this water on soil, crop quality, potential risks to human health and environment should be assessed. In case of water coming from industrial activities, monitoring of the heavy metals and ion concentration in water, soil and crops is needed.

Non-conventional water is double – edged weapon where its use advantages can move to large health and environmental problems if this water is not treated well, in line with the purpose for which it will be used and not to be a reason to the spread of infectious diseases carried by water or the accumulation of chemical contaminants in food chain topped by man.

1. CURRENT STATUS OF WRS

These resources comprise conventional and non-conventional water.

1.1. Conventional Water

It consists of inland water, resulting from rainfall excluding evaporation, that emerges, runs and discharges within the Syrian political boundaries, in addition to international waters according to the legal conditions of the Euphrates and Tigris rivers and others.

1.1.1. Inland Surface and Groundwater

The studies showed that average total surface water is 10635 million m^3/year, and average total groundwater including springs is 5256 million m^3/year. Table 1 presents the average surface and groundwater distributed to the seven water basins as well as total available regulated water.

Table 1. WRs (surface and groundwater) in Syria

WRsbasins	Hydrological basins							Total m.m^3
	Barada & Awaj	Yarmouk	Badia	Orontes	Coastal	Tigris & Khabour	Euphrates & Aleppo	
Surface (m.m^3)	19	168	152	1036	1453	735	7073	10635
Ground (m.m^3)	774	249	168	1499	726	1493	346	5256
Total (m.m^3)	793	417	320	2535	2179	2228	7419	15891
Regulation degree (%)	90	85	60	85	65	95	98	
Available regulated WRs (m.m^3)	714	354	192	2155	1416	2117	7271	14218

1.2. Water Uses

Considering Table 2, we see that the total (surface and groundwater) water used in irrigated agriculture was 14 billion m^3 in 2002, while the water amount used for drinking and domestic purposes is more than 1 billion m^3, and 561 million m^3 for industry in the same year. Evaporation losses from free water bodies (natural lakes and storage dams) amounted 1962 million m^3/year.

Table 2. Evaporation and uses of available WRs in the different sectors

Water use/basin		Hydrological basins							Total m.m^3
		Barada & Awaj	Yarmouk	Badia	Orontes	Coastal	Tigris & Khabour	Euphrates & Aleppo	
Agricultural irrigation	Ground	785.8	211.8	68	1137.2	99.5	4305	1440.7	8048
	Surface	-	188.6	-	954.9	466.8	-	4314	5925.1
Drinking and domestic use		269	76	44	240	81	38	322	1070
Industry		76	38	2	229	85	45	86	561
Evaporation losses		6	31	15	148	16	132	1614	1962
Total use		1136.8	545.4	129	2709.1	748.3	4520	7777.5	17566.1

Studying tables 1 & 2 and comparison of available WRs with their uses in Syria, a clear water shortage exceeding 3 billion m^3/year is remarkable.

1.3. Non-Conventional WRs

Due to the growing pressure on WRs, dependence on non-conventional WRs increased. Non-conventional water plays a considerable role in sustainable water resource management as an alternative to fresh water in several fields as irrigation, aquaculture and others.

Table 3. Non-conventional WRs (drainage water and wastewater) in Syria

WRs/basin	Hydrological basins							Total $m.m^3$
	Barada & Awaj	Yarmouk	Badia	Orontes	Coastal	Tigris & Khabour	Euphrates & Aleppo	
Drainage effluents	75	35	0	222	72	404	728	1536
Wastewater and industrial effluents	254	85	35	352	200	102	172	1200
Total	329	120	35	574	272	506	900	2736

Non-conventional WRs mean wastewater, drainage water, and low-quality brackish well water which development and improved utilization became an urgent need that should be considered because this water is a substitute source for conventional sources and can't be used without treatment in order to make their specifications consistent with the intended use without compromising the environment, and with legal and legislative aspects of water quality and uses.

Non-conventional WRs reuse in Syria lies in the following:

- Drainage water reuse.
- Wastewater reuse.
- Industrial wastewater reuse.

1.3.1. Drainage Water

Care for drainage water started with the expansion of irrigation and land reclamation projects and construction of large-scale drainage systems to make good reuse of this water once again.

Drainage water is one of the most important available water sources for reuse, and is considered a major source for non-conventional WRs. Drainage effluents are estimated to be 1.536 billion m^3 at 10 – 15% of agricultural irrigation water. It localized in the following water basins: Tigris and Khabour, Euphrates, and Orontes as well as water losses in Damascus water basin that recharge groundwater and flow of rivers (Barada and Awaj).

