Towards Sustainable Treatment and Reuse of Wastewater in the Mediterranean Region

Local Action and Investment Plans

(Output 6.1)

31 August 2023

The AQUACYCLE project is funded and supported by the European Union through the ENI CBC Mediterranean Sea Basin Programme under the Grant Contract A_B41_0027_AQUACYCLE.
Project duration: 50 months (September 2019 – October 2023)

Towards Sustainable Treatment and Reuse of Wastewater in the Mediterranean Region
ENI CBC MED Grant Contract
A_B41_0027_AQUACYCLE
http://www.enicbcmed.eu/projects/aquacycle/

Local Action and Investment Plans (Output 6.1)

Contributors

Dirk De Ketelaere, Anna Spiteri (Editors)
Integrated Resources Management Co Ltd, (IRMCo), Malta
www.environmentalmalta.com

Ahmad El Moll, Mohamad Khalil, Tawfik AL-Naboulsi, Fatima Yahya, Omar Nashar
Faculty of Public Health & Doctoral School of Science & Technology, Lebanese University (UL), Lebanon
https://www.ul.edu.lb/

Hamadi Kallali, Yasmin Cherni, Samira Melki, Mohamad Ali Wahab
Centre des Recherches et des Technologies des Eaux (CERTE), Tunisia
http://www.certe.rnrt.tn/

Fadel M'Hiri, Khitem Mensi, Anis Ghattassi, Safa Chaabane
Centre International des Technologies de l' Environnement de Tunis (CITET), Tunisia
http://www.citet.nat.tn

Isabel Oller Alberola, Inmaculada Polo López, Leila Samira Nahim Granados
Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, Plataforma Solar de Almería (CIEMAT-PSA), Spain
http://www.psa.es/

Pedro Jose Simon Andreu
Entidad de Saneamiento y Depuración de la Región de Murcia (ESAMUR), Spain
http://www.esamur.com/

Anastasios Karabelas, Plakas Konstantinos, Ioannis Manakos, Rizos Theodoros Chadoulis, Eleanna Pana
Centre for Research &Technology Hellas (CERTH), Greece
https://www.certh.gr/

This document has been produced with the financial assistance of the European Union under the ENI CBC Mediterranean Sea Basin Programme. The contents of this document are the sole responsibility of CERTH and IRMCo and can under no circumstances be regarded as reflecting the position of the European Union or the Programme management structures

The 2014-2020 ENI CBC Mediterranean Sea Basin Programme is a multilateral Cross-Border Cooperation (CBC) initiative funded by the European Neighbourhood Instrument (ENI). The Programme objective is to foster fair, equitable and sustainable economic, social and territorial development, which may advance cross-border integration and valorise participating countries' territories and values. The following 13 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestine, Portugal, Spain, Tunisia. The Managing Authority (JMA) is the Autonomous Region of Sardinia (Italy). Official Programme languages are Arabic, English and French. For more information, please visit: www.enicbcmed.eu.

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.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Executive Summary

The present **Local Action and Investment Plans** report informs about the aims and outcomes of the third series of stakeholders which was joined mainly by representatives at the local decision-making level, i.e. councillors of municipalities and representatives of Unions of Municipalities in Lebanon, and by policy- and decision-makers at the national level in Tunisia. Organized as a webinar in Spain, the event was joined mainly by wastewater treatment plant operators and technicians, as well as by entities involved in the planning and design of wastewater treatment projects, and research entities on wastewater treatment systems.

While the first chapter reiterates on the aims and scope of the events, the second chapter informs about the preparatory activity of drawing up actions plans with a target of reusing 300.000 m^3 of treated wastewater per annum. The third chapter informs, briefly, about the presentations that were made at the respective events, while the fourth chapter brings the succinct outcomes from of the discussions and exchange of views that took place. Finally, chapter 5 takes stock of the significant level of attendance and of the wide media coverage that were achieved on the occasion of the third, and final, series of stakeholder workshops.

1. Aims and scope of the third series of stakeholder workshops

In contrast to the second series of stakeholder workshops which was addressed to the local communities around the pilot demonstration sites of AQUACYCLEs eco-innovative wastewater treatment system in Lebanon, Spain and Tunisia, the third series of stakeholder workshops was targeted to potential investors, national policy and decision-makers in the water and sanitation sector, agricultural, health and land use planning sectors; water managers, wastewater treatment operators; and municipal authorities around the demonstration sites.

