Towards Sustainable Treatment and Reuse of Wastewater in the Mediterranean Region

SWOT Analysis of local Governance Framework
Case of AQUACYCLE Demo-sites (Lebanon, Spain and Tunisia)

(Output 3.1)

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AQUACYCLE

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The European Union is made up of 28 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders.

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Executive Summary

The present document brings the analysis of the **Strengths, Weaknesses, Opportunities and Threats (SWOT) of the local Governance Framework** in the three countries where the APOC demonstration pilots are planned to installed, i.e. Lebanon, Spain and Tunisia.

The first chapter places the scope of the present SWOT analysis in the context of the overall aim and the specific objectives of Work Package 3 'Preparing for participatory decision-making'.

Chapter 2 elaborates briefly on the rationale for the SWOT analysis to be based on a desk review of available reports and assessment studies and interviews with representatives of the public authorities involved at the national, regional and local level. This is followed by a detailed description of the roles and involvement of the main stakeholders' groups in Chapter 3, while Chapter 4 brings an overview of the regulatory framework for sanitation, wastewater treatment and reuse in agriculture in the respective countries. Chapter 5 informs on the semi-structured questionnaire that was elaborated for the purpose of interviewing the main stakeholders in each country and reports on the outcomes of the 15 stakeholder interviews that were conducted.

Chapter 6 presents the outcomes of the SWOT analysis of the eco-innovative wastewater treatment technology brought by AQUACYCLE, (for technical details on the technology see Output 4.1 APOC technical guide). In turn, these outcomes provided a solid basis for the elaboration in Chapter 7 of forward looking strategies for the Mediterranean Region as a whole and for the targeted case study countries in particular. Finally, overall conclusions and recommendations are provided in Chapter 8.

Abbreviations

AD	Anaerobic Digestion
ANCSEP	Agence Nationale de Contrôle Sanitaire et Environnemental des Produits
ANPE	Agence nationale de protection de l'environnement
APOC	Anaerobic Digestion, Photocatalytic Oxidization, Constructed wetlands
CDR	Conseil du Développement et de la Reconstruction
CERTE	Centre des Recherches et des Technologies des Eaux
CERTH	Centre for Research and Technology Hellas
CITET	Centre International des Technologies de l'Environnement de Tunis
CW	Constructed Wetlands
DGGREE	Direction générale du génie rural et de l'exploitation de l'eau
DGRE	Direction Générale des Ressources en Eau
DHMPE	Direction de l'Hygiène du Milieu et de la Protection de l'Environnement
ELV	Environmental Limit Values
GDA	Groupements de Développement Agricole
GIS	Geographic Information System
INRGREF	Institut de Recherche en Génie Rural, Eaux et Forêts
NGO	Non-Governmental Organization
NCWR	Non-Conventional Water Resources
ONAS	Office National d' Assainissement
PGIS	Participatory Geographic Information System
SAR	Sodium Absorption Rate
SWOT	Strengths, Weaknesses, Opportunities and Threats
SWWTR	Sanitation, Wastewater Treatment and Reuse
TWW	Treated Wastewater
WWMS	Wastewater Management System
WP	Work Package
WWTPs	Wastewater Treatment Plants

1. SCOPE OF THE SWOT ANALYSIS

The SWOT Analysis of local Governance Framework (Output 3.1) had been performed for the three countries (Lebanon, Spain and Tunisia) where the APOC system will be implemented in demo-sites in the context of the AQUACYCLE project. This output is related to the activity 3.1.1 concerning the Review of Governance Framework and 3.1.2 Interviews of main stakeholders. These activities have been conducted in preparation for the Collection of stakeholders' expectations and training needs on the new technology which will be our next specific objective: i.e. to set up a prototype webGIS to collect bottom-up inputs for the reuse of treated effluent and to develop the prototype into an operational decision-support tool across borders. Jointly, these objectives and their related activities will contribute to the overall aim of WP3, which consists in preparing the ground for a truly participatory planning process to implement the new wastewater treatment technology (APOC) through the use of Participatory GIS (PGIS).

2. INTRODUCTION

The Mediterranean region is characterized by common issues related to environmental and development problems, in particular, concerning water resources management, their development and pollution control. However, the two shores (North/East and South) of the basin are strongly contrasted and face the arising issues differently. The wastewater management system (WWMS) has to be significantly improved to meet sustainability requirements. Indeed, we have to shift from a WWMS focused on meeting the demand for treatment and safe discharge of the water to prevent the pollution and spread of disease to a WWMS focused on achieving a 'closed loop' through initiatives such as water recycling and reuse. This is especially true for locations where the available supply of fresh water has become inadequate to meet water needs.

This objective cannot be met without joining efforts of all stakeholders in a participatory bottom-up approach so as to create opportunities to:

- ✓ improve current wastewater management practices;
- ✓ increase social acceptance and favourability for reuse;
- ✓ create a potential for replication in terms of environmental conditions, lifestyles and building styles, and
- ✓ enhance the institutional support and the involvement of NGOs.

We intend to perform a concise overview of the main **strengths**, **weaknesses**, **opportunities** and **threats** as derived from the institutional, policy and regulatory framework governing wastewater treatment and the use of treated effluent in the pilot case studies. The SWOT analysis will be based on a desk review of available reports and assessment studies and interviews with representatives of the public authorities involved at the national, regional and local level (their role and involvement will feed into the WP2 Who's Who Catalogue).

3. STAKEHOLDERS' ANALYSIS

3.1 Definition

We define stakeholders as the people and organizations who affect or are affected by a decision; Stakeholders can be directly or indirectly involved in an endeavour.

3.2 Stakeholders identification

An analysis of the stakeholders for AQUACYCLE project has identified the individuals, groups and organizations that will be influenced and affected by the collection, treatment and reuse of wastewater projects. These stakeholders include:

- government ministries and agencies,
- regional authorities
- NGOs

A desk review of the institutional and regulatory framework, identified the stakeholders considered to be the key players and determined their interests in relation to collection, treatment and reuse of wastewater. Their capacities and mandates have been analyzed and their role and involvement with regard to the drawing up of strategies, policies, implementation, operation and control of wastewater management has been assessed according to whether their level of influence is high, medium or low. The analysis has identified the potential participants and the *modus operandi* of their involvement.

3.3 Description of the main stakeholders' groups in the three countries of the Demo-sites

3.3.1 Lebanon

The main stakeholders involved in the wastewater sector in Lebanon, include the following:

3.3.1.1 Government Ministries and Agencies

Numerous government institutions, ministries, autonomous agencies and municipalities are involved in policy-making, planning and the management of the waste sector in Lebanon. This includes the Ministry of the Environment, the Ministry of Energy and Water, the Ministry of Agriculture, the Ministry of health, the Ministry of Industry, the Council of Development and reconstruction, CDR, the four regional water establishments formed in 2002 (North Lebanon, South Lebanon, Beirut and Mount Lebanon and Bekaa)

and the Litani River Authority charged with the provision of the irrigation requirement in Litani Basin and South Lebanon districts.

3.3.1.1.1 Ministry of Environment (MoE)

About greening the waste sector, aside from the Council of Ministers, the most central government ministry is the **Ministry of Environment** (MoE). Its duties are to formulate a general environmental policy and propose measures for its implementation in coordination with the various concerned government administrations; to protect the natural and man-made environments in the interests of public health and welfare; and to fight pollution by taking preventive and remedial action. Within MoE, waste management issues fall under the Service of Urban Environment (Department of Urban Environmental Pollution Control) with the tasks to:

- review studies and tender documents related to solid waste and wastewater treatment plants;
- participate in committees linked to solid waste treatment facilities and landfills;
- prepare and formulate Master plans for the management of MSW;
- define environmental limit values for the disposal of non-hazardous solid and liquid waste in water bodies and on soil.

3.3.1.1.2 Ministry of Energy and Water Resources (MEWR)

The **Ministry of Energy and Water** is in charge of electricity, water, wastewater, irrigation and stormwater drainage projects. The **Four Water Establishments and the Litani River Authority** are acting under its auspices. (www.litani.gov.lb)

Regional water establishments: its mission is to meet the regions' water supply needs and protect water sources by:

- Protecting and properly utilizing the water resources of the Establishment, through the conservation of groundwater sources and the reduction of water losses and non-revenue water in the water supply systems.
- Increasing coverage of water supply and sewerage services in un-served areas of the Establishment, where it is economically practical.
- Applying the best practices of commercial behavior for water supply and sewerage services through the adoption of sound business principals to achieve full cost recovery from revenues and collections.

- Acting to raise water awareness through the implementation of public education programs; and encouraging the exchange of information to allow for transparency in the decision-making processes of the establishment.
- Motivating the staff of the establishment by rewarding good performance.

Litani River Authority: Since its establishment, the Litani River Authority was considered to be a public institution whose functions are identified as follows:

- Implement the Litani irrigation, drying, drinking water and electricity projects.
- Establish a network linking up power stations in Lebanon.
- Establish electrical substations and distribution lines in all the Lebanese regions.
- Invest in the different parts of the project at both the technical and the administrative levels.

The Litani River Authority was also considered to be a public institution with an administrative and financial personality and autonomy.

Other decrees and decisions gave the Authority other functions, namely:

- Ensure water monitoring in all Lebanese rivers.
- Examine, manage and exploit the irrigation water in Central and Northern Bekaa, including the Yammouneh and Wadi Massa-Yahfoufa project.
- Study and scan the locations of dams in the northern Lebanese rivers.
- Study the blueprint of the agriculture water plan for South Lebanon in collaboration with the Food and Agriculture Organization (FAO).

3.3.1.1.3 Ministry of Interior and Municipalities (MoIM)

MoIM represents the municipalities on a national level, the latter of which ultimately are responsible for collection and disposal activities in Lebanon. Governors' offices, municipalities and unions of municipalities collaborate in solid waste and wastewater related activities, environmental monitoring, enforcement of environmental guidelines, contribution to awareness raising and assessments, and in support of rapid response in case of disease outbreaks and other emergencies.

3.3.1.2 Public sector

This category includes Municipalities. It has been separated from the Governmental agencies because municipalities are not employees of the government but elected by the population. However,

Municipalities report to the government and in practice all municipal decisions and activities have to be endorsed by the Ministry of Interior and Municipal Affairs and their relevant funds disbursed by the Ministry of Finance.

Council of Development and reconstruction, CDR: which is established in 1977, reports directly to the Council of Ministers and is the lead agency in charge of national planning and infrastructure project design and implementation in all sectors, including SWM and wastewater treatment. Almost 85% of foreign funds earmarked for reconstruction transit through CDR.

3.3.1.3 Private sector

This includes the private companies, which may provide design, construction, and/or operation services of sewerage systems, be it full scale or package units. Furthermore, training institutions are considered stakeholders, as there is a pressing need to build the capacity of everyone involved in the wastewater sector on the operation and maintenance of sewerage systems.

3.3.1.4 Donors and international organizations

This includes, for example, the European Community, the USAID, and international organizations whose work may benefit the achievement of the wastewater objectives, such as the Global Environment Facility (GEF) which places strong emphasis on international waters, and which may provide funding for reducing the pollution load to the Mediterranean.

3.3.1.5 Beneficiaries

This refers to the people who will be served by the wastewater projects developed as a part of achieving the sector objectives. This category also includes the farmers who will use the treated wastewater for irrigation purposes, and owners of large industrial firms for which pre-treatment of industrial wastewater may be required.

3.3.1.6 Research institutes and universities

This includes both private and public research bodies, which can provide assistance in devising means to improve the performance of the wastewater management scheme during all of its phases, including collection, pumping, treatment, and final disposal.

3.3.2 Spain and Murcia region

The main stakeholders involved in the wastewater sector in Murcia Region, include the following:

3.3.2.1 General State Administration

The **General State Administration** is in charge of the national planning for the water, lays down the national rules in water, and coordinates with the Autonomous Communities. Several Ministries are involved: MITECO (Ministry for the ecological Transition) is in charge of the environmental aspects. Agriculture Ministry is in charge of the water issues related with agriculture. Health Ministry establish the principles for preserving human health and it´s in charge of drinking water and water reuse monitoring.

3.3.2.2 Basin Agencies (Confederaciones de Cuencas Hidrográficas)

Basin Agencies (Confederaciones de Cuencas Hidrográficas) are in charge of planning, constructing and operating major water infrastructure such as dams; elaborating basin plans; setting water quality targets, as well as monitoring and enforcing them; granting permits to use water, as well as inspecting water facilities for which permits were granted; undertaking hydrological studies; and to provide advisory services to other entities at their request. Basin Agencies are headed by a President who is nominated by the Cabinet at the proposal of the Minister of Environment. Each agency has a Board, a user assembly and a council to ensure broad participation by various stakeholders in its decision-making process, both in planning and operations. There are 15 Basin Agencies in Spain for rivers that flow through more than one autonomous community. If a river runs entirely within the territory of an autonomous community the water administration of the respective autonomous community, instead of one of the basin agencies, is in charge of managing its water resources. This is the case in Galicia, Catalonia, the Balearic Islands, the Canary Islands, the Basque country and Andalusia.

While Basin Agencies do not provide water and sanitation services, they play an important role in determining the framework for the provision of such services.

3.3.2.3 Regional authorities

Depending on the Regional Law, municipalities and regional bodies can share some responsibilities in matter of water. This is the case of Murcia Region where, regarding wastewater treatment, a body of Regional Government that can manage WWTPs by agreement with municipalities.

In addition, the planning of wastewater treatment system is carried out for Water Directorate, which is a part of the Water Regional Ministry.

3.3.2.4 Municipalities

Service provision is the responsibility of more than 8,000 municipalities in Spain, unless Regional Law enable other regional public bodies to carry out this task. Municipalities can provide services directly or through a municipal public company (54% of market share), or through concessions to a mixed public-private company (13%) or a private company (33%). In some cities, water supply is the responsibility of a company, while sanitation services are provided directly by the municipality. This is the case, for example, in Barcelona.

Other relevant point for the municipalities is the control of industrial discharges, key point for an adequate performance of the WWTPs.