These effluents can be reused partially or fully in agriculture after blending with fresh water at different ratios, depending on the research results obtained via Water Research Centers in Syria, including:

- Care should be given to the selection of salinity-tolerant/resistant crops.
- Non-use of brackish water (drainage water) in irrigation if water table level is not at least 1.5 and 2 m deep in light and heavy textured soils respectively.
- Potential blending of drainage water with fresh water at 1:¾ and 1:1 according to salinity Ec level.
- Proper land leveling to avoid salt accumulation in some parts of the field.
- The establishment and pre-growing rapid irrigations should be with fresh or high-quality water to avoid plant damages as a result of brackish water irrigation in germination and elongation stages.
- The need for soil leaching with fresh water when in case of brackish water irrigation as follows:
    - ❖ Irrigation with water 1000 ppm, leaching should be with fresh water after 20 irrigations.
    - ❖ Irrigation with water 2000 ppm, leaching should be with fresh water after 10 irrigations.
    - ❖ Irrigation with water 5000 ppm, leaching should be after five irrigation and so on.
- Care should be given to fertilization to keep the equilibrium between nutrients lost by leaching.

Recently, Syria geared to drainage water reuse for irrigating a part of irrigated areas amounting 1.4 million ha, taking several measures such as: periodic and regular monitoring of drainage water quality and its salinity level, in addition to the study of the effects resulting from this reuse on soil properties, crop productivity, and fresh water sources.

A number of irrigation projects were implemented depending on drainage water reuse, of which Ziara irrigation project on an area of 17400 ha under Al-Ghab development framework. Water requirements of the actually cultivated areas are about 125 million m^3/year. In addition, a number of large-scale irrigation projects were implemented in the middle and lower Euphrates basin depending on drainage water for irrigating certain crops.

1-3-2. Wastewater (Domestic and Industrial)

Wastewater plays a significant role in water resource management as a substitute for fresh water (in irrigation practices) on which demand increased in large Syrian cities (Damascus – Aleppo – Hama – Homs – Lattakia…) to meet water needs for drinking, domestic and industrial uses.

Wastewater and industrial wastewater are estimated to 1.2 billion m^3 constituting 75% of water used in drinking and industry sectors.

The use of wastewater for irrigation dated back to the date of wastewater systems introduction into population communities in Syria. The final drain was going to the river, valley or agricultural lands without notable treatment.

In the light of population growth, increasing consumption of water for drinking and domestic uses, and rising demand on food, Syria had to take the necessary measures for wastewater treatment and reuse in irrigation. Over the recent years, the government implemented large-scale programmes to establish wastewater treatment plants in all provinces. Tables 4, 5, 6 and 7 show the main Syrian treatment plants (under exploitation, under construction, studied and ready for implementation) in case of funds availability.

Table 4. Exploited treatment plants in Syria

Plant location	Objective	Population	Discharge m^3/day	Treatment method	Area (ha)
Adra, Rural Damascus	• Water reuse • Pollution abatement of water sources • Environment improvement	3000000	485000	Conventional activated sludge	67.5
Huran al-Awamid, Rural Damascus	• Water reuse • Pollution abatement of water sources • Environment improvement	8500	680	Plants and granular graduation	1.1
Rural Aleppo	• Water reuse • Pollution abatement of Qweiq river • Environment improvement	2260000	345600	Mechanized oxidation ponds	125
Rural Homs	• Water reuse • Pollution abatement of Orontes river • Environment improvement	900000	133900	Conventional activated sludge	33
Salamya, Hama	• Water reuse • Pollution abatement of water sources • Environment improvement	73000	7000	Natural oxidation ponds	3.65
Ras al-Ain, Hassakeh	• Water reuse • Pollution abatement Water sources • Environment Improvement	25070		Lagoons	1.6

Table 5. Treatment plants (under construction) in Syria

Plant location	Objective	Population	Discharge m^3/day	Treatment method	Area (ha)	Comments
Deir Atyah, Rural Damascus	• Water reuse • Pollution abatement of water sources • Environment Improvement	23872	2400	Conventional activated sludge	1.6	Under construction
Yabroud, Rural Damascus	• Water reuse • Pollution abatement of water sources • Environment Improvement	48872	3910	Mechanized oxidation ponds	3.2	Under construction
Idleb	• Water reuse • Pollution abatement of water sources • Environment Improvement	249000	29900	Mechanized aerated oxidation ponds	12.5	Under construction
Hama	• Water reuse • Pollution abatement of Orontes river • Environment Improvement	583000	70000	Conventional activated sludge	17.5	Under construction