The pilot demonstration sites are located (see Fig. 1), at a site owned by the real estate company Sanabel in Deddeh, which is located south of Tripoli in Lebanon; at the existing wastewater treatment facility in the Murcia Region of Spain (Blanca); and at a site in the Zaghouan Governorate of Tunisia (Bent Saidane).

Figure 1: ***Satellite images of the demonstration location sites in Lebanon, Spain and Tunisia***

The final series of workshops was planned with a 3-fold purpose:

1) To invite participants' appraisal of the project's WebGIS to arrive at actions plans for the reuse of treated wastewater;
2) To innvite participants' viewpoints on investment routes and opportunities for the implementation of reuse action plans; and
3) To invite participants' appraisal of the semi-final version of the MedAPOC Charter, which among other, drew on outcomes and feedback collected from the local comunities who participated in the second series of stakeholder workshops. More specifically, the former were aimed at (a) the collection of bottom-up inputs towards the drawing up of reuse action plans of treated domestic wastewater, and (b) to collect the 'voices' and 'aspirations' with respect to reuse of treated domestic wastewater of local communities in Lebanon, Spain and Tunisia in a charter for the safe and sustainable reuse of treated domestic wastewater, i.e., the foreseen MedAPOC Charter. This title for the charter directly links to AQUACYCLE's eco-innovative domestic wastewater treatment system, the APOC system. The scope and outcomes of the second purpose of the workshops were collected in the MedAPOC Charter (Output 6.2, part 2).

1.1 Context and purpose of demonstrating the functionality of the project's WebGIS

The originally foreseen pathway to arrive at action plans for the reuse of treated wastewater, with a target volume of 300,000 m^3 per year, was through the collection of bottom-up inputs by the local communities. However, the attention had been drawn by the Italian company NAXTA, which was entrusted with an audit performance of the ENI CBC Med programme, to the selection of key programme performance indicators, and in particular the indicator pertaining to the drawing up of action plans for the reuse of treated wastewater with a target volume of 300,000 m^3 per year.

More specifically the NAXTA representatives expressed concern that although the latter target represents the volume of domestic effluent that is typically generated in one year by a small to medium sized rural community, the volume of domestic effluent to be treated by the pilot demonstration units is limited to around just 5 to 25 m^3 per day. Hence, In NAXTA's view, inviting local communities to draw up action plans targeting a volume of 300,000 m^3 per year would be giving them the false impression that such a volume was going to be made available directly from the demonstration units, which is clearly not the case, since the design volume of the demonstration is limited to between 5 and 25 m^3/day.

In Chapter 2, it is elaborated in more detail how an alternative pathway to reach action plans for the reuse of 300,000 m^3 of treated wastewater per year was achieved based on the project's Irrigation Suggestion Tool developed by PhD candidate MSc. Rizos Theodoros Chadoulis, Research Fellow, under the guidance of Dr. Ioannis Manakos, Principal Researcher, who conceptualized, led the design and followed up the realization. Both are employed at the Information Technologies Institute (ITI), Centre for Research and Technology Hellas (CERTH), AQUACYCLE's Lead Beneficiary.

1.2 Invitation Cards to the third series of stakeholder workshops

The invitation cards to the third series of stakeholder workshops, designed by Eleanna Pana (CERTH) are illustrated in the figure below.

Figure 2: Invitation cards to third series of stakeholder workshops (clockwise) in Lebanon, Tunisia and Spain

2. Local action plans for the reuse of treated wastewater in Lebanon, Tunisia and Spain

2.1 Application of WebGIS functionality in Lebanon and in Tunisia

For the reasons explained in the previous section (1.1), prior to the third series of workshops, the partners in Lebanon and in Tunisia drew up actions plans for the reuse of treated wastewater with a target volume of 300,000 m^3 per year, using the WebGIS functionality developed by the Lead-Beneficiary, CERTH.

This section informs how this was accomplished in more detail and then also shared with the participants who joined the third series of stakeholder workshops.

Figure 3: Access page to the online Irrigation Suggestion Tool (http://web-gis-irrigation.iti.gr/)

As shown in Fig. 3, a visitor is informed that the Irrigation Suggestion Tool is a WebGIS application for automatically querying a stack of raster files to find the areas for which irrigation is possible and viable.

Typically, a user will be required to start by uploading a set of maps available for a given area of interest - and this can be any location in the world - that are relevant to the task at hand. All maps are stored in raster format by the WebGIS, i.e. closed polygon shapes are replaced by sets of square pixels.