3.3.2.5 Public and Private-Public Companies

The main water service provider in Spain is Aguas de Barcelona (Agbar), a private company that provides water services to about 13 million people in more than 1,000 localities under concession contracts. Sewer services are provided to 8.25 million people in 365 localities, and wastewater treatment is carried out for 9.3 million people in 445 localities. Its main competitor is Aqualia. The largest public water company is Canal Isabel II that serves the metropolitan area of Madrid.

3.3.2.6 NGOs and Associations

Spanish water and sanitation association (AEAS)

The Spanish Association of Water Supply and Sanitation, is a professional non-profit association for the promotion and development of scientific, technical, administrative and legal aspects of urban water and sanitation services.

Its origin dates back to 1971, when the members of the Spanish Committee of the International Water Supply Association (IWSA) decided to establish a national association that, in the image of the international association, took care of all facets of the urban water cycle.

It currently has 330 associates and the operating entities integrated in the association serve more than 35 million inhabitants in more than 1,700 Spanish municipalities.

Spanish Association of Water Sustainable Reuse (ASERSA)

ASERSA is a non-profit association that was created with the objective of promoting the efficient use of water resources through the sustainable reuse of water. It generates, contributes to its generation and make available to users the scientific knowledge and technical means necessary for optimal water reuse,

and encourage institutional collaboration for the effective development of technologies related to the activity of water regeneration and reuse.

3.3.2.7 Research institutes and universities

This includes both private and public research bodies, which can provide assistance in devising means to improve the performance of the wastewater management scheme during all of its phases, including collection, pumping, treatment, and final disposal.

In Murcia Region, due to the scarcity of water, this is a topic of high interest in the region, as also everything related with the agriculture.

3.3.3 Tunisia

The national stakeholders involved in wastewater treatment and reuse in Tunisia are the following:

Ministry	Entities	Website
Ministry of Local Affairs and Environment ***http://www.environnement.gov.tn***	• The National Sanitation Utility (ONAS) • Tunis International Center for Environnemental Technologies • National Agency for the Protection of the Environment (ANPE) • Ministry Department of environment and life quality, • Ministry Department of Regulations, Cleanliness and Environmental Protection, • Municipalities,	*www.onas.nat.tn* *www.citet.nat.tn* *www.anpe.nat.tn*
Ministry of Agriculture, Hydraulic Resources and Fisheries ***http://www.agriculture.tn/***	• Directorate General of Rural Engineering and Water Exploitation (DGGREE), • Directorate General of Water Resources (DGRE), • Company of Waterway Operation and Northern Waters transfer (SECADENORD), • Regional Commissariats for Agricultural Development (CRDA) • National research Institute of Rural engineering, Water and Forests (INRGREF)	*www.agriculture.tn/* *www.inrgref.agrinet.tn/*
Ministry of Industry and SMEs	• Tunisian National Institute for Standardization and Industrial Property	*www.innorpi.tn*

Ministry	Entities	Website
Ministry of Higher Education and Scientific Research	• Directorate General for Research Results Valorization • Directorate General for Scientific Research • Water Researches and Technologies Centre • Biotechnology Centre of Sfax	www.mes.tn www.certe.rnrt.tn www.cbs.rnrt.tn
Ministry of Health	• Directorate of Hygiene and Protection of the Environment	www.santetunisie.rns.tn
NGOs	• Agricultural Development Group (GDA Sidi Amor) • Tunisian Union of Agriculture and Fisheries • Sanitation, water and Development Association	www.sidiamor.org/gda1/

3.3.3.1 Government Administration and Related Structures

The institutional framework for wastewater management (raw and treated) includes several actors at national, regional and local levels.

3.3.3.1.1 Ministry of Local Affairs and the Environment

It develops the regulatory framework for wastewater management. It is in charge of establishing treated wastewater discharge standards and participates in those relating to their reuse. The ministry includes several agencies and institutions under its supervision:

3.3.3.1.1.1 Sewerage National Utility (ONAS)

ONAS is the key player in the field of wastewater management: it is the main producer of treated wastewaters. It is essentially on the quality of the treated wastewaters that their reuse depends. ONAS was established in August 1974. It is a public industrial and commercial establishment endowed with civil personality and financial autonomy. It is responsible for protecting the water environment in the areas covered by its prerogative assignments (municipalities and areas of tourist and industrial development). It ensures the management, operation, maintenance, renewal and construction of any work intended for the sanitation of cities such as treatment plant, outfall at sea, pumping stations and wastewater collectors. Currently, ONAS has started to delegate to private operators the activities of operation and maintenance of its sewerage network and its works (approximately the exploitation of 2000 km of

networks and Eleven (11) treatment plants is conceded to private sector). **Article 2 of law 93-41 of 04/19/1993 relating to ONAS**, explicitly includes among the attributions of ONAS **« promotion of the distribution and sale of treated water, sludge from treatment plants and all other by-products»**. Treated wastewater reuse (TWWR) is one of the objectives of ONAS. Numerous projects and actions have been launched to maximize the reuse of treated wastewater. ONAS provides the Treated wastewater free of charge. In 1993, a unit specifically dedicated to the recovery of Treated wastewater was created within ONAS, at the Central Wastewater Treatment and Recovery Department.

3.3.3.1.1.2 National Environmental Protection Agency (ANPE)

ANPE intervenes in the approval of environmental impact studies of projects for the execution of treatment plants and those for irrigation using treated wastewater. It monitors releases and ensures compliance with standards. It also intervenes in the control of industrial pollution.

In accordance with Decree 2273-1990 of December 25, 1990, relating to the status of expert controllers of the National Agency for the Protection of the Environment, they are responsible for regularly carrying out control operations on all sources of pollution and monitoring the state of the environment throughout the Tunisian territory. The Agency carries out sectoral control campaigns and instant controls, following complaints or requests from other institutions such as ONAS, etc.

3.3.3.1.1.3 National Agency for Coastal Protection and Planning (APAL)

APAL was created in 1995 with the mission of executing state policy in the field of coastal protection in general and the maritime public domain in particular. Its main areas of intervention are:

- Management of coastal areas and monitoring of development operations for these areas, their use and occupation,
- Regularization and clearance of existing land situations on the date of creation of the APAL,
- The preparation of studies relating to the protection of the coast and the enhancement of natural areas and the development of the necessary research, studies and expertise,
- Observing the evolution of coastal ecosystems.
- APAL exercises control over TWW discharge works.

3.3.3.1.1.4 International Center for Environmental Technologies of Tunis (CITET)

The mission of **CITET** is to acquire, adapt and develop new techniques, to promote eco-technologies and their production, to strengthen national capacities and to develop the scientific knowledge necessary for the development and implementation of point of environmental techniques appropriate to specific

national and regional needs, with a view to sustainable development. It is responsible in particular for the transfer, adaptation and development of environmental techniques (including those of wastewater treatment, waste management and recovery) and their availability to users at national, regional or international level.

3.3.3.1.2 Ministry of Agriculture, Water Resources and Fisheries (MARHP)

MARHP is the department responsible for the water sector. It is responsible for the management of water resources. It is also a key player in the reuse of treated wastewater.

The Ministry authorizes the use of TWWs for agricultural purposes and fixes the list of crops by decree. It draws up, jointly with the Ministry of local Affairs and the Environment (MALE) and the Public Health Ministry (MSP), the specifications setting the terms for the reuse of treated wastewater. It is responsible for the execution of irrigation scheme for development projects, the operation and maintenance of works and equipment as well as the distribution of water to farmers.

3.3.3.1.2.1 Directorate General of Water Resources (DGRE)

DGRE is in charge of the water resources inventory and administers the authorizations for the exploitation of underground resources. It manages the measurement and observation networks for the various components of water resources. It is responsible for surface and underground water resources as well as the preservation of water quality. It participates in the selection of effluent disposal sites and irrigation sites.

The Directorate of Unconventional Waters and Artificial Aquifer Recharge is responsible, within the DGRE, for the quantitative and qualitative evaluation of unconventional water resources, mainly brackish water and wastewater, and for the preparation of studies to promote the exploitation of these resources.

3.3.3.1.2.2 General Directorate of Rural Engineering and Water Exploitation (DGGREE)

DGGREE with its districts for Rural Engineering (GR) and public irrigated areas at the Regional commissioners for agricultural development (CRDAs) in each Governorate, ensure the studies, management and distribution of rural water and in particular irrigation water including TWW. It has among its attributions, the rationalization of the use of water and the development of unconventional water. CRDAs finance and build the water supply infrastructure for the various areas from the treatment plants. They provide irrigation water to farmers and partially recover the costs of operating and maintaining water transfer infrastructure and apply the texts and regulations in force. CRDAs delegates the irrigated areas management to community management.

3.3.3.1.2.3 Institution for Research and Higher Education in Agriculture (IRESA)

In the field of agricultural development of unconventional waters, the National Institute for Research in Rural Engineering, Water and Forests (INRGREF) is the first research structure to be interested in this field since the 80s. It contributes to the promotion of EUTs through research on the impacts of TWWs on plants and soil and groundwater as well as on methods of improving the quality of TWWs. It works on its experimental stations and on irrigated perimeters for farmers. It also provides training sessions and hosts information days.

Other institutions higher education in agriculture that belong to IRESA are also active in the sector mainly Tunisian National Institute of Agronomy (INAT), Higher Education School for rural Engineering of Mejez El Bab (ESIER), and Higher Education School of Agronomy of Mograne (ESIM) etc.

3.3.3.1.3 Public Health Ministry (MSP)

MSP ensures health control. It intervenes at the level of the irrigated plot in the TWW and the receiving environment. It controls TWW, crops and groundwater. Its control aims to protect users, workers, the public, consumers and the environment.

3.3.3.1.3.1 Directorate of Hygiene and Environmental Protection (DHMPE)

DHMPE represents the main MSP actor. At the regional level, the Regional Directorate of Public Health represents DHMPE. The hygiene services carry out epidemiological studies, health education and prophylactic campaigns. The role of the Ministry of Public Health is crucial in the area of TWW reuse. The confidence of the people and their perception of the health risks linked to reuse depend on the effectiveness of its action.

3.3.3.1.3.2 National Agency for Sanitary and Environmental Control of Products (ANCSEP)

ANCSEP created in 1999 as a public institution under the Ministry of Public Health, has the mission to:

1) ensure the compliance with regulations and national and international standards for health and environmental control of products,
2) take decisions concerning the application of standards and rules in force and in particular those relating to processes and results analyzes,
3) contribute to training and health control information and environmental impact of products.

3.3.3.1.4 Ministry of Industry and Small and Mean Enterprises (MIPME)

MIPME intervenes in pre-treatment of industrial wastewater and by setting the normalization of wastewater reuse via the National Institute for Standardization and Industrial Property (INNORPI). The

Institute mission is "to undertake all actions concerning standardization, the quality of products and services and the protection of industrial property"

In this context, the Institute:

- Centralizes and coordinates all work, studies and surveys in these various fields. It plays a role of information and training
- Establishes, in collaboration with the bodies concerned, the general program for developing standards, creates technical standardization committees, organizes their work within it and provides the secretariat. INNORPI is the national information point on standards.
- Certifies compliance with standards for products, services and management systems and manages national standards compliance marks.
- Issuing invention patents, registering trademarks, service marks and industrial designs.
- Receives and records all acts affecting industrial property rights.
- Maintains the central trade register.
- Represent Tunisia to the International Organization for Standardization, ISO, the International Electrotechnical Commission, IEC and the World Intellectual Property Organization WIPO.

3.3.3.1.5 Ministry of Higher Education and Scientific Research (MESRS)

Water Research and Technology Center (**CERTE**) is the main actor representing **MESRS** in research on Water and Wastewater domain.

CERTE is responsible for carrying out research and technological development in the water sector and their integration in the economic and social field. CERTE is responsible for the following activities (article 2, Decree N ° 337/2005):

- Carry out research projects and research programs under a Program-contract signed with the government.
- Undertake, at the request of ministries, national and international institutions, establishments and public and private companies, any research, experimentation or expertise in the field of water.
- Develop, improve of manufacturing processes or production equipment for the improvement of water quality,
- Develop and improve water treatment and recycling processes and technologies,
- Promote Research on the Treatment and improvement of the quality of unconventional waters, etc.

- Promote research for sustainable water governance.

4. REGULATORY FRAMEWORK FOR SANITATION, WASTEWATER TREATMENT AND REUSE IN AGRICLTURE

4.1 Lebanon

4.1.1 Environmental framework

The environmental framework of Lebanon is managed and supervised by the Ministry of Environment (MOE) that was created by law 216 of April 2nd 1993, to be the Government institution responsible for the development of a national strategy for sustainable development. The MoE is undergoing several review procedures to up-date the country's environmental policies and regulations including the preparation of an Environmental Impact Assessment (EIA) decree, as well as norms and standards for environmental protection.

Existing laws and regulations for environmental protection in Lebanon date as back as 1925. Ground and surface water resources have been protected since the introduction of Order No. 144 dated June 1925, which covered the major springs that supply the country's potable and irrigation needs.

4.1.2 Sanitation framework and wastewater treatment

Protection against pollution was first addressed by Decree No. 8735 of October 1974. It prohibited the digging of wells for the disposal of raw sewage, banned infiltration from septic tanks and the use of sewage for the irrigation of vegetables and some fruit trees. However, in most Lebanese regions this law is not respected. In 2011, the Minister of Agriculture issued a decree, prohibiting the use of wastewater in irrigation.

Decision No. 8/1 dated March 2001 reviewed the previously issued wastewater standards to cover the discharge of wastewater to the sea, to surface water and to sewerage systems (table 2). However, standards for the reuse of treated effluents have not being addressed.

The first guidelines for the use of treated wastewater for irrigation were implemented by FAO in 2010 (table 3). It must be noted that these standards are not the official ones but until Lebanon will develop its own, the government is advising on these limits.

4.1.3 Treated wastewater reuse

Wastewater collection, treatment and reuse in Lebanon are weak and not implemented. There is neither a policy/institutional framework on the treatment and re-use of wastewater nor guidelines on the most cost-effective wastewater treatment techniques and on the use of TWW in agriculture.