Table 6. Treatment plants (under study and inspection) in Syria

Plant location	Objective	Population	Discharge m^3/day	Treatment method	Area (ha)	Comments
Al-Tal, Rural Damascus	• Water reuse • Pollution abatement of water sources • Environment Improvement	75000	3075	Long aerated activated sludge	3.9	Under study
Nabek, Rural Damascus	• Water reuse • Pollution abatement of water sources • Environment Improvement	34000	3264	Traditional activated sludge	1.5	Under study
Beit Jen, Rural Quneitra	• Water reuse • Pollution abatement of water sources • Environment Improvement	4000	480	Aerated activated sludge	0.5	Under study
Mehrdeh, Shezr	• Water reuse • Pollution abatement of water sources • Environment Improvement	6470	6600	Long aerated activated sludge	3.2	Under study & inspection

Table 7. Treatment plants (under study and inspection) in Syria

Plant location	Objective	Population	Discharge m^3/day	Treatment method	Area (ha)	Comments
Deir Ezzor	• Water resource pollution abatement	449193	67848	Long	13.5	Under inspection
Tartous	• Agricultural land protection	145000	33437	aerated	4.5	Under study
Al-Sisinah, Tartous	• Improvement of health and environmental conditions	14000	1680	activated	9	Under inspection
Mu'ara, Tartous		5000	625	sludge	3	Under inspection
Safita, Tartous		35490	3797		2.3	Under study
Sheikh Maskin, Dera'a		96463	22186		5	Under inspection
Miadin, Deir Ezzor		55905	4480		4.3	Under inspection
Hassakeh	• City pollution abatement	157000	37314	Traditional	20	Under inspection
Raqqa	• Water reuse in agriculture	333371	61689	activated	15.6	Under inspection
Sweida		156250	18750	sludge	5	Under study
Lattakia	• City pollution abatement • Water reuse in agriculture • Sea pollution abatement	208500	33360		10.5	Under study