Once the upload is completed, each of the maps can be used to define relevant criteria. A digital elevation model (DEM) can be queried to, for example, retain only areas at a topographic elevation which would not bring about excessive pumping costs, i.e. to retain only areas to which irrigation water could be supplied in an economically viable manner. Once the user has defined criteria for the respective maps, and presses the 'submit' button, the WebGIS generates the output in a matter seconds.

By way of illustration, the set of maps uploaded for the Deddeh Koura area in North Lebanon and the criteria applied to each of the maps is shown in Table 1.

Once relevant criteria have been selected and the user has defined the geospatial bounds of the area of interest (shown by the rectangle in blue in Fig. 3), the user is prompted to "submit" the query (rectangular button encircled in green in Fig. 4). Within seconds, the WebGIS displays all the pixels within the area of interest in black colour.

The attention of users is drawn to the fact that the output can only be representative of the information that has been uploaded to the WebGIS. As with any decision-support tool, a user is invited to carefully check the degree of accuracy and timeliness of the maps supplied but should additionally bear in mind that the WebGIS can perform queries only on the basis of the information made available to it.

Table 1: WebGIS layers and example criteria applied for Deddeh Koura, North Lebanon

Layer name	Example Criteria
Elevation	Do not exceed an elevation of 255 metres AMSL (= stay within 25 metres above the topographic elevation of 230 m AMSL of the pilot demonstration unit to avoid excessive pumping costs)
Artificial areas	Exclude all areas except green urban and green sports areas
Agricultural areas	Include only active agricultural food production = exclude urban sprawl areas, abandoned agricultural land and livestock rearing units, e.g. poultry farms)
Wooded lands	Include only agricultural units
Other Land use/Land cover	Exclude all other land use/land cover categories
Soil type	Exclude coastal sand, sand dunes and gravel
Geospatial Bounds	Draw a rectangle around the location of Deddeh (shown by blue rectangle in Fig. 3)

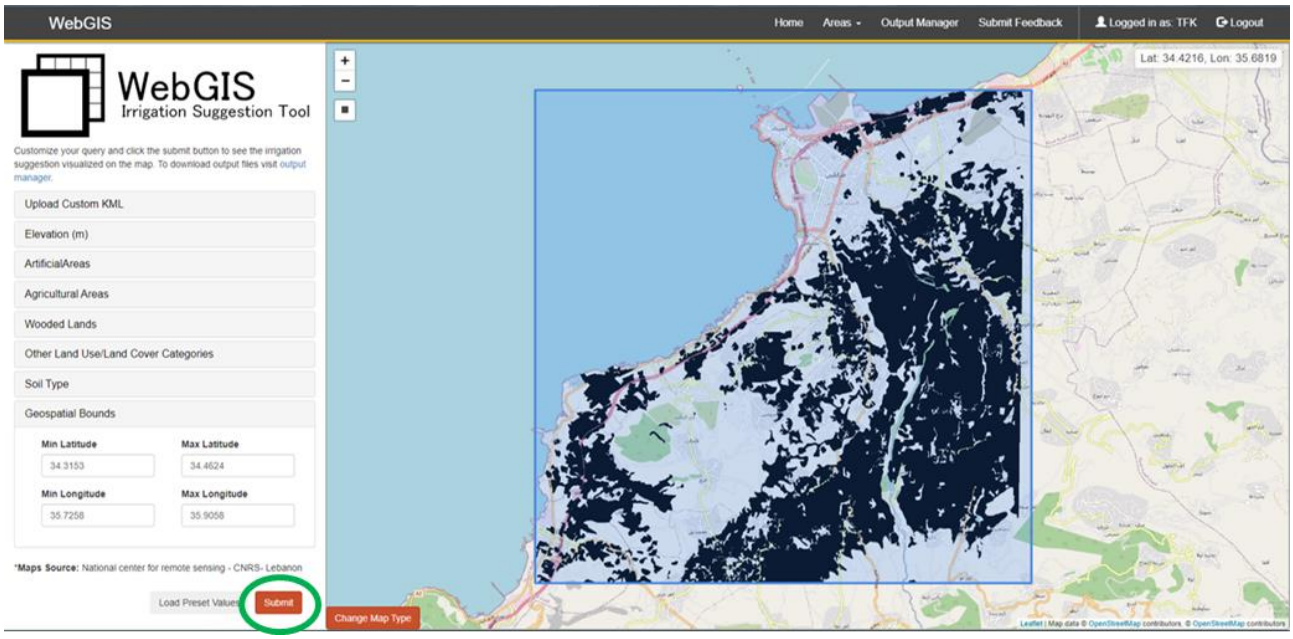

Figure 4: WebGIS displays pixels (in black) that satisfy all the example criteria within the environs of Deddeh Koura, North Lebanon

A further functionality was added to the WebGIS which permits the user to export the raster output into a .kml shape file. This functionality was motivated to enable the AQUACYCLE research teams to import the WebGIS output back onto the PGIS landing pages which had been developed to collect bottom-up inputs towards the drawing up of action plans for the reuse of treated wastewater.