The Ministry of Energy and Water (MoEW) in the 'National Strategy for Wastewater Sector' reports that in Lebanon there are 310 million m3/year of available wastewater of which 250 million are urban wastewater and 60 million are industrial wastewater. Only two thirds of the population are connected to a sewage network but only 8 percent of wastewater reaches (five) operational wastewater treatment plants (Saida, Ghadir, Baalbeck, Zahle and Yamouneh). There is no pre-treatment of industrial wastewater that is often discharged together with urban wastewater in sea, rivers or lands or unsafely used by farmers. The Lebanese Government is committed to strengthen collection and treatment of wastewater and support the use of TWW in agriculture, industrial and amenity but also to recover TWW costs based on the polluter-pays-principle. Also, in trying to address the problems the Government has issued a national strategy for the wastewater sector that includes 5 strategic initiatives to:

1) strengthen wastewater collection and reuse through the finalization of the waster network;

2) improve the regulatory and policy framework;

3) define responsibilities for services delivery on the use of TWW;

4) define financial measures to provide affordable services;

5) involve the private participation on the wastewater sector.

Recently FAO has also responded to request of support from Lebanon with the implementation of two TCPs to prepare guidelines on both the use of TWW and sludge in agriculture (See Annex 2 and 3).

4.2 Spain

4.2.1 Environmental framework

The Spanish environmental legal framework comprises laws regulating particular industries and activities, and laws protecting the environment and controlling certain contaminating agents.

Most Spanish environmental laws derive from the transposition of EU legislation. The main regulated environmental fields are:

- Integrated environmental control.
- Natural heritage and biodiversity protection.
- Air quality and atmosphere protection.
- Environmental responsibility.
- Nuisance activities.
- Environmental impact assessment.

- Contaminated land.
- Waste.

The local Autonomous Regions (Comunidades Autónomas) can develop and enforce their own environmental legislation, and local authorities have environmental protection powers.

Recently, several significant environmental laws have been enacted in Spain including:

- The National Energy and Climate Plan for 2021 to 2030 (NECP).
- Royal Decree 244/2019, of 5 April, regulating the administrative, technical and economic conditions for the self-consumption of electricity.
- Royal Decree 18/2019, of 25 January, developing certain aspects of the application of GHG Emissions Trading for the 2021-2030 period.
- Royal Decree 958/2018, of 27 June, creating and regulating the Inter-ministerial Commission for Climate Change and Energy Transition.
- Royal Decree 818/2018, of 6 July, adopting measures for the reduction of national emissions of certain atmospheric pollutants.
- Law 4/2019, of 21 February, of Energy Sustainability of the Basque Country.
- Law 9/2018, of 5 December, which modifies Law 21/2013 on Environmental Assessment.
- Law 7/2018, of 20 July, modifying Law 42/2007 of Natural Heritage and Biodiversity.
- Law 8/2018, of 8 October, adopting measures against climate change and for the transition towards a new energy model in the Autonomous Region of Andalusia.
- Law 9/2018, of 31 July, modifying Law 12/2016 of environmental evaluation of the Balearic Islands.
- Decree 32/2018, of 12 April, approving the Strategic Action against the Climate Change of Cantabria Autonomous Region for the 2018-2030 period.

Additionally, it may be a criminal offence under the Spanish Criminal Code to breach laws or other general environmental provisions so as to cause directly or indirectly serious damage to the environment by emissions, spillages, radiation, extractions or excavations, filling with earth, noises, vibrations, injections or deposits the atmosphere, ground, subsoil, surface water, ground water or sea water (including the high seas, even if they affect cross-border spaces) or water catchment basins.

The penalties for this offence are:

- Fines: between ten and 14 months (or 8 and 24 months for serious damage).

- Imprisonment: between six months and two years (or between two and five years for serious damage).
- Special disqualification from conducting related business activities for between one and two years (or between one and three years for serious damage).

4.2.2 Sanitation framework and wastewater treatment

In the case of Spain, with the Water Law, approved in 1985, a new strategy was initiated regarding the pollution control due to numerous stipulations that changed traditional approach of discharges that were considered. The most relevant aspects of this new strategy were (i) "All discharges that can generate pollution require authorization". In practice, this was translated into the requirement to achieve corrective measures to minimize their impact on the environment; (ii) Discharges will be fixed according to their typology and polluting features; (iii) Failure to comply with the limits imposed in the authorization would entail a disciplinary action for damages to the public hydraulic domain. Despite this regulation, in order to apply the mentioned requirements (such as discharge authorizations) in practice, the Hydrological Basin Plans (PHC following their acronym in Spanish) had to be approved because they would establish the "basic features of water quality and the management of wastewater discharges according to their uses".

The Water Law was soon changed when Spain joined the European Economic Community (EEC), in 1986, and had to comply with the European norms regarding water quality. European environmental policy presents among its fundamental principles the conservation, protection, and improvement of water quality, as well as the prudent and rational use of natural resources (water bodies, aquatic ecosystems, etc.). In order to achieve these objectives, different strategies have been followed during last decades, ranging from water resources protection based on water uses (quality objectives), to the discharges control through emission standards. The above-mentioned principles were incorporated into the norms of the European Members States. In this context, Firstly, Spain had to incorporated directives with quality objectives (bathrooms, fish life, pre-drinking, etc.), and next directives of emission standards whose main exponent was the Directive 91/271/EEC concerning urban waste-water treatment.

This Directive concerns the collection, treatment and discharge of urban wastewater. This legislation lays down the time limit for complying with requirements about having wastewater collecting systems, secondary treatment and more stringent treatments for the case of discharges in sensitive areas. It establishes a limit of 2000 p.e. in the agglomerations to comply with these requirements and for lower. In order to abide with to abide by the Directive 91/271/EEC, Spain sets the National Plan of Sanitation

and Water Treatment (1995–2005, PNSD). According to the Spanish Ministry, in 2010, the Autonomous Communities of Madrid, Comunidad Foral de Navarra, Región de Murcia, La Rioja and the autonomous cities of Ceuta and Melilla depicted the highest compliance degree of Spain with the Directive 91/271/EEC (showing a compliance degree of 100%). However, Canarias, with only 52%, was the region with the lowest compliance percentage in Spain. Regarding Spanish River Basin districts, Tajo, Guadiana and Guadalquivir depicted, in 2011, the worst levels of water quality. Meanwhile Miño-Sil, Ebro, Galicia Costa, Western and Eastern Cantábrico and Júcar were the River Basin districts where all the monitoring stations registered values with low pollution.

The PNSD considered investments with an approximate value of 11.4 billion Euros, according to provided data by the Autonomous Communities in 1995. This investment aimed to finance the total needs for sanitation and purification in Spain, through the three administrations with power (state, autonomous and local). The Plan assigned, from the contribution of the General State Administration (AGE following its acronym in Spanish) for each Autonomous Community, 25% of the total investment, which was required in actions classified as general interest. Therefore, the remaining amount (75%) had to be financed by the Autonomous Communities before December of 2005. A relevant element was to ensure the proper installations management (operation and maintenance of the purification systems) to avoid their failure once these plants were built. Thus, AGE recommended to the Autonomous Communities the creation of supra-municipal management entities, which could keep the mentioned installations operatives, directly, or through specialized companies. In addition, this entailed the collection of a sanitation tax in order to cover operating costs, installations financing that must be assumed by the Autonomous Communities in the PNSD framework, etc. In particular, several Autonomous Communities, due to the problems related with the management of numerous wastewater plants, created entities in this sense such as ESAMUR in Murcia, EPSAR in Valencia, ACA in Cataluña, the Canal de Isabel II in Madrid, NILSA in Navarra, and others in the Balearic Islands, Rioja, Galicia, Aragón and the Basque Country.

4.2.3 Treated wastewater reuse

Regarding water reuse, there isn´t any European water reuse regulation so far, but it´s going to change in the next months, because there is an agreement between European Council and European Parliament to lay down a regulation in this matter. It´s foreseen this new regulation will entry in force after three years once it is approved.

Currently in Spain, since the year 2007, there is a Spanish regulation on water reuse, by the Royal Decree 1620/2007. This regulation establishes the legal framework for the reuse: Legal regime of reuse, allowed uses, criteria of quality and monitoring and the procedure for obtaining the grant of reuse.

In Annex 4, we can see the allowed uses and their requirements.

Due to the water scarcity in Murcia Region, and the agricultural production is very high, water reuse is a very common practice in the region. Around 98 % treated water is reused, usually in agricultural irrigation, by direct and indirect way, after receiving an advanced tertiary treatment or, at least, disinfection. There are many reclamation facilities working, that are able to achieve the requirements of Spanish regulation on water reuse. Currently, ESAMUR is working to design and upgrade the reclamation facilities, to be able to comply the new strict requirements of oncoming European regulation.

4.3 Tunisia

4.3.1 Environmental framework

The new constitution presents a comprehensive, global vision of the environmental protection of in its Preamble (which has the same value as the measures themselves, according to Article 145: "the preamble is an integral part of this constitution") and in Article 45. Indeed, the preamble presents a comprehensive vision of environmental concerns, while setting these concerns in their complex context.

Thus, the preamble communicates "the necessity of contributing to climate protection and to safeguarding a healthy environment with the purpose of guaranteeing the sustainability of our natural resources and the pursuit of a secure existence for future generations." This globalizing dimension is reiterated in the context of Article 45, which states that: "The State guarantees the right to a healthy and balanced environment and the contribution to a secure climate. It is incumbent upon the State to provide the necessary means for the eradication of environmental pollution".

This approach constitutionalizes and clarifies a legislative and regulatory trend that was initiated in Tunisian law in 1993. In fact, the first legal text, which alluded to this law, was decree no. 93-2061 of 11 October 1993, establishing the National Commission for Sustainable Development (Commission nationale pour le développement durable) (CNDD). Article 2, of this decree, lists, as one of the Commission's missions, to "preserve the right of future generations to a healthy and viable environment".

However, the most direct text on this subject is article 1 of the Code for the Management of Land and Urban Areas (Code de l'aménagement du territoire et de l'urbanisme) (CATU), which clearly states the need to "guarantee a sustainable development and citizens' rights to a healthy environment".

The same is true for law no. 2007-34 of 4 June 2007 on air quality. Indeed, Article 1 of this law states that: "This law aims to prevent, limit and reduce air pollution and its negative impact on human health

and on the environment and to set air quality control procedures in order to give effect to citizens' rights to a healthy environment and to ensure a sustainable development".

Despite the fact that the new constitution limited itself to the declaratory aspect of a right to a healthy and balanced environment, The Constitution of 27 January 2014 has favored certain components of the environment, clearly marking them as part of certain provisions, or by devoting specific articles to them. This is the case for the clear reference to:

- The fight against pollution (Preamble and Article 45), which constitutes a constant feature of the protection of the environment. In fact, under the terms of Article 2 of the law pertaining to the ANPE (National Agency for Environmental Protection), pollution constitutes: "any direct or indirect introduction of a biological, chemical or physical pollutant into the environment".

  In this respect, Article 8 of the law establishing the ANPE stipulates that: "natural or legal persons and particularly industrial, agricultural or commercial establishments that damage the environment or whose activity causes environmental pollution with solid, liquid or gaseous waste, or other, are held to eliminating, reducing and potentially recovering rejected materials as well as repairing the damage caused".

- Safeguarding a secure climate is a fairly recent component of environmental protection, which clearly appears in the Constitution (Preamble and Article 45) without any opposition whatsoever from the different members of the National Constituent Assembly;
- The right to water: under pressure by the associations whose purpose it is to defend this right, the recognition of the right to water appeared in the Constitution, and sparked a very interesting debate. However, the usual wording does not reflect the proposal of experts, and remains truncated and very general. Indeed, Article 44 of the Constitution provides that: "the right to water is guaranteed.
- Water conservation and its rational use are a duty of the State and the society". Meanwhile, the proposed wording was: "The right to water is guaranteed, all individuals have the right to a sufficient quantity and a satisfactory quality". On this subject, the Tunisian Constitution complements and reinforces a legal and regulatory measure pertaining to water, primarily made up of the water code adopted in 1975, and its implementing provisions. In this context, fresh water is found as surface waters: waterways, rivers, streams, wadis, and sources of any kind. Groundwater is the water contained in the different water tables, in particular groundwater tables. Salt water primarily originates from the sea, but also from lakes, sabkha, etc. In addition to these resources is an area characterized by the presence of water on its surface but at "a

shallow depth": wetlands. These areas are made up of "stretches of lakes, sabkhas, marshland, fens, peat land or temporary or permanent, natural or artificial bodies of water where the water is static or flowing, fresh, brackish or saltwater and including shores or banks frequented by birds". These are therefore sensitive areas that are very fragile, and that warrant protection.

- Management of national/natural resources/wealth (Preamble and articles 12 and 13): the integration of this component raised fierce debates within the Constituent Assembly. In addition, the wording that was eventually retained and consensually adopted remain very mixed: between use and exploitation on the one hand, and between wealth and resources on the other. This also seems to reflect a vision of natural resources that is more in line with the economic dimension than with the environmental/ecological dimension, thus tipping the balance in the direction of sustainable development.
- Protection of cultural heritage is contemplated in Article 42 paragraph 2, which postulates that "the State protects cultural heritage…". This clear statement of the State's obligation was also unanimously approved by all members of the Constituent Assembly, especially following the pillaging of sites and theft of antiques revealed after 14 January 2011. Indeed, environmental protection in its various components, both natural and cultural, is becoming heritage. In this context, we are in fact witnessing an environment whose components are becoming heritage. In this respect, reference to the label "heritage" can be found in certain provisions. In this case, the Tunisian legislation qualifies the heritage of forests subject to a safeguarding duty incumbent upon all citizens. Likewise, the national biological richness is also part of the forest heritage. Besides, soil is also perceived as natural heritage essential for agricultural production. For its part, the water code enshrines water as being "agricultural or industrial heritage".