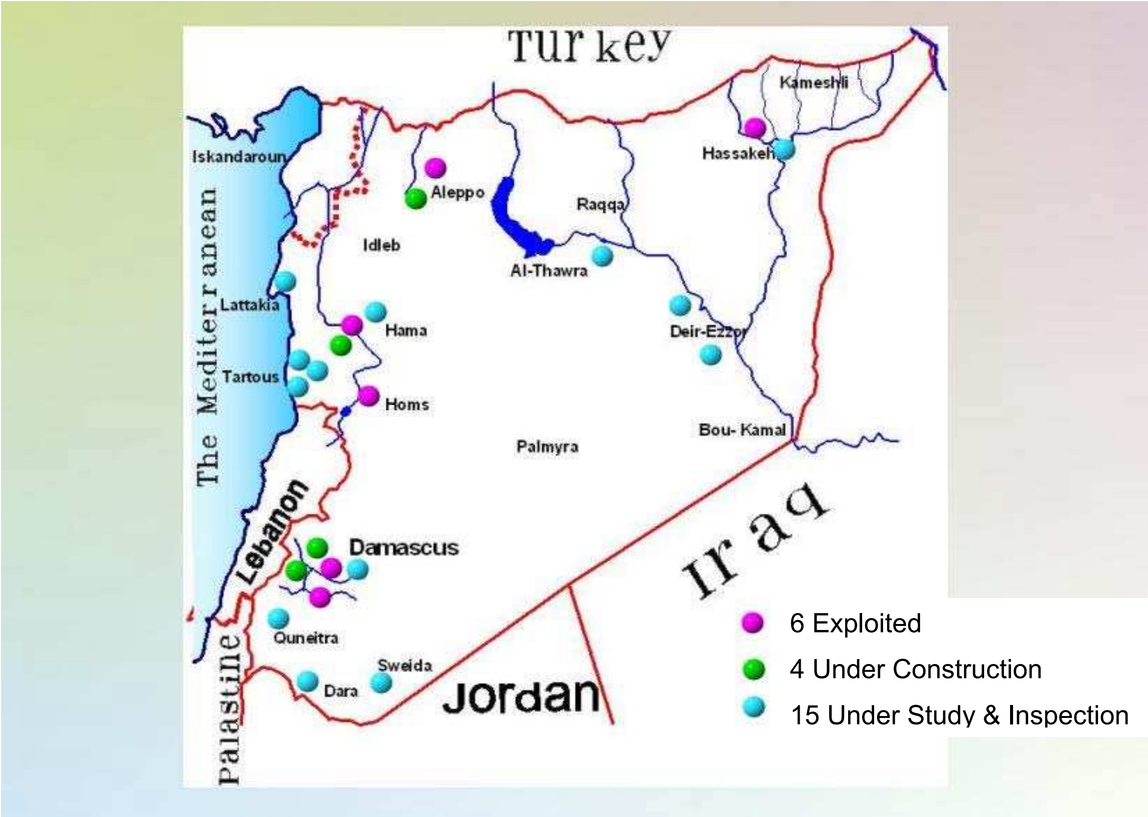

Figure 1. Treatment plants in Syria

Locally exploited treated wastewater is exceeding 350 million m^3/year resulting from treatment plants in Damascus, Aleppo, Homs and Hama, and this figure can reach more than 500 million m^3 after the completion of plants which relevant technical and structural studies were already prepared.

The objectives of treatment plants are the following:

- Pollution alleviation of water sources and cities.
- Protection of agricultural lands from pollution and degradation.
- Improvement of environmental and healthy conditions.
- Water reuse in agriculture.

Techniques adopted in wastewater treatment in various Syrian regions vary for different considerations: technical, economic, social aspects, population, land nature, wastewater flow amount. Treatment methods comprise activated sludge which is used in Damascus, Hama, Homs, Dera'a, Lattakia and Tartous while oxidation ponds method is used in Salamya region east of Hama province. Each method has advantages summed up by the following points:

- Water treatment with high-concentration contaminants (activated sludge)
- No need for large areas (activated sludge)
- Tolerance to sudden changes in water quality and composition (aerated)
- Obtained good characteristics in terms of pathogens (worm eggs) (aerated)

Disadvantages are summed up by:

- High costs of establishment, operation and maintenance processes (activated sludge).
- The need for specialized trainers (activated sludge).
- The problem of permanent sludge (activated sludge).
- The need for large areas (aerated).
- The influence of atmospheric temperature in winter, slackening treatment process (aerated).

2. WASTEWATER AMOUNT

Domestic Wastewater Effluent

Produced drinking water was 1391 million m^3 in 2002. Since the average use loss is 30%, the net consumed water amount (wastewater) is equal to 1070 million m^3/year.

Industrial Wastewater Effluent

The amount of water used in industry was estimated to 561 million m^3 in 2002, so the industrial effluent equaled to 392.7 million m^3 /year at a use efficiency of 70%.

Agricultural Use of Wastewater

Agricultural sector is considered the largest consumer of WRs, and it is in need for the exploitation of any additional water source, conducive to attain food security and its conservation. However, wastewater utilization is very slight comparing to its amount. Areas irrigated with treated wastewater, in different provinces, are estimated to 37000 ha, constituting 2.6% of irrigated area in Syria with water consumption equal to the total wastewater production of treatment plants, distributed as follows:

- 18.7 thousand ha in Damascus Ghouta,
- 10.0 thousand ha in Aleppo plains,
- 2.600 thousand ha in Hama province,
- 5.000 thousand ha in Homs province, and
- 700 ha in Salamya region.

A part of these areas was transferred from rainfall-depending lands to permanent irrigated lands under a studied agricultural plan and selection of appropriate crops in consistent with soil, water quality, and prevailing climate.

- Treated wastewater constitutes 29.2% of total wastewater in Syria.
- 34.6% of total wastewater is used for irrigating certain crops (fodder, industrial, fruit trees with small areas) without treatment in line with the Ministry of Agriculture and Agrarian Reform's (MAAR) resolution No./2823/ Dated 29/8/1990. This resolution prevents growing vegetables irrigated with wastewater whatever its source was. Accordingly, the use of wastewater was restricted to fodder, industrial crops and fruit trees on small-scale areas, resulting in large damages to agricultural environment such as deterioration of groundwater quality and soil composition as well as damages to public health (insects, rodents, diseases). Total areas irrigated with untreated wastewater are estimated to 32 thousand ha, constituting 2.2% of total irrigated areas, owing to the environmental and health risks of this kind of water. Table 8 presents the total areas irrigated with untreated wastewater in Syria.
- 36.2% of total wastewater is lost to final water bodies (valleys, sea).