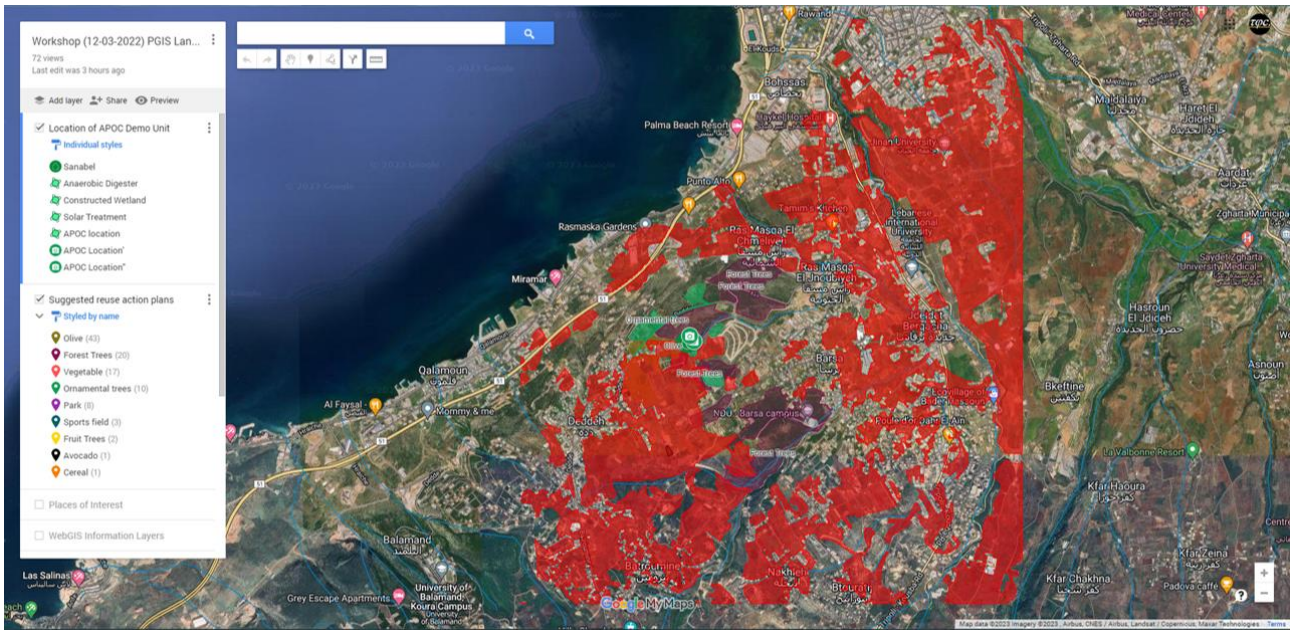

Figure 5: WebGIS output imported onto PGIS Landing page for Deddeh Koura, North Lebanon

In a consequent step, a user can compare the output thus obtained against the existing irrigation areas to find out which of these could be replaced either in part or entirely through the use of treated wastewater. Currently irrigated areas in the environs of Deddeh Koura, North Lebanon, are shown in Fig. 4. The total surface of these irrigated areas amounts to just over 209 ha, and the detailed breakdown in relation to the crop types is presented in Table 2.