4.3.2 Sanitation framework and wastewater treatment

4.3.2.1 Water Code N ° 76-75

Promulgated on March 31, 1975 The Water provides specific measures to the pollution prevention of water resources and partly deals with marine waters. It was supplemented in 1985 by Decree No. 56 of 2/1/85 specifying the general conditions for discharges into the receiving environment. The water code was modified by law 2001-116 of November 26, 2001 which enriched the water mobilization system based on the development of hydraulic resources including the exploitation of unconventional resources such as desalination of brackish and salty waters from groundwater, sea and sabkhas. Likewise, the modifications to the 2001 code require that "the planning and use of hydraulic resources must be based on the principle of maximizing the value of the production of the cubic meter of water throughout the

country according to economic conditions and acceptable techniques and the works of water from one basin to another must be preceded by an economic study for a better valuation of the quantities of water transfer". However, changes to the water code partially took into account the requirements of environmental protection and limited it to unconventional resources.

4.3.2.2 Laws and Decrees

After the establishment of ONAS in 1974 and promulgation of the water code in 1975 (law n° 75-16 of 31 March 1975), the national water supply utility (SONEDE) has been charged with billing and collection of sanitation fees on behalf of ONAS (Decree No. 75-492 of July 26, 1975). In 1979, the decree No. 79-768 of September 8, 1979, regulated the connection conditions and effluent discharge into the public sanitation network. This decree had been completed by:

- Decree No. 94-2050 of October 3, 1994, setting conditions for connection to public networks sanitation in the intervention areas of ONAS, and amended by decree n ° 2001-1534 of June 25, 2001.

- Decree No. 94-1885 of September 12, 1994, laying down the conditions for the dumping and rejection of wastewater other than domestic in sanitation networks located in areas intervention of ONAS.

In 1982, a law had been promulgated on standardization (Law 82-66 of August 6, 1982), and in 1985, it had been decreed on the regulation of discharges into the receiving environment (Decree No. 85-56 of January 2, 1985). This decree has been completed by Order of the Minister of Local Affairs and the environment and the Minister of Industry and small and medium-sized businesses, from 26 March 2018, setting the limit values for discharge of effluents into the receiving environment.

In 2005, Decree No. 2005-1991 of July 11, 2005, had been emitted for establishing the requirement of the compulsory to achieve the environmental impact assessment studies and for fixing the categories of units subject to the impact study on the environment and the categories of units submitted to terms of specifications sheets.

At the end of 2005, the decree n ° 2005-3280 of December 19, 2005, set the conditions and procedures for granting the financing concession, realization and operating sanitation works for private sector.

4.3.3 Treated wastewater reuse

4.3.3.1 Tunisian Standard NT 106-002, relating to releases of TWW to the environment

The purpose of this standard is to define the conditions to which effluent discharges into the water bodies subject to authorization (see Decree No. 85-56 of January 2, 1985) and the conditions for connection and discharge of effluents in the public sanitation network (see decree n ° 79-768 of 8

September 1979). For a more rigorous management of liquid discharges, NT 106.002 was approved on July 20, 1989 and took effect on October 1, 1989 and modified by decree n ° 93-2447 of December 13, 1993. This standard has defined the quality of the effluent as a function of the receiving environment, whether it is maritime, public hydraulic or public pipelines without taking into account its particularities. It defined the rejection thresholds for 54 physico-chemical and bacteriological parameters, several heavy metals and some organic micro-pollutants: hydrocarbons, pesticides, PCB / PCT and phenols. This standard has been revised and replaced by the order of the Minister of Local Affairs and the Environment and the Minister of Industry and Small and Medium-Sized Enterprises of March 26, 2018, setting the limit values for effluent discharges into the receiving environment.

4.3.3.2 Tunisian Standard NT 106-003, relating to TWW reuse in agriculture

Standard NT106.003, relating to the quality of reuse of TWWs in agriculture; The purpose of this standard is to define the quality of treated wastewater that can be reused in agriculture.

The conditions of use of treated wastewater (TWW) for agricultural purposes are set by decree 89-1047 of July 28, 1989, amended by decree 93-2447. This decree sets the terms and conditions for the use of treated wastewater for agricultural purposes as amended, as well as the decree of the Ministry of National Economy and Finance of May 18, 1990 promulgating the Tunisian standard relating to the specifications of water treated for agricultural purposes and the Decree of the Ministry of Agriculture of June 21, 1994 establishing the list of crops that can be irrigated by the treated water. The use of treated wastewater for the irrigation of vegetables which can be eaten raw is prohibited.

The treated wastewater can be used for wood crops (vines, lemons, peach olives etc.) for hay crops, for industrial crops (cotton, tobacco, sugar cane) as well as for cereals and land gulf. The treated wastewater must meet the specifications by standard NT 106.03 of 1989. The frequency of physico-chemical and parasitological analyzes of TWWs was also fixed by article 3 of decree n ° 89-1047.

5. SEMI-STRUCTURED STAKEHOLDER INTERVIEWS

5.1 The interviews

As a tool for obtaining an insight about wastewater management stakeholders' perceptions, views, plans, activities, suggestions and APOC adoption availability, a series of in-depth, structured interviews were used based on beforehand dispatch of a questionnaire to the interviewee, discussed face to face and finally transcribed. The typewritten text of the answers was sent to the respondents, in order to have possible misunderstandings corrected.

5.1.1 Questionnaire structure

AQUACYCLE partners CERTE, CERTH and IRMCo had prepared a structured questionnaire. It is composed from five parts:

5.1.1.1 Part A: personal data

It is requested to the interviewee, who will sign,

- his/her Name, surname, age, level of education, job position and contacts and
- his/her Field of expertise
- tasks assigned within his/her organization among Operator of WWTPs, Licensing of WWTPs, Certification of WWTPs' operators, Drawing/deciding wastewater management policies/strategies, Other.

5.1.1.2 Part B: current status in sanitation – domestic wastewater treatment

Strategy at national/regional/local level, main barriers that hinder the sanitation needs (Lack of sanitation planning, Institutional reasons, Financial reasons (in relation to OPEX), Fewer funding opportunities (in relation to CAPEX), Lack of reliable and up-to-date data, Lack of awareness, Other.

Are there sufficient WWTPs for cities in your region? (Approximation of WWT coverage)

Are there sufficient WWTPs for small communities (villages) in your region? (Approximation of WWT coverage)

How would you characterize the performance of the existing municipal wastewater treatment installations in your country/region? (Excellent, Adequate, Inadequate / Insufficient, Not operating / Lack of treatment, Don't know / Cannot answer)

How is sanitation covered in small communities (villages, small towns)?

Would you consider centralized or decentralized domestic wastewater treatment systems for small communities and why?

5.1.1.3 Part C: domestic wastewater reuse

How is the treated wastewater dealt with in your region/country (strategic regulations and norms for treated water quality; reuse management)?

Are you aware of any domestic wastewater reuse plan in your region/country? If yes, details

Are you aware of wastewater reuse activities in other neighboring countries? If yes, details

What is your perception of wastewater reuse?

What are the criteria/drivers that support your institution's decision for a wastewater reuse project (e.g. quantitative/qualitative criteria, technology verification/certification, water pressures, employment opportunities-needs, investments, etc.)?

What are the criteria/drivers that hinder your institution's decision for a wastewater reuse project?

How would you describe the social perceptions and attitudes towards the reuse of treated effluent? E.g. farmers, civil societies, others?

5.1.1.4 Part D: steps to address the sanitation issue

What has your organization done to address sanitation, WWT and reuse issues?

How well have these efforts worked?

What do you think should be done to address sanitation, WWT and reuse? (short- and long-term actions)

Do you consider there is sufficient investment available to build new WWT?

How likely is an upgrade of existing municipal wastewater treatment infrastructure in your country/region the next years towards reuse? (Very likely, Less likely, Don't know / Cannot answer)

Rank the following drivers towards the installation of new infrastructure that promotes the use of non-conventional water supplies in your country/region (from major driver to less significant driver).

- Protection of the environment
- All year water availability for reuse (in agriculture or other domestic/industrial purposes)
- Decreased costs (CAPEX, OPEX)

- Water savings (fresh water sources) and energy conservation (e.g. use of solar energy, production of biogas)
- Income from byproducts (anaerobic digestion sludge as fertilizer, biogas as energy source)
- Other (define)

Are you aware of technologies that are available for tackling the need for tertiary treatment of domestic wastewater (e.g. Best Available Technologies) (Yes / No, If Yes, please give some examples)

5.1.1.5 Part E: readiness to adopt the APOC system

What is your knowledge level about the technologies used in the APOC system and their efficacy in WWT and reuse? (Anaerobic digestion, constructed wetlands, solar treatment)

What information would your organization need to consider using the APOC system (training needs)?

What is the level of willingness of your organization to adopt the APOC system? (High, moderate, low, Don't know / Cannot answer)

What is the level of capacity of your organization to adopt the APOC system? (Space availability, trained personnel for the installation/operation of large APOC systems, available resources). (High, moderate, low, Don't know / Cannot answer)

What factors would facilitate its adoption?

Set the following APOC attributes in an order, starting from the highly important to the less important. (Minimum total annualized cost (OPEX), Minimizing GHG emissions, Low maintenance, Low operational complexity, Reclaimed water for use in agriculture/domestic/industry, Recovery/production of energy.

What factors might undermine or complicate this adoption?

5.1.2 Stakeholders selection

From each country of demo-sites, we selected at least five public and civil society institutions to interview. The selection criteria are established after a classification of the stakeholders according to his degree of influence from policy makers, operators and NGOs, at national, regional and local levels.

5.1.2.1 Lebanon

In order to hear the voice of public authorities and private organizations related to water and sanitation sector, 5 main governmental stakeholders were chosen: Ministry of Environment (MoE), Ministry of Energy and Water (MoEW), Ministry of Agriculture (MoA), Council of Development and reconstruction (CDR) and the Tripoli Municipality. Because of the recent movement in Lebanon, only the Tripoli

municipality were reached while the others were postponed and to be conducted as soon as possible. It worth noting that all these stakeholders have been contacted, already, by phone and/or email.

Other stakeholders have been interviewed like LARI (Lebanese Agriculture Research Institution), AUF, Difaf and Tanmia association (NGO).

5.1.2.2 Spain

In the case of Spain, five stakeholders were identified. The idea of the selection was to know the point of view of the most of the sectors involved in water reuse, with different responsibilities and approaches, and so to have the perception and forecast from different perspectives. Selected interviewees were:

- General Director of Water in Murcia Region, responsible of wastewater treatment system planning in Murcia Region.
- President of ASERSA, the main Spanish association for promoting water reuse.
- General Secretary of the biggest irrigators' association in Murcia Region, managing more than 40.000 Ha of irrigated surface (Comunidad de Regantes Del Campo de Cartagena).
- A relevant researcher on food safety of a prestigious Spanish Research Center (CEBAS-CSIC).
- Expert in wastewater treatment in one of the biggest Water Companies in Spain (ACCIONA), working in relevant water projects worldwide.

5.1.2.3 Tunisia

In the case of Tunisia, six institutions were identified to request their responses to the questionnaire and to be interviewed. They are:

- The National Sanitation Utility (ONAS)
- Ministry Directorate General of environment and life quality
- Directorate General of Rural Engineering and Water Exploitation (DGGREE)
- Regional Commissariat for Agricultural Development (CRDA) of Nabeul
- Directorate of Hygiene and Environmental Protection (DHMPE)
- Group for agriculture Development (GDA) Sidi Amor

5.1.3 Outcomes from the interviews

5.1.3.1 Lebanon

Part A: Personal data

With no interviewed women, there was a lack in Gender representativeness of interviewees. However, all the interviewees are highly educated and have a very good expertise in their field of practice.

Part B: Current status in sanitation – domestic wastewater treatment

- All interviewees described the sanitation situation in Lebanon as poor. The wastewater is driven the watercourses and to the sea without any treatment.
- The barriers are financial as the country is going through an economic crisis, lack of sanitation planning and awareness.
- In Tripoli region, there is only one treatment plant, which is considered as one of the biggest plants in Lebanon, but it is only function at 20% because of lack of networking.
- The concerned parties in WWT are Ministries and CDR (council of construction and reconstruction) on national level and Municipalities at regional level.

Part C: Domestic Wastewater Reuse

- Some small communities are covered with small WWTP funded by some international organizations (but many of them are not functional because of operation and maintenance cost) and in the majority of villages there is no treatment for wastewater.
- Even if the wastewater is treated, it is not reused, but it is necessary to plan reuse as the country is facing shortage of water in near future.
- Regarding the criteria that support the project, the majority agreed that the need of water and the improvement of the water quality.
- About the reuse of treated water, the water is actually used untreated so the people will welcome the idea of using treated water.

Part D: Steps to Address the Sanitation Issue

- To address the sanitation issues the interviewee have organized many: seminar and conferences, research and studies, projects with national and internationals parties,

- Their effort made some changes but were not enough because many reasons like the lack of cooperation and the situation of the country.
- Regarding the short-term actions: research, demo plants and ensure finances.
- Long-term actions: establish and impose rules and regulation.
- The interviewees collaborate with: universities, many national and international NGOS SWISS cooperation office, chamber of commerce and industry of Zahle, GVC (Italian NGO), World Bank, AUF (francophone university agency),..
- All agreed that there is no sufficient investment for improving nor expending of WWTP.

The rank of drivers was as follows:

- Protection of the environment
- Water savings and energy conservation
- Decreased costs
- Income from by-products
- Water savings and energy conservation
- All of interviewees are aware of technologies, but usually only of conventional ones.

Part E: Readiness to Adopt the APOC System

- Most of interviewees are aware of the AD and CW.
- The level of willingness to adopt the APOC system is high for most of the interviewees but with low capacity to adopt it.
- To facilitate the adoption, different type of support and clear guide.
- Order for the APOC attributes:
- Reclaimed water for reuse
- Recovery/production of energy
- Low operational complexity
- Minimizing greenhouse gas emissions
- Low maintenance
- Minimum OPEX

The factors that can undermine the adoption of APOC system: the cost and financial necessary, area needed, and the absence of trained personnel.

Regarding the interest to participate in training activities all the interviewees welcomed the idea and they will provide the list of names and the contacts when it is needed.