Table 8. Areas irrigated with untreated wastewater

Province	Area (ha)	Farming
Rural Damascus	3654	Fruit trees, fodder crops, vegetables eaten cooked
Quneitra	-	No sewerage systems except for al-Ba'ath city, and Khan Arnabeh and Qahtaniah villages. Wastewater is disposed in al-Raqqad valley
Dera'a	-	Wastewater is discharges to the following valleys (al-Zeidi, al-Ghar, al-Arram, Abu al-Laban, al-Ghazali)
Sweida	-	Wastewater is disposed in the open
Homs	1960	Winter and summer crops, fruit trees., Wastewater is discharges within irrigation channels branched from the Orontes river
Hama	159	Wheat, cotton, maize, sunflower, peanuts, fruit trees
Al-Ghab	224	Wastewater is discharged via closed sewers and disposed in the Orontes river
Idleb	2000	Cotton, wheat, sunflower
Aleppo	19400	Wheat, cotton, maize, fruit trees, vegetables eaten cooked. Wastewater is discharged toward Qweiq, al-Sajour and Ifrin rivers.
Raqqa	2115	Winter and summer crops, limited vegetables
Deir Ezzor	-	-
Hassakeh	1800	Cereals, cotton, vegetables eaten cooked
Tartous	-	Wastewater is discharged in the sea
Lattakia	500	Citrus, summer vegetables. Wastewater is discharged in the sea

3. JUSTIFICATIONS OF WASTEWATER UTILIZATION AND REUSE FOR AGRICULTURAL IRRIGATION IN SYRIA

- Disposal of water resulting from population and urbanization development through practical and studied way.
- Wastewater reuse can be considered as an additional source by which irrigated area can be increased despite its restrictive use, due to special considerations, for certain crops, so that high-quality water can be saved for domestic and other purposes.
- Marginal costs of good quality additional water provision with the same amount of wastewater is generally higher than that of wastewater. Hence, wastewater treatment is necessary where it is used as efficient and useful as possible.
- The safe and intended use of wastewater could reduce the associated environmental and health risks.
- Wastewater can provide supplementary irrigation for crops, hence increase their yield accordingly.
- Wastewater can provide nutrients for soil and plant especially nitrogen and phosphor, decrease the overall needs of commercial fertilizers, and increase the economic revenues for the farmers.

4. NEGATIVE EFFECTS OF WASTEWATER (TREATED AND UNTREATED) USE AND PROTECTIVE MEASURES

4.1. Negative Effects

There is a range of water quality related problems in most water basins, including:

- Disease outbreak as a result of improper use of wastewater for irrigating crops exceeded one million waterborne infections in 2003, of which 5781 typhoid and 34629 diarrhea for the under-five children.
- Increasing non-infectious diseases (toxicity, cancer) resulting from irregular industrial wastewater.
- Degradation of water ecosystems due to river water pollution resulting in unpleasant smells, insects and rodents, and this reduces the economic and recreational value of river and the nearby areas together with diseases outbreak.
- The concentration of BOD, ammonia and nitrates exceeded the adopted criteria of river water in most observatories at most time round the year due to sewage water and industrial water disposal in some rivers without treatment.

- Contamination of groundwater (wells) in certain areas with toxic elements such as NO_3-N, Ni, Cr and other toxic elements.
- Degradation and salinization of agricultural lands along with high concentration of heavy and toxic metals as a result of irrational use of wastewater and drainage water.

The negative effects are not restricted to untreated wastewater reuse, but there are other effects resulting from treated wastewater reuse for several reasons:

- Design failures in some plants.
- Repeated damages in some plant components.
- Overlapping in treatment plant works by governmental agencies.
- Unavailability of a specialized central lab for conducting lab analysis necessary for work monitoring and mechanism control in plants and their related channels.
- Treated wastewater users' lack of awareness on handling method.
- Violation of laws (if any) controlling growing crops with this water by some treated wastewater users.
- Lack of laws and legislation controlling the work mechanisms of these plants and how to utilize their resultant effluents.
- Non-adoption of environmental management principles to reduce and eliminate the contaminants in the source, and wastewater reuse and recycling in industries.
- Non-application of the "polluter pays" principle and the assessment of environmental impact effectively.
- Lack of trained staff for monitoring the closed circuits in the industrial structures.
- Lack of specialized technical staff for the management, operation and maintenance of treatment plants, and for monitoring and analysis of solid, liquid and gas wastes.