5.1.3.2 Spain

Part A: Personal data

Gender representativeness of interviewees is adequate, with two woman and three men. The field of expertise of the interviewees goes from Drawing/deciding wastewater management policies/strategies at regional level to WWTP licensing, irrigation techniques and research in the field of WWTP performance improvement. All the interviewed persons are highly educated (Engineers and PhD).

Part B: Current status in sanitation – domestic wastewater treatment

Spain suffers from a chronic structural water deficit, although water reuse and desalination have been a priority for some time now, the percentage of untreated wastewater should be halved by 2030. The current situation depends on the region; there are some of them with a good situation and in others ones not so good but almost wastewater treatment situation in Spain is good in the most of the regions, but in Murcia it's Excellent. Indeed, the country SWWT is mostly complete in the whole country, particularly for communities larger than 2,000 inhabitants. The reference treatment process is secondary biological treatment, mostly using conventional processes but also including nature-based solutions. All the interviewees think that the main barriers that hinder the sanitation needs in Spain are financial reasons (in relation to OPEX and CAPEX) with in addition, Institutional reasons and lack of sanitation planning. They are aware of sufficient WWTPs for cities in almost the regions, sufficient WWTPs for small communities. The performance of the existing municipal wastewater treatment installations in the region of Murcia, are excellent for some of the interviewees but for other, it is rather adequate (satisfies the legal standards) as there are some WWTPs that are not implementing tertiary treatments that will be necessary to satisfy the legal standards.

Regarding the centralized or decentralized matter, there are different answers, in both positions. Some believe that centralized domestic wastewater treatment systems are more appropriate for small community. As by doing so, we can in one hand reduce the pressure on the allowed budget by scale economy and in another hand allow the implementation of more efficient and optimized systems for the treatment of wastewater.

For granting the availability of funds, Murcia Region imposed a tax called “canon de saneamiento”.

Part C: Domestic Wastewater Reuse

In general there is a coincidence about the high involvement of water reuse in Murcia Region. Current regulations are considered enough currently, except one of the interviewees, that consider they are not enough demanding. In the most of the cases, the perception about the users’ confidence on reclaimed water is very good. The main criteria to push the water reuse is the scarcity. Regarding criteria that hinders water reuse, the main criteria are economical ones.

Part D: Steps to Address the Sanitation Issue

In order to address WWT and Water Reuse, every interviewee explains his/her efforts in this matter, considering these are positive.

Regarding the short-term actions, the most of them are focused to improve the treatments, especially because the oncoming new European regulation on water reuse.

Regarding the long-term actions, the most of interviewees highlight the issues of improvement of treatments and the process viability.

There is a high variability regarding the availability of enough investment. Some of them consider it´s enough and other the opposite. All of them consider very likely the upgrade of facilities in the next years.

In the ranking of drivers, the mostly voted was:

1. Availability
2. Water savings and energy conservation
3. Protection of the environment
4. Decreased costs
5. Income from by-products

Part E: Readiness to Adopt the APOC System

In general, the interviewees have low Knowledge about technologies, except two of them. However, the WWTP operator knows deeply the technologies.

Regarding the training needs, they are mainly interested to know the viability of the system, but they are not interested in training matters because it´s not their field in the most of the cases.

The level of willingness to adopt the APOC system is high for Administration representative and plant operator and medium or low for the others.

The factors to facilitate the adoption of the system are mainly the demonstration of the system efficiency and advantages after test.

The order for the APOC attributes is:

1. Minimum OPEX
2. Reclaimed water for reuse
3. Minimizing greenhouse gas emissions
4. Low operational complexity
5. Low maintenance
6. Recovery/production of energy

The factors that can undermine the adoption of APOC system are the need of large surface, possible presence of insects and odours and obtained water quality.

Regarding the interest to participate in training activities, the only interested people is who is acting in the field.

5.1.3.3 Tunisia

Part A: Personal data

Women are well represented among the interviewees. The interviewers were received by three women (DGEQV, DGGREE, DHMPE) and 7 men (2 ONAS, 1 DHMPE, 1 GDA, 1 DGGREE, CRDA-Nabeul 2)

The field of expertise is mostly Drawing/deciding wastewater management policies/strategies, only ONAS as WWTPs operator, CRDA-Nabeul as executer of DGGREE plans in public irrigated areas with TWW and GDA as a representative of farmers' interest. All the interviewed persons are highly educated (Engineers and PhD).

Part B: Current status in sanitation – domestic wastewater treatment

For the Ministry of Environment (DGEQV and ONAS), it consider that with 270 million m^3 (90% is domestic) of TWW in 122 ONAS WWTPs (2018) mainly treating to level II with some 25 WWTPs to level III (5% of total mobilized water resources), 53% produced in the Greater Tunis region, 17% in the North

and 30% in Cap Bon and the South, the urban connection rate is on the right track. But for rural areas, the road is still long.

Contrariwise, The Ministry of Agriculture (DGGREE and CRDA), the situation is unsuitable for the reuse of wastewater in agriculture due to the obsolescence of the WWTPs and their overload gives water qualities out of norms. They think that there is a delay in their rehabilitation and extension. At regional level, CRDA Nabeul congratulates ONAS for retrofitting and rehabilitant SE4 and ask to accelerate the studies for SE3. At the same way, the public health ministry representatives (DHMPE) and GDA (Ariana Governorate) ask to improve the reclaimed waters quality and to deal with sanitation in rural areas where they advocate for decentralized systems.

All the interviewees think that the main barriers that hinder the sanitation needs in Tunisia are Financial reasons (in relation to OPEX and CAPEX) with in addition, Institutional reasons behind the poor sanitation in rural areas.

Part C: Domestic Wastewater Reuse

The non-availability of irrigation alternative from other conventional resources generates a demand for TWW, as is the case of the perimeter of Borj Touil.

Concern of health problems and risks health and environmental conditions depend on educational and social level of farmers

A third factor playing a role in the acceptance of TWW is the type of culture applied in the irrigated area. It seems that the perimeters of arboriculture are more successful.

In addition, the crop restriction poses a limiting factor for farmers who want to irrigate crops with high yielding such as vegetable crops.

Part D: Steps to Address the Sanitation Issue

At the strategic level, many initiatives and studies carried out by the DGEQV and ONAS (ONAS 2002 TWW valuation strategy)

Profitability study of using TWWs in sectors other than agriculture.

Feasibility study of transferring EUTs from treatment plants in Greater Tunis to areas of reuse inside the country.

Technical, economic and environmental feasibility study of aquifer recharge with TWWs

Development of a national communication and awareness-raising strategy for reuse of TWW and sludge from WWTP and initiation of awareness-raising activities at regional scale.

Development of a national master plan for REUT in Tunisia "water reuse 2050" in the part of the Adapt'Action Facility (2017-2021).

Short-term actions:

Assure TWWs compliance with reuse standards for agricultural purposes to avoid negative impact on the environment (water, soil ...) and human health by strict control of industrial wastewater pre-treatment and illegal spills in ONAS networks.

Study the possibility of inter-seasonal storage of TWWs.

Assure the beneficiaries' adhesion to the reuse project.

Raising awareness of the reuse of TWWs

Reinforcement of research in the field of reuse of TWWs in agriculture and disseminate research results.

Monitoring the application of mitigation measures proposed by the study of Environmental Impact Assessments for WWTPs and Irrigated areas (rehabilitation, extension)

Revision of the TWWs tariff according to the actual cost of the m3 (20 millimes=0,0064 euros).

Long term actions:

ONAS has to proceed to the rehabilitation of the WWTPs and the introduction of complementary treatments (disinfection, SS reduction by filtration).

DGGREE have to rehabilitate the old irrigated areas with TWW and to improve inter-seasonal storage possibilities.

Improve coordination between the intervening institutions and the flow of information.

5.1.3.3.6 Part E: Readiness to Adopt the APOC System

About the knowledge level about the technologies used in the APOC system and their efficacy in WWT and reuse, the majority of the interviewees has small idea about AD mainly in sludge treatment, good idea about CWs and no idea on ST. They need information and training on the APOC technology. They are willing to adopt the system if first it ensures good treatment performances and if it is Low O&M complexity and costs. Secondly, it provides Reclaimed water for use in agriculture/domestic/industry, allows Recovery and production of energy with Minimizing GHG emissions.

6. SWOT ANALYSIS OF APOC SYSTEM

6.1 Introduction

A general overview and technical details of the APOC system have been provided in the Technical Guide (Output 4.1) of the AQUACYCLE project. As outlined in Starkl et al. (2013), often assessment studies focus on technical aspects only, with no or little consideration of the non-technical aspects. It has been argued that the non-technical aspects do influence the long-term sustainability of technologies and therefore their critical assessment is of importance. This step forwards the participatory process, compliments the previous information gathered through investigations on environmental, health and safety as well as economic, social and institutional aspects of the APOC system by a strength-weaknesses-opportunities-threats (SWOT) analysis.

The SWOT analysis provides a framework for analyzing a situation by identifying strengths and weaknesses, but also recognizes challenges and develops strategies for the future (Srivastava et al., 2005). Thus, in this analysis, the strengths are viewed as advantages that support the decision to implement a system; weaknesses show what can be improved or what needs to be investigated before implementation. Opportunities refer to possible chances and positive improvements, whereas threats show risks and obstacles for the future.

Indeed, every project development and management plan have its strengths and weaknesses, opportunities and threats. Considering these strengths, weaknesses, opportunities and threats (SWOTs), a project coordinator can deal more effectively with the problems that are likely to come up, and look at ways and means of converting the threats into opportunities, and off-setting the weaknesses against the strengths (Johnson et al., 1989).

6.2 Objectives

The main intended benefit of the three case studies in the three AQUACYCLE partner countries of Lebanon, Spain and Tunisia is the provision of safe treated wastewater for unrestrictive agricultural reuse. Thus, the project will assess APOC system performances in the case studies to see if its intended benefits are achieved. In the SWOT study, other relevant expected and unexpected benefits are studied, for example income generation and employment for those communities that are associated with the systems and risks that could jeopardize the successful functioning of the system. Based on the intended and unintended benefits, current risks and future risks, the case studies will be classified as “success” or “failure” cases. With a SWOT analysis, we want to identify the reasons, which can underlie the success

or the failure of the cases. In other words, this stakeholder-based SWOT analysis was performed to develop a strategic action plan of APOC implementation in the target demo-sites.

It aimed to identify the positive and negative factors, as well as internal and external factors, that might have an impact on the proposed APOC system. SWOT analysis is intended to maximize both strengths and opportunities, minimize the external threats, transform the identified weaknesses into strengths and to take advantage of opportunities along with minimizing both internal weaknesses and external threats (Saaty, 1987). Thus, SWOT is used for analyzing internal and external environments in order to reach a systemic approach and support for a decisive situation. It can provide a good basis for successful strategy formulation.

6.3 Implementation

6.3.1 Lebanon

A. Current Status In Sanitation – Domestic Wastewater Treatment

Strengths

- In Tripoli region, there is one treatment plant, which is considered as one of the biggest plant in Lebanon.

Weaknesses

- Poor sanitation situation in Lebanon
- Release of untreated wastewater to the watercourses and to the sea.
- Lack of financial resources as the country is going through an economic crisis,
- lack of sanitation planning and awareness.
- Tripoli WWTP functionning at only 20% of its capacity because of lack of connected sewerage lines in the network.

Opportunities

- Adopt a new paradigm for sanitation and WWT in mid sized cities and rural areas
- Adopt new technologies adapted to sustainable development such as the eco-innovative technology offered by the APOC system

Threats

- Loss of financial institutions' trust in debt repayment
- Corruption in allocation of public contracts
- Delay in projects implementation

B. Domestic wastewater reuse

Strengths	Weaknesses
▪ Some small communities are covered with small WWTP funded by some international organizations	▪ Disfunction of rural areas WWTPs because of lack of OPEX resources. ▪ obsolescence of the WWTPs and their overload results in water quality outside the norms for safe reuse ▪ Lack of Financial resources (in relation to OPEX and CAPEX) ▪ Institutional Gap behind the poor sanitation in rural areas
Opportunities	**Threats**
▪ Adopt a new paradigm for sanitation and WWT in mid sized cities and rural areas ▪ Adopt new technologies adapted to sustainable development	▪ Loss of financial institutions' trust in debt repayment ▪ Corruption in allocation of public contracts ▪ Delay in projects implementation

C. Steps to address the sanitation issues.

Strengths

- Many seminars and conferences have been organized for educating people and raising awareness on the bad situation of the water and wastewater sectors.
- Research and studies, projects with national and internationals parties have been held in these fields.
- Decentralizing the wastewater treatment by building small treatment plants.

Weaknesses

- Lack of cooperation and the situation of the country.
- Lack of investment for improving or expending of WWTP.
- Lack of laws and laws monitoring in wastewater sector.

Opportunities

- Lebanon is going through a somewhat revolution accompanied with a huge rise in awareness.
- Both local and global parties show her willingness to help finding solutions in all sectors including the water treatment sector.

Threats

- Cultural and religion believes on the reuse of wastewater as improper source.
- Delayed in implementation of projects.
- Corruption and lack of confidence in all governmental entities

D. Readiness to Adopt the APOC System

Strengths

- Upcoming crisis in water sector.
- Most of interviewees are aware of the AD and CW.
- High willingness to adopt the APOC system but with low capability to adopt it.
- The proposal of new technology to treat wastewater with economical, touristic, environmental benefits.
- Creating the opportunity to use a new NCWR

Weaknesses

- Lack of the necessary cost and financial.
- Area needed.
- The absence of trained personnel.

Opportunities

- Learning to stakeholders a new paradigm for sanitation and WWT and reuse
- Training personnel in public and private sector on new WWT technology (APOC).
- Decentralizing domestic WWT systems wich is relevant for Lebanese small communities.

Threats

- The willingness of governmental parties to collaborate.
- Conflict of interest with CDR.

6.3.2 Spain

A. Current Status In Sanitation – Domestic Wastewater Treatment

Strengths

- 98 WWTPs are covering the Sanitation in the Region (99,3 % of population)
- 105 Million m3 are treated every year in the Region
- Efficiencies obtained in WWTPs are very High (99 % in BOD5 removal)

Weaknesses

- Operational costs of conventional treatments are high.
- Emissions of CO2 with conventional treatments are high

Opportunities

- To develop a new system which is more environment friendly and with lower operational costs.