4.2. Precautionary Measures Against Negative Effects

- Treatment of human, industrial and agricultural wastes before use or disposal, in compliance with the international standards and criteria needed for irrigation water.
- Limitations that identify the appropriate growing of agricultural crops: processing, fodder, forestry, ornamental.
- Selection of appropriate irrigation methods that provide water duty and reduce pollution hazards by ceasing gravity irrigation and all irrigation processes at least two weeks prior to crop harvesting.
- Dissemination and promotion of health/environmental awareness for farmers and consumers via society institutions and media, and strengthening them to participate actively in environment protection and their own protection.
- Establishing a network for epidemic monitoring in order to identify the diseases resulting from water pollution and their relation to environmental pollution studies in the considered areas.
- Following up the intensive scientific research for studying the parasite and bacteriological pathogens, and their spread methods and effects on plant, animal and human, associated with full viral study.

5. INSTITUTIONS RESPONSIBLE FOR WATER SECTOR IN SYRIA

In Syria, water sector is managed by several institutions and ministries with slight overlapping in responsibilities.

- **Ministry of Irrigation (MoI)**

MoI and its directorates in the provinces are responsible for water management and development together with routine monitoring of surface and groundwater quality and water provision for irrigation purposes.

- **Ministry of Agriculture and Agrarian Reform (MAAR)**

It is in charge of the economic use of water for irrigation purposes in the agricultural areas, including the search for modern techniques that reduce water losses and growing low-water consumption and salinity-tolerant crops.

- **Ministry of Housing and Construction**

In charge of supplying the rural and urban areas with drinking water and wastewater treatment.

- **Ministry of Environment and Local Administration**

In charge of monitoring water quality and developing the criteria necessary for water resource protection.

Each of the above ministries has a number of representative directorates at province or basin level. For example, MoI has General Directorate of the Basin & Directorate of Wastewater Pollution Control in each province.

Ministry of Environment has specialized directorates for water protection and waste management.

Ministry of housing, in all Syrian provinces, has General Companies for Drinking Water and Sanitation; the same is for the General Company for Sewage Water.

6. RESEARCH PROJECTS EXECUTED IN COLLABORATION WITH INTERNATIONAL ORGANIZATIONS LIKE UNDP, FAO, JICA, IDRC…. ETC

A number of projects were executed in collaboration with international organization in the field of water resource management and use rationalization, of which:

- On-Farm Demand Side Management of Conventional and Non-conventional WRs – SYR/98/007 Project in collaboration with UNDP.
- Integrated Watershed Management – SYR/98/003 Project in collaboration with UNDP.
- Strengthening the Technical Capacity in the Field of Treated Wastewater Reuse for Irrigation Purposes, in collaboration with FAO.

6.1. Objectives of the Above-mentioned Projects

These projects aimed at promoting the government's goal of a sustainable increase of agricultural production and improved rural income by using conventional and non-conventional WRs in a sustainable, safe and environmental friendly manner:

- To strengthen at local-level technical institutional capabilities for the actual projects of conventional and non-conventional WRs projects.
- To evaluate the farmers' perceptions of the use of wastewater in agricultural production and their involvement in different water management stages at farm level.
- To strengthen the research programmes related to non-conventional WRs.
- To find the local criteria, guidelines, and recommendations for the optimum treatment, reuse, management and disposal of wastewater and drainage water.
- To study the environmental impacts of treated wastewater reuse on human health, soils, and groundwater.

6.2. Important Achievements

- Contribution to sustainable increased agricultural production and improved rural income by developing a number of researches aiming at water use rationalization for irrigating agricultural lands by means of modern irrigation techniques as compared to other traditional methods in a bid to obtain specific results, showing the preference of some techniques to others. This primarily aims at country's water budget conservation and optimum use for expanding the cultivated area, meeting the food security, and increasing the farmers' economic income and country's national income accordingly.
- Safe reuse of treated wastewater and drainage water for irrigation agricultural lands by conducting several trials on this low-quality water and the linkage between their quality and crop and crop productivity on one hand, and irrigation systems used on the other hand. At the same time, the environmental impacts of this low-quality water on groundwater, pollutant and salt

accumulation in soil and on human health and society, together with farmers, technicians and engineers' training on handling with kind of water were addressed.

- Awareness of large-scale sectors of population including farmers, technicians and engineers from different ministries (Agriculture, Health, Environment, Housing) on the hazards of low-quality water irrigation. This had been done via educational meetings, field days, seminars, local and abroad training courses and study tours.

It is clear that these programmes have effective contribution to strengthening national capacity, implementation of projects and their objectives realization, and training of several generations of farmers for the next long-term years.

a. Reconnaissance of farmers' opinion and evaluation of their perceptions on the use of wastewater in agricultural production and their involvement in different stages of irrigation management.
b. The government and farmers' benefit (ministries of agriculture, housing and health) through the programmes of strengthening the society capacity on experimental research in the field of irrigation agriculture using drainage water and treated wastewater and the impact of this water qualities on groundwater storage, the overall impact on agricultural production and society health, water availability for sustaining the country development and money saving by reducing the need for chemical fertilizers, and the safe disposal of wastewater by more positive and economic manner.
c. Implementing a permanent research programme related to:
    - Monitoring of groundwater quality and development according to the exploitation level.
    - Monitoring of groundwater bacteriological pollution resulting from treated wastewater use in irrigation.
    - Following up the changes of heavy metals concentrations in groundwater.

7. MEASURES NECESSARY FOR WATER RESOURCE POLLUTION CONTROL AND SAFE AND ENVIRONMENTALLY SOUND UTILIZATION OF TREATED AND NON-TREATED WASTEWATER

For better utilization of non-conventional WRs and meeting more than 80% of water shortage in water balance for a dry year, the government took a range of measures at policy, institution, utilization, training and information levels:

Policy

- Completing the development of legislation related to water that would be discharged to water bodies and forcing the industrial sectors to do so.
- Starting the application of the "polluter pays" principle and environmental impact assessment.
- Implementation of government plan related to economically efficient wastewater treatment in Syria.
- Adoption of environmental management principles in order to control and reduce the contaminants at source, and wastewater reuse and recycling in industries.
- Use of closed circuits techniques in the industrial structures.

Institutional Measures

- Promoting coordination processes between the ministries concerned with water resource management and utilization.
- Ensuring the monitoring of water resource quality.
- Developing the inspection process of industrial structures and their commitment to national legislations.

Utilization Measures

- Implementing model projects for wastewater treatment plants in villages and countryside.
- Implementing model plants for industrial water treatment in the public sector.

- Establishing industrial zones with environmental and health conditions and providing them with common treatment plants, and creating motives for movement to the industrial zones (under implementation).
- Developing an integrated plan for industrial water management in line with water legislations.

Training and Informatics

- Training on operation and management (O&M) of wastewater treatment plants.
- Training on environmental impact assessment.
- Training on monitoring and analysis of solid, liquid and gas wastes.

8. CONCLUSIONS

- Non-conventional WRs, in Syria, are restricted to drainage water and wastewater.
- Agricultural sector is the largest consumer of conventional and non-conventional WRs.
- Wastewater amount, in Syria, is estimated to be 1.2 billion m^3/year and drainage water 1.536 billion m^3/year.
- 29.2% of wastewater is treated, 34.6% is used without treatment, and 36.2% is lost by discharge to water bodies and valleys.
- The need for establishing treatment plants at small community level with population (5000 – 10000) to make use of water randomly lost, contaminating the environment.
- Lack of crucial local criteria for wastewater use in agriculture. The existing criteria are merely indicators and preliminary guidelines that can be developed through research activities.
- The appearance of a number of environmental, health and economic problems as a result of improper and irrational use of wastewater.
- The essential pre-requisites for the development of safe non-conventional water use lie in the development of institutional and legislative aspects together with training, information and others.

9. RECOMMENDATIONS

- Implementation of pilot projects for the optimal utilization of conventional water and giving top priority to the most critical and urgent issues.
- Establishment of small treatment plants in the regions where population is between 5000 – 10000,and supplying these plants with all equipment necessary for the proper use of treated wastewater in agricultural irrigation.
- Supporting scientific and research centers and institutions for conducting integrated and applied water research and studies since these centers and institutions are an integral part of the institutional structures responsible for water resource development and utilization.
- Training of technical and scientific staff and giving special consideration to skill upgrading, performance promotion and capacity improvement.

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