Threats

- Lack of future funding to upgrade WWTPs
- Possible future requirements to reduce the greenhouse effect gas emissions in the treatments
- Required surface for the treatment could be very large

B. Domestic wastewater reuse

Strengths

- 98 % treated water is reused
- High experience in tertiary treatments
- High experience in safety food

Weaknesses

- Conventional tertiary systems consume a lot of energy or use chemicals that are able to harm the environment.

Opportunities

- To develop a new system which is more environment friendly and with lower operational costs.

Threats

- Required surface for the tertiary system could be very large
- Nitrates should be removed to avoid algae in solar reactor
- Requirements for water reuse so high that the viability of the process is impossible
- Effect of emerging compounds is not completely known and could be a barrier in the future
- Lack of confidence among reclaimed water users or consumers
- Salinity in the wastewater is increasing

C. Steps to address the sanitation issues.

Strengths

- High experience in current treatment systems
- A lot of studies and research to improve the viability of the treatments, to explore new systems and to advance in the food safety.

Weaknesses

- Funding depends on political decisions
- Sometimes the consumers are not confident in agricultural products irrigated with reclaimed water

Opportunities

- To develop a new system which is more environment friendly and with lower operational costs
- Improvement of health in population
- To go further in the study of effects of some compounds, to know if we should remove or not
- Awareness-raising in population and politicians on the need of research in this field

Threats

- Lack of future funding for research

D. Readiness to Adopt the APOC System

Strengths

- Very promising and eco-friendly system
- High reduction of sludge
- Low consumption of energy
- Production of methane
- Low CAPEX and OPEX costs

Weaknesses

- Fear of the risk brought by new unknown systems
- Due to the surface needed, it is feasible only in small and medium-sized agglomerations
- The system needs warm temperatures and low concentration of sulphates in the wastewater

Opportunities

- To develop a new system which is more environment friendly and with lower operational costs.
- Due to the low requirements of maintenance and costs, many small agglomerations will be able to improve the quality of life, especially in developing countries
- A source of safe water for many uses.

Threats

- Construction and Water Companies prefer to stay with the traditional systems 'they know'
- To manage the methane dissolved in the digester effluent

6.3.3 Tunisia

A. Current Status In Sanitation – Domestic Wastewater Treatment

Strengths

- 122 WWTPs covering large and medium cities
- 270 million m3 are treated to level 2
- Programme for retrofitting and rehabilitating of old and overloaded WWTPs

Weaknesses

- Lack of sanitation and WWT in rural areas
- obsolescence of the WWTPs and their overload gives water qualities out of established norms
- Lack of Financial resources (in relation to OPEX and CAPEX)
- Institutional Gap behind the poor sanitation in rural areas

Opportunities

- Adopt a new paradigm for sanitation and WWT in mid-sized cities and rural areas
- Adopt new technologies adapted to sustainable development

Threats

- Loss of financial institutions trust in debt repayment
- Corruption in allocation of public contracts
- Delay in projects implementation

B. Domestic wastewater reuse

Strengths

- TWW availability for reuse
- 270 million m3 are treated to level 2
- Programme for retrofitting and rehabilitating of old and overloaded WWTPs
- Programme for enlargement of WWTPs to encompass the level 3 treatment

Weaknesses

- mismatch of TWW production areas and the needs for reuse areas
- obsolescence of the WWTPs and their overload gives water qualities out of norms of reuse
- Lack of Financial resources (in relation to OPEX and CAPEX)
- Institutional Gap behind the poor sanitation in rural areas

Opportunities

- Adopt a new paradigm for sanitation and WWT in mid-sized cities and rural areas
- Adopt new technologies adapted to sustainable development

Threats

- Loss of financial institutions trust in debt repayment
- Corruption in allocation of public contracts
- Delay in projects implementation

C. Steps to address the sanitation issue

Strengths

- At the strategic level, many initiatives and studies carried out by the DGEQV and ONAS
- Profitability study of using TWWs in sectors other than agriculture.
- Feasibility study of transferring EUTs from treatment plants in Greater Tunis to areas of reuse inside the country.
- Technical, economic and environmental feasibility study of aquifer recharge with TWWs
- Development of a national communication and awareness-raising strategy for reuse of TWW and sludge from WWTP and initiation of awareness-raising activities at regional scale.
- Development of a national master plan for REUT in Tunisia "water reuse 2050" in the part of the Adapt'Action Facility (2017-2021).

Weaknesses

- TWWs noncompliance with reuse standards for agricultural purposes
- Absence of inter-seasonal storage of TWWs.
- Lack of the beneficiaries' adhesion to the reuse project.
- Lack of awareness of the reuse of TWWs
- Lack of research in the field of reuse of TWWs in agriculture and disseminate research results.
- Non-application of mitigation measures proposed by the study of Environmental Impact Assessments for WWTPs and Irrigated areas (rehabilitation, extension)
- TWWs tariffs do not allow the improvement of provided quality

Opportunities

- Propose new technology to achieve the compliance with reuse standards
- Create facilities for inter-seasonal storage of TWWs.
- Improve beneficiaries' adhesion and awareness to the reuse project by the PGIS platform
- Enhancement of research in the field of reuse of TWWs in agriculture and disseminate research results of AQUACYCLE
- Propose a methodology of LCA and retrofitting to address the issue of how pays what? In the chain of collection-treatment-reuse of wastewaters

Threats

- Loss of people trust in governmental institutions and action plans
- Corruption in allocation of public contracts
- Delay in projects implementation

D. Readiness to Adopt the APOC System

Strengths

- Readiness to adopt the APOC system in case if it proves high performances
- 270 millions m3 are treated to level 2
- Programme for retrofitting and rehabilitating of old and overloaded WWTPs
- Availability of stakeholders for training and information dissemination

Weaknesses

- Lack of knowledge on new technologies of WWT
- Lack of information and training on the APOC technology
- Lack of coordination of activities between the Ministry of Environment and the Ministry of Agriculture

Opportunities

- Learning to stakeholders a new paradigm for sanitation and WWT and reuse
- Inform and Train the stakeholders on new technologies and APOC system
- Gather the different stakeholders at the same table to address problems and plan integrated actions

Threats

- Availability of ONAS in collaborating in AQUACYCLE activities
- Conflicts of interest between the government authorities

7. STRATEGIES DERIVED FROM THE SWOT ANALYSIS

A. Common Strategies in the Mediterranean Countries

a) Stakeholders involvement and Engagement

While considering the overall factors of strengths, weaknesses, opportunities and threats, the following strategies are derived to be used for effective community and stakeholders' participation in **Sanitation and wastewater treatment and reuse (SWWTR)**:

- Community participation should be accompanied by human resources development (HRD) and capacity building, which means that HRD is needed for a high degree of participation and involvement by developing awareness and skills among the community for proper implementation of Sanitation and wastewater treatment and reuse.
- The role of youths, homemakers and senior citizens in community participation should be strengthened.
- Community participation can increase the employment of target youths, through setting up of WWTPs operators microenterprises and maximizing mutual self-help among the community.
- Need to impart environmental education (EE) to the community and to resolve how it can be more effective in increasing community participation in SWWTR through awareness raising and training activities using EE-based information, education and communication (IEC) materials.
- Strengthening mutual consensus through public workshops and hearings to solve social problems in the community along with environmental problems for managing SWWTR at the regional level.

b) Government authorities (local, regional and national) responsible for SWWTR

While considering the overall factors of strengths, weaknesses, opportunities and threats, the following strategic actions are derived to be used for the effective role of the authorities in SWWTR:

- Provision by government of financial resources and simultaneously by the community of human resources for SWWTR to support organizations for community-based initiatives.
- Cooperation between government and community in planning and implementation for SWWTR.
- Decentralization of SWWTR services.
- Increasing good communication and building up partnerships among government and community for SWWTR.

- Bottom-up planning process in SWWTR.
- Increasing support to microenterprises and cooperation to the economy of community-based organizations.
- Consideration by government of new alternatives to enhance community participation.
- Increasing government responsiveness.
- Looking for consensus regarding the best possible solution to adopt proper SWWTR.

B. Specific Strategies for the study target countries

a) Lebanon

As the SWWTR sector is not fully developed, it is time to embrace a new approach and a new paradigm to tackle the problem with a vision based on the "closed loop" principle. It consists first to operate a diagnosis of the actual situation of the concerned sectors and the identification of coherent technical, economical and institutional options to rationalize the investments.

In addition, the new Vision has to set out concepts, which lead to the following objectives:

- Environmental and Ecological Sustainability; this requires that the external effects of the wastewater sector be taken fully into account when public or private decisions are made to determine future developments. The aim is to ensure that environmental issues are addressed as an integral part of the formulation of the wastewater vision.
- Economic and Financial Sustainability; this requires that available resources be used efficiently and that assets be maintained properly. The aim is to make wastewater cost-effective, continuously responsive to changing demands and capable of, at least, financing its operation and maintenance.
- Social Sustainability; this requires that the benefits of improved wastewater reach all sections of the community. The aim is to target the wastewater problems of low-income groups, and to protect these groups against the negative impacts on the environment. In addition, the strategy has to implement an awareness action to change population and especially farmers' perception of wastewater reuse.

b) Spain

With the National Water Quality Plan set in 2007 with the main objective was achieving the total compliance with the Directive 91/271/EEC and the Water Framework Directive (WFD), as well as meeting future sanitation and purification needs, Spain is on track for full compliance. Murcia for instance could be a good example for other autonomous regions as Extremadura or Galicia.

c) Tunisia

Tunisia has extensive experience and a long-time tradition of WWT and reuse. Today is the appropriate time for:

- Renovation of WWTPs and irrigation areas
- Revision of standards
- More coordination between public stakeholders (Ministries) (Governance issue)
- More information spreading and shearing (accelerate the establishment of the National Information System for Water "SINEAU")
- Strengthening procedures related to the involvement of farmers (set up of TRUST)
- diversifying the monitoring indicators and actors (neutral point view)
- An economic reflection to review the pricing structure of the use of treated wastewater but also identify promising markets
- A multilateral exchange between research institutions.

8. CONCLUSIONS AND RECOMMENDATIONS

The SWOT analysis looked at the success of different scenarios through a systemic approach of introspection into both positive and negative concerns of the wastewater management through community participation. Whatever course of action is decided upon, decision-making should contain each of the salient elements (i.e., building on strengths, minimizing weak-nesses, exploring opportunities and counteracting threats) to make a successful strategic management plan (the SWOT process). Strategies have been identified and formulated from the SWOT matrix in relation to increasing participation of the community and government for the SWWTR program.

For the government authority, the strategies required are:

- build partnerships with community, private sector and support organizations,
- decentralize SWWTR,
- increase the democratic process in decision-making and formulation of strategies of SWWTR for cities,
- enhance bottom-up planning by generating community-based initiatives,
- increase the government responsiveness,
- enhance comprehensive, appropriate and logical communication between government and community,
- encourage community-based organizations and SWWTR microenterprises, and
- look for mutual consensus among the stakeholders for the best solution and appropriate strategy.

In comparison between the studied case studies, we can affirm that Murcia can be an example to show the path to pursue for Tunisia for safe reuse of treated wastewater. Meanwhile, Tunisia can also show the path to pursue for Lebanon, which has a good opportunity to learn from the Tunisian experience and avoid the missteps.

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ANNEXES

Annex 1: EUROPEAN COUNCIL DIRECTIVE of 21 May 1991 concerning urban wastewater treatment (91/271/EEC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

- Having regard to the Treaty establishing the European Economic Community, and in particular 130s thereof,
- Having regard to the proposal from the Commission [1],
- Having regard to the opinion of the European Parliament [2],
- Having regard to the opinion of the Economic and Social Committee [3],
- Whereas the Council Resolution of 28 June 1988 on the protection of the North Sea and of other waters in the Community [4] invited the Commission to submit proposals for measures required at Community level for the treatment of urban waste water;
- Whereas pollution due to insufficient treatment of waste water in one Member State often influences other Member States' waters; whereas in accordance with Article 130r, action at Community level is necessary;
- Whereas to prevent the environment from being adversely affected by the disposal of insufficiently-treated urban waste water, there is a general need for secondary treatment of urban waste water;
- Whereas it is necessary in sensitive areas to require more stringent treatment; whereas in some less sensitive areas a primary treatment could be considered appropriate;
- Whereas industrial waste water entering collecting systems as well as the discharge of waste water and disposal of sludge from urban waste water treatment plants should be subject to general rules or regulations and/or specific authorizations;
- Whereas discharges from certain industrial sectors of biodegradable industrial waste water not entering urban waste water treatment plants before discharge to receiving waters should be subject to appropriate requirements;
- Whereas the recycling of sludge arising from waste water treatment should be encouraged; whereas the disposal of sludge to surface waters should be phased out;
- Whereas it is necessary to monitor treatment plants, receiving waters and the disposal of sludge to ensure that the environment is protected from the adverse effects of the discharge of waste waters;

- Whereas it is important to ensure that information on the disposal of waste water and sludge is made available to the public in the form of periodic reports;
- Whereas Member States should establish and present to the Commission national programs for the implementation of this Directive;
- Whereas a Committee should be established to assist the Commission on matters relating to the implementation of this Directive and to its adaptation to technical progress,

HAS ADOPTED THIS DIRECTIVE:

Article 1

This Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors.

The objective of the Directive is to protect the environment from the adverse effects of the abovementioned wastewater discharges.

Article 2

For the purpose of this Directive:

1. "urban waste water" means domestic waste water or the mixture of domestic waste water with industrial waste water and/or run-off rain water;
2. "domestic waste water" means waste water from residential settlements and services which originates predominantly from the human metabolism and from household activities;
3. "industrial waste water" means any waste water which is discharged from premises used for carrying on any trade or industry, other than domestic waste water and run-off rain water;
4. "agglomeration" means an area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected and conducted to an urban waste water treatment plant or to a final discharge point;
5. "collecting system" means a system of conduits which collects and conducts urban waste water;
6. "1 p.e. (population equivalent)" means the organic biodegradable load having a five-day biochemical oxygen demand (BOD5) of 60 g of oxygen per day;
7. "primary treatment" means treatment of urban waste water by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD5 of the incoming waste water is reduced by at least 20 % before discharge and the total suspended solids of the incoming waste water are reduced by at least 50 %;

8. "secondary treatment" means treatment of urban waste water by a process generally involving biological treatment with a secondary settlement or other process in which the requirements established in Table 1 of Annex I are respected;
9. "appropriate treatment" means treatment of urban waste water by any process and/or disposal system which after discharge allows the receiving waters to meet the relevant quality objectives and the relevant provisions of this and other Community Directives;
10. "Sludge" means residual sludge, whether treated or untreated, from urban wastewater treatment plants;
11. "eutrophication" means the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned;
12. "estuary" means the transitional area at the mouth of a river between fresh-water and coastal waters. Member States shall establish the outer (seaward) limits of estuaries for the purposes of this Directive as part of the program for implementation in accordance with the provisions of Article 17 (1) and (2);
13. "coastal waters" means the waters outside the low-water line or the outer limit of an estuary.

Article 3

1. Member States shall ensure that all agglomerations are provided with collecting systems for urban wastewater,
   - at the latest by 31 December 2000 for those with a population equivalent (p.e.) of more than 15000,
   - at the latest by 31 December 2005 for those with a p.e. of between 2000 and 15000.

   For urban waste water discharging into receiving waters which are considered "sensitive areas" as defined under Article 5, Member States shall ensure that collection systems are provided at the latest by 31 December 1998 for agglomerations of more than 10000 p.e.

   Where the establishment of a collecting system is not justified either because it would produce no environmental benefit or because it would involve excessive cost, individual systems or other appropriate systems which achieve the same level of environmental protection shall be used.

2. Collecting systems described in paragraph 1 shall satisfy the requirements of Annex I (A). These requirements may be amended in accordance with the procedure laid down in Article 18.

Article 4

1. Member States shall ensure that urban waste water entering collecting systems shall before discharge be subject to secondary treatment or an equivalent treatment as follows:
   - at the latest by 31 December 2000 for all discharges from agglomerations of more than 15000 p.e.,
   - at the latest by 31 December 2005 for all discharges from agglomerations of between 10000 and 15000 p.e.,
   - at the latest by 31 December 2005 for discharges to fresh-water and estuaries from agglomerations of between 2000 and 10000 p.e.
2. Urban waste water discharges to waters situated in high mountain regions (over 1500 m above sea level) where it is difficult to apply an effective biological treatment due to low temperatures may be subjected to treatment less stringent than that prescribed in paragraph 1, provided that detailed studies indicate that such discharges do not adversely affect the environment.
3. Discharges from urban wastewater treatment plants described in paragraphs 1 and 2 shall satisfy the relevant requirements of Annex I.B. These requirements may be amended in accordance with the procedure laid down in Article 18.
4. The load expressed in p.e. shall be calculated on the basis of the maximum average weekly load entering the treatment plant during the year, excluding unusual situations such as those due to heavy rain.

Article 5

1. For the purposes of paragraph 2, Member States shall by 31 December 1993 identify sensitive areas according to the criteria laid down in Annex II.
2. Member States shall ensure that urban wastewater entering collecting systems shall before discharge into sensitive areas be subject to more stringent treatment than that described in Article 4, by 31 December 1998 at the latest for all discharges from agglomerations of more than 10000p.e.
3. Discharges from urban wastewater treatment plants described in paragraph 2 shall satisfy the relevant requirements of Annex I B. These requirements may be amended in accordance with the procedure laid down in Article 18.
4. Alternatively, requirements for individual plants set out in paragraphs 2 and 3 above need not apply in sensitive areas where it can be shown that the minimum percentage of reduction of the overall load entering all urban wastewater treatment plants in that area is at least 75 % for total phosphorus and at least 75 % for total nitrogen.

5. Discharges from urban waste water treatment plants which are situated in the relevant catchment areas of sensitive areas and which contribute to the pollution of these areas shall be subject to paragraphs 2, 3 and 4.

d) In cases where the above catchment areas are situated wholly or partly in another Member State Article 9 shall apply.

6. Member States shall ensure that the identification of sensitive areas is reviewed at intervals of no more than four years.
7. Member States shall ensure that areas identified as sensitive following review under paragraph 6 shall within seven years meet the above requirements.
8. A Member State does not have to identify sensitive areas for the purpose of this Directive if it implements the treatment established under paragraphs 2, 3 and 4 over all its territory.

Article 6

1. For the purposes of paragraph 2, Member States may by 31 December 1993 identify fewer sensitive areas according to the criteria laid down in Annex II.
2. Urban waste water discharges from agglomerations of between 10000 and 150000 p.e. to coastal waters and those from agglomerations of between 2000 and 10000 p.e. to estuaries situated in areas described in paragraph 1 may be subjected to treatment less stringent than that prescribed in Article 4 providing that:
   - such discharges receive at least primary treatment as defined in Article 2 (7) in conformity with the control procedures laid down in Annex I D,
   - comprehensive studies indicate that such discharges will not adversely affect the environment.

   Member States shall provide the Commission with all relevant information concerning the abovementioned studies.
3. If the Commission considers that the conditions set out in paragraph 2 are not met, it shall submit to the Council an appropriate proposal.
4. Member States shall ensure that the identification of less sensitive areas is reviewed at intervals of not more than four years.
5. Member States shall ensure that areas no longer identified as less sensitive shall within seven years meet the requirements of Articles 4 and 5 as appropriate.

Article 7

Member States shall ensure that, by 31 December 2005, urban waste water entering collecting systems shall before discharge be subject to appropriate treatment as defined in Article 2 (9) in the following cases:

- for discharges to fresh-water and estuaries from agglomerations of less than 2000 p.e.,

- for discharges to coastal waters from agglomerations of less than 10000 p.e.

Article 8

1. Member States may, in exceptional cases due to technical problems and for geographically defined population groups, submit a special request to the Commission for a longer period for complying with Article 4.
2. This request, for which grounds must be duly put forward, shall set out the technical difficulties experienced and must propose an action program with an appropriate timetable to be undertaken to implement the objective of this Directive. This timetable shall be included in the program for implementation referred to in Article 17.
3. Only technical reasons can be accepted and the longer period referred to in paragraph 1 may not extend beyond 31 December 2005.
4. The Commission shall examine this request and take appropriate measures in accordance with the procedure laid down in Article 18.
5. In exceptional circumstances, when it can be demonstrated that more advanced treatment will not produce any environmental benefits, discharges into less sensitive areas of waste waters from agglomerations of more than 150000 p.e. may be subject to the treatment provided for in Article 6 for waste water from agglomerations of between 10000 and 150000 p.e.
6. In such circumstances, Member States shall submit beforehand the relevant documentation to the Commission. The Commission will examine the case and take appropriate measures in accordance with the procedure laid down in Article 18.

Article 9

Where waters within the area of jurisdiction of a Member State are adversely affected by discharges of urban wastewater from another Member State, the Member State whose waters are affected may notify the other Member State and the Commission of the relevant facts.

The Member States concerned shall organize, where appropriate with the Commission, the concertation necessary to identify the discharges in question and the measures to be taken at source to protect the waters that are affected in order to ensure conformity with the provisions of this Directive.

Article 10

Member States shall ensure that the urban wastewater treatment plants built to comply with the requirements of Articles 4, 5, 6 and 7 are designed, constructed, operated and maintained to ensure sufficient performance under all normal local climatic conditions. When designing the plants, seasonal variations of the load shall be taken into account.

Article 11

1. Member States shall ensure that, before 31 December 1993, the discharge of industrial wastewater into collecting systems and urban wastewater treatment plants is subject to prior regulations and/or specific authorizations by the competent authority or appropriate body.
2. Regulations and/or specific authorization shall satisfy the requirements of Annex I C. These requirements may be amended in accordance with the procedure laid down in Article 18.
3. Regulations and specific authorization shall be reviewed and if necessary, adapted at regular intervals.

Article 12

1. Treated wastewater shall be reused whenever appropriate. Disposal routes shall minimize the adverse effects on the environment.
2. Competent authorities or appropriate bodies shall ensure that the disposal of wastewater from urban wastewater treatment plants is subject to prior regulations and/or specific authorization.
3. Prior regulations and/or specific authorization of discharges from urban wastewater treatment plants made pursuant to paragraph 2 within agglomerations of 2000 to 10000 p.e. in the case of discharges to fresh waters and estuaries, and of 10000p.e. or more in respect of all discharges, shall contain conditions to satisfy the relevant requirements of Annex I B. These requirements may be amended in accordance with the procedure laid down in Article 18.
4. Regulations and/or authorization shall be reviewed and if necessary, adapted at regular intervals.

Article 13

1. Member States shall ensure that by 31 December 2000 biodegradable industrial waste water from plants belonging to the industrial sectors listed in Annex III which does not enter urban waste water

treatment plants before discharge to receiving waters shall before discharge respect conditions established in prior regulations and/or specific authorization by the competent authority or appropriate body, in respect of all discharges from plants representing 4000 p.e. or more.

2. By 31 December 1993, the competent authority or appropriate body in each Member State shall set requirements appropriate to the nature of the industry concerned for the discharge of such wastewater.
3. The Commission shall carry out a comparison of the Member States' requirements by 31 December 1994. It shall publish the results in a report and if necessary, make an appropriate proposal.

Article 14

1. Sludge arising from wastewater treatment shall be re-used whenever appropriate. Disposal routes shall minimize the adverse effects on the environment.
2. Competent authorities or appropriate bodies shall ensure that before 31 December 1998 the disposal of sludge from urban wastewater treatment plants is subject to general rules or registration or authorization.
3. Member States shall ensure that by 31 December 1998 the disposal of sludge to surface waters by dumping from ships, by discharge from pipelines or by other means is phased out.
4. Until the elimination of the forms of disposal mentioned in paragraph 3, Member States shall ensure that the total amount of toxic, persistent or bio-accumulable materials in sludge disposed of to surface waters is licensed for disposal and progressively reduced.

Article 15

1. Competent authorities or appropriate bodies shall monitor:
   - discharges from urban waste water treatment plants to verify compliance with the requirements of Annex I.B in accordance with the control procedures laid down in Annex I.D,
   - Amounts and composition of sludges disposed of to surface waters.
2. Competent authorities or appropriate bodies shall monitor waters subject to discharges from urban wastewater treatment plants and direct discharges as described in Article 13 in cases where it can be expected that the receiving environment will be significantly affected.
3. In the case of a discharge subject to the provisions of Article 6 and in the case of disposal of sludge to surface waters, Member States shall monitor and carry out any other relevant studies to verify that the discharge or disposal does not adversely affect the environment.

4. Information collected by competent authorities or appropriate bodies in complying with paragraphs 1, 2 and 3 shall be retained in the Member State and made available to the Commission within six months of receipt of a request.
5. Guidelines on the monitoring referred to in paragraphs 1, 2 and 3 may be formulated in accordance with the procedure laid down in Article 18.

Article 16

Without prejudice to the implementation of the provisions of Council Directive 90/313/EEC of 7 June 1990 on the freedom of access to information on the environment [5], Member States shall ensure that every two years the relevant authorities or bodies publish situation reports on the disposal of urban wastewater and sludge in their areas. These reports shall be transmitted to the Commission by the Member States as soon as they are published.

Article 17

1. Member States shall by 31 December 1993 establish a program for the implementation of this Directive.
2. Member States shall by 30 June 1994 provide the Commission with information on the program.
3. Member States shall, if necessary, provide the Commission by 30 June every two years with an update of the information described in paragraph 2.
4. The methods and formats to be adopted for reporting on the national programs shall be determined in accordance with the procedure laid down in Article 18. Any amendments to these methods and formats shall be adopted in accordance with the same procedure.
5. The Commission shall every two years review and assess the information received pursuant to paragraphs 2 and 3 above and publish a report thereon.

Article 18

1. The Commission shall be assisted by a Committee composed of the representatives of the Member States and chaired by the representative of the Commission.
2. The representative of the Commission shall submit to the committee a draft of the measures to be taken. The committee shall deliver its opinion on the draft within a time limit, which the chairman may lay down according to the urgency of the matter. The opinion shall be delivered by the majority laid down in Article 148 (2) of the Treaty in the case of decisions, which the Council is required to adopt on a proposal from the Commission. The votes of the representatives of the Member States

within the committee shall be weighted in the manner set out in that Article. The chairman shall not vote.

3. (a) The Commission shall adopt the measures envisaged if they are in accordance with the opinion of the committee.

(b) If the measures envisaged are not in accordance with the opinion of the committee, or if no opinion is delivered, the Commission shall, without delay, submit to the Council a proposal relating to the measures to be taken. The Council shall act by a qualified majority.

If, on the expiry of a period of three months from the date of referral to the Council, the Council has not acted, the proposed measures shall be adopted by the Commission, save where the Council has decided against the said measures by a simple majority.

Article 19

1. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive no later than 30 June 1993. They shall forthwith inform the Commission thereof.
2. When Member States adopt the measures referred to in paragraph 1, they shall contain a reference to this Directive or shall be accompanied by such a reference on the occasion of their official publication. The methods of making such a reference shall be laid down by the Member States.
3. Member States shall communicate to the Commission the texts of the main provisions of national law which they adopt in the field governed by this Directive.

Article 20

This Directive is addressed to the Member States.

Done at Brussels, 21 May 1991.

For the Council

The President

R. STEICHEN

[1] OJ No C 1, 4. 1. 1990, p. 20 and OJ No C 287, 15. 11. 1990, p. 11.

[2] OJ No C 260, 15. 10. 1990, p. 185.

[3] OJ No C 168, 10. 7. 1990, p. 36.

[4] OJ No C 209, 9. 8. 1988, p. 3.

[5] OJ No L 158, 23. 6. 1990, p. 56.

Annex 2: Lebanese Standards of Environmental Limit Values (ELV) for wastewater discharges into surface water

Parameter	For discharge to the sea	For discharge to surface watercourses	For discharge to downstream sewer networks
pH	6-9	6-9	6-9
temperature	35	30	35
BOD (mg O_2/l)	25	25	125
COD (mg O_2/l)	125	125	500
Total Phosphorus (mg/l)	10	10	10
Total Nitrogen (mg/l)	30	30	60
Suspended solids mg/l	60	60	600
AOX	5	5	5
Detergents (mg/l)	3	3	---
Coliform Bacteria 37°C in 100ml[2]	2000	2000	---
Salmonellae	Absence	Absence	Absence
Hydrocarbons (mg/l)	20	20	20
Phenol index (mg/l)	0.3	0.3	5
Oil and Gease (mg/l)	30	30	50
Total Organic Carbon (mg/l)	75	75	750
Ammonia (mg/l)	10	10	---
Silver (mg/l)	0.1	0.1	0.1
Aluminum (mg/l)	10	10	10
Arsenic (mg/l)	0.1	0.1	0.1
Barium (mg/l)	2	2	2
Cadmium (mg/l)	0.2	0.2	0.2
Cobalt (mg/l)	0.5	0.5	1
Chromium total (mg/l)	2	2	2

Parameter	For discharge to the sea	For discharge to surface watercourses	For discharge to downstream sewer networks
Hexavalent Chromium (mg/l)	0.2	0.2	0.2
Copper total (mg/l)	1.5	0.5	1
Iron total (mg/l)	5	5	5
Mercury total (mg/l)	0.05	0.05	0.05
Manganese (mg/l)	1	1	1
Nickel total (mg/l)	0.5	0.5	2
Lead total (mg/l)	0.5	0.5	1
Antimony (mg/l)	0.3	0.3	0.3
Tin total (mg/l)	2	2	2
Zinc total (mg/l)	5	5	10
Active Chlorine (mg/l)	1	1	---
Cyanides (mg/l)	0.1	0.1	1
Fluoride (mg/l)	25	25	15
Nitrate (mg/l)	90	90	---
Phosphate (mg/l)	5	5	---
Sulphate (mg/l)	1000	1000	1000
Sulphide (mg/l)	1	1	1

(source: Ministry of Environment).

Annex 3: FAO Guidelines for the reuse of treated wastewater in irrigation

	Category of treated wastewater		
Parameter	Class I	Class II	Class III
BOD_5	25	100	100
COD	125	250	250
TSS	60	200	200
pH	6-9	6-9	6-9
Cl_2 residual	30	30	30
N-NO_3	30	30	30
Faecal Coliforms (in 100ml)	<200	<1000	None required
Helminth ova (in 1 litre)	<1	<1	<1

(source: FAO)

Class I: (Irrigation of vegetable eaten raw is not allowed)

1. Fruit trees and crops that are eaten cooked

2. Parks, public gardens, lawns, golf courses and other areas with direct public exposure

3. In case of stabilization pounds, the TSS limit value is 200 mg/l.

Water treatment expected to meet the criteria: Secondary treatment + filtration + disinfection

Class II

1. Fruit trees

2. Lawns, wooded areas, and other areas with limited public access, roadsides outside urban areas

3. Landscape impoundments: ponds, water bodies and ornamental streams, where public contact with water is not allowed.

Water treatment expected to meet the criteria: Secondary treatment + filtration + disinfection or Secondary treatment + either storage or well-designed series of maturation ponds or infiltration percolation.

Class III

1. Irrigation of cereals and oleaginous seeds, fiber, & seed crops

2. Crops for canning industry, industrial crops

3. Fruit trees (except sprinkler-irrigated)

4. Plant nurseries, ornamental nurseries, wooden areas, green areas with no access to the public.

Annex 4: Spanish Regulations for Water Reuse: Extract from Royal Decree n° 1620/2007 of 7 December 2007

INTENDED USE OF WATER	MAXIMUM ACCEPTABLE VALUE (MAV)				
	INTESTINAL NEMATODES[1]	*ESCHERICHIA COLI*	SUSPENDED SOLIDS	TURBIDITY	OTHER CRITERIA
1. URBAN USES					
QUALITY 1.1: RESIDENTIAL[2] a) Irrigation of private gardens[3] b) Supply to sanitary appliances[3]	1 egg/10 L	0 (CFU[4]/100 mL)	10 mg/L	2 NTU[5]	OTHER CONTAMINANTS[6] included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances[7], use of reclaimed water must comply with environmental quality standards.[8] *Legionella spp*. 100 CFU/L (if there is a risk of aerosolization)
QUALITY 1.2: SERVICES a) Landscape irrigation of urban areas (parks, sports grounds and similar)[9] b) Street cleansing[9] c) Fire hydrants[9] d) Industrial washing of vehicles[9]	1 egg/10 L	200 CFU/100 mL	20 mg/L	10 NTU	

1 At least the following genera must be included in all quality categories: *Ancylostoma, Trichuris* and *Ascaris*.

2 Controls must be performed to ensure the correct maintenance of facilities.

3 Authorization will only be given if each section up to the point of use is a marked dual circuit.

4 Colony-forming units.

5 Nephelometric turbidity units.

6 See Appendix II of RD 849/1986, of 11 April.

7 See Appendix IV of RD 907/2007, of 6 July.

8 Environmental quality standard; see Article 245.5.a of RD 849/1986, of 11 April, amended by RD 606/2003, of 23 May

9 If there is a risk of water aerosolization, the conditions of use stipulated on a case-by-case basis by public health authorities must be followed; otherwise, such uses will not be authorized.

INTENDED USE OF WATER	MAXIMUM ACCEPTABLE VALUE (MAV)				
	INTESTINAL NEMATODES	*ESCHERICHIA COLI*	SUSPENDED SOLIDS	TURBIDITY	OTHER CRITERIA
2. AGRICULTURAL USES[1]					
QUALITY 2.1[2] a) Crop irrigation using a system whereby reclaimed water comes into direct contact with edible parts of crops to be eaten raw.	1 egg/10 L	100 CFU/100 mL Based on a 3-class sampling plan[3] with the following values: n = 10 m = 100 CFU/100 mL M = 1,000 CFU/100 mL c = 3	20 mg/L	10 NTU	OTHER CONTAMINANTS included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances, use of reclaimed water must comply with environmental quality standards. *Legionella spp*. 1,000 CFU/L (if there is a risk of aerosolization) It is compulsory to conduct detection tests for presence-absence of pathogen (*Salmonella*, etc.) when results repeatedly show that c=3 for M=1,000.

1 Reclaimed water characteristics that require additional information: Conductivity, 3.0 dS/m; Sodium Adsorption Ratio (SAR), 6 ; Boron, 0.5 mg/L; Arsenic, 0.1 mg/L; Beryllium, 0.1 mg/L; Cadmium, 0.01 mg/L; Cobalt, 0.05 mg/L; Chrome, 0.1 mg/L; Copper, 0.2 mg/L; Manganese, 0.2 mg/L; Molybdenum, 0.01 mg/L; Nickel, 0.2 mg/L; Selenium, 0.02 mg/L; Vanadium, 0.1 mg/L. The following formula should be used to calculate the SAR (a dimensionless value, indicated by translators): Sodium Absorption Rate.

2 If there is a risk of water aerosolization, the conditions of use stipulated on a case-by-case basis by public health authorities must be followed; otherwise, such uses will not be authorized.

3 Where n = number of aliquot samples analyzed; m = (MAV) maximum acceptable value for the bacterial count; M = maximum permitted value for the bacterial count (MAV + Maximum Deviation Limit); c =maximum number of aliquot samples whose bacterial count falls between “m” and “M”.

INTENDED USE OF WATER	MAXIMUM ACCEPTABLE VALUE (MAV)				
	INTESTINAL NEMATODES	*ESCHERICHIA COLI*	SUSPENDED SOLIDS	TURBIDITY	OTHER CRITERIA
QUALITY 2.2 a) Irrigation of crops for human consumption using application methods that do not prevent direct contact of reclaimed with edible parts of the plants, which are not eaten raw but after an industrial treatment process. b) Irrigation of pastureland for milk- or meat-producing animals. c) Aquaculture.	1 egg/10 L	1,000 CFU/100 mL Based on a 3-class sampling plan[1] with the following values: n = 10 m = 1,000 CFU/100 mL M = 10,000 CFU/100 mL c = 3	35 mg/L	No set limit	OTHER CONTAMINANTS included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances, use of reclaimed water must comply with environmental quality standards. *Taenia saginata* and *Taenia solium:* 1 egg/L (when irrigating pastureland for milk- or meat producing animals) It is compulsory to conduct detection tests for presence-absence of pathogen (*Salmonella*, etc.) when results repeatedly show c=3 for M=10,000.
QUALITY 2.3 a) Localized irrigation of tree crops whereby reclaimed water is not allowed to come into contact with fruit for human consumption. b) Irrigation of ornamental flowers, nurseries and greenhouses whereby reclaimed water does not come into contact with the crops. c) Irrigation of industrial non-food crops, nurseries, silo fodder, cereals and oilseeds.	1 egg/10 L	10,000 CFU/100 mL	35 mg/L	No set limit	OTHER CONTAMINANTS included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances, use of reclaimed water must comply with environmental quality standards. *Legionella spp*. 100 CFU/L

1 Where n = number of aliquot samples analyzed; m = (MAV) maximum acceptable value for the bacterial count; M = maximum permitted value for the bacterial count (MAV + Maximum Deviation Limit); c = maximum number of aliquot samples whose bacterial count falls between "m" and "M".

INTENDED USE OF WATER	MAXIMUM ACCEPTABLE VALUE (MAV)				
	INTESTINAL NEMATODES	*ESCHERICHIA COLI*	SUSPENDED SOLIDS	TURBIDITY	OTHER CRITERIA
3. INDUSTRIAL USES					
QUALITY 3.1[1] a) Process and cleaning water, except for use in the food industry. b) Other industrial uses.	No set limit	10,000 CFU/100 mL	35 mg/L	15 NTU	OTHER CONTAMINANTS included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances, use of reclaimed water must comply with environmental quality standards. *Legionella spp.:* 100 CFU/L
c) Process and cleaning water for use in the food industry.	1 egg/10 L	1.000 CFU/100 mL Based on a 3-class sampling plan [2] with the following values: n = 10 m = 1,000 CFU/100 mL M = 10,000 CFU/100 mL c = 3	35 mg/L	No set limit	OTHER CONTAMINANTS included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances, use of reclaimed water must comply with environmental quality standards. *Legionella spp*.: 100 CFU/L It is compulsory to conduct detection tests for presence absence of pathogen (*Salmonella*, etc.) when results repeatedly show that c=3 for M=10,000
QUALITY 3.2 a) Cooling towers and evaporative condensers.	1 egg/10 L	Absence CFU/100 mL	5 mg/L	1 NTU	*Legionella spp*: Absence CFU/L Authorization is subject to: - Approval by public health authorities of a facility's specific control program, as provided for in Royal Decree 865/2003, of 4 July, on the health and hygienic criteria for the prevention and control of legionnaires' disease. - Use for industrial purposes only and in facilities that are not located in urban areas or near public or /commercial buildings.

1 If there is a risk of water aerosolization, the conditions of use stipulated on a case-by-case basis by public health authorities must be followed; otherwise, such uses will not be authorized.

2 Where n = number of aliquot samples analyzed; m = (MAV) maximum acceptable value for the bacterial count; M = maximum permitted value for the bacterial count (MAV + Maximum Deviation Limit); c = maximum number of aliquot samples whose bacterial count falls between "m" and "M".

INTENDED USE OF WATER	MAXIMUM ACCEPTABLE VALUE (MAV)				
	INTESTINAL NEMATODES	*ESCHERICHIA COLI*	SUSPENDED SOLIDS	TURBIDITY	OTHER CRITERIA
4. RECREATIONAL USES					
QUALITY 4.1[1] a) Golf course irrigation.	1 egg/10 L	CFU200 /100 mL	20 mg/L	10 NTU	OTHER CONTAMINANTS included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances, use of reclaimed water must comply with environmental quality standards. If irrigation water is directly applied to soil (drip irrigation, micro-sprinkler), criteria for Quality 2.3 shall apply. *Legionella spp*. 100 CFU/L (if there is a risk of aerosolization)
QUALITY 4.2 a) Ornamental ponds and lakes in which public access to water is prohibited.	No set limit	10,000 CFU/100 mL	35 mg/L	No set limit	OTHER CONTAMINANTS included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances, use of reclaimed water must comply with environmental quality standards. PT: 2 mg P/L (in standing water)

1 If there is a risk of water aerosolization, the conditions of use stipulated on a case-by-case basis by public health authorities must be followed; otherwise, such uses will not be authorized.

INTENDED USE OF WATER	MAXIMUM ACCEPTABLE VALUE (MAV)				
	INTESTINAL NEMATODES	*ESCHERICHIA COLI*	SUSPENDED SOLIDS	TURBIDITY	OTHER CRITERIA
5. ENVIRONMENTAL USES					
QUALITY 5.1 a) Aquifer recharge by localized percolation through the ground.	No set limit	CFU1/100 mL ,000	35 mg/L	No set limit	$N_{T\,1}$: 10 mg N/L NO_3: 25 mg NO_3/L Articles 257 to 259 of RD 849/1986.
QUALITY 5.2 a) Aquifer recharge by direct injection.	1 egg/10 L	CFU/100 mL 0	10 mg/L	2 NTU	
QUALITY 5.3 a) Irrigation of woodland, green areas and other spaces not accessible to the public. b) Sylviculture.	No set limit	No set limit	35 mg/L	No set limit	OTHER CONTAMINANTS included in the treated effluent disposal permit: discharge of these contaminants to the environment must be limited. In the case of hazardous substances, use of reclaimed water must comply with environmental quality standards.
QUALITY 5.4 a) Other environmental uses (maintenance of wetlands, minimum stream flows and similar).	Minimum quality requirements will be set on a case-by-case basis.				

1 Total nitrogen: the sum of the inorganic and organic nitrogen in the sample.