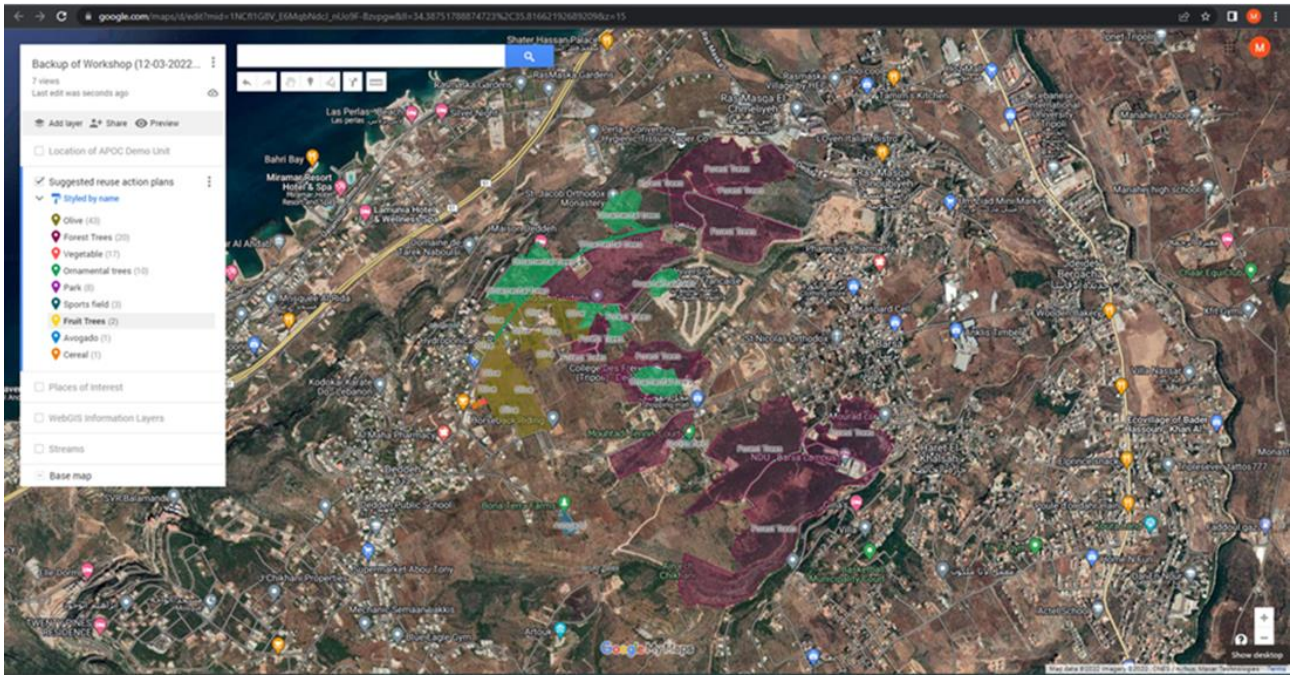

Figure 6: Currently irrigated areas and type of irrigation application in the environs of Deddeh Koura, North Lebanon

Table 2: Actual irrigated areas in environs of Deddeh Koura, North Lebanon

Crop	Area (ha)	Crop	Area (ha)
Avocado	0.75	Ornamental trees	22.939
Cereal	0.184	Park	5.554
Forest trees	141.176	Sports Field	6.187
Fruit trees	2.09	Vegetable	7.081
Olive	23.393	**Aggregate Total**	**209.354**

Assuming an annual irrigation volume of 1000 mm per hectare, all of the currently irrigated areas in the environs, together with a further 90 ha of land to reach an action plan with the target volume of 300.000 m^3 of treated wastewater per annum. However, this may not necessarily be the most optimum action plan.

In the final step to arrive at an optimum action plan for the reuse of treated domestic effluent, the outcome obtained from the Irrigation Support Tool (Fig. 5), which aggregates to an area of 1.470 ha can be overlaid on the map showing the actual irrigated areas on the PGIS Landing Page (Fig. 6) to determine the most viable areas for irrigation to then match an irrigation volume of 300.000 m^3 per annum with treated wastewater:

Table 3: Potential action plans requiring 300.000 m^3 of treated wastewater

Action plan based on:	Area (ha)	Required Irrigation volume (m^3)
WebGIS output (areas that can be irrigated in a cost-effective manner)	1.470	1.470.000
Replacing actual irrigation areas with treated wastewater	209	209.000
Overlay (crossing of above maps in a GIS environment)	**300**	**300.000**

As can be derived from Table 3, there are an infinite number of options to reach an action plan around the environs in Deddeh for the reuse of 300.000 m^3 of treated wastewater per annum. However, it is clearly logical that an optimum plan would consider (in order of priority):

1) Replace areas as indicated by the WebGIS that match areas which are already under irrigation (to replace the irrigation with conventional water resources with treated wastewater),
2) Add areas as suggested by the local community that match the output of the WebGIS, thereby encouraging a sense of ownership of the resulting action plan, and
3) Add further areas to the action plan that are in the closest proximity to the outlet of the treatment plant (resulting in the most cost-efficient irrigation network) up to a volume of 300.000 m of treated wastewater (the volume that is purported to be available on an annual basis).

The same steps were applied to determine an action plan for the reuse of treated wastewater in the Bent Saidane environs in the Zaghouan Governorate of Tunisia. The land use/land cover map is illustrated in Figure 7 while the irrigated perimeters and crop types in the environs of Bent Saidane are illustrated in Figure 8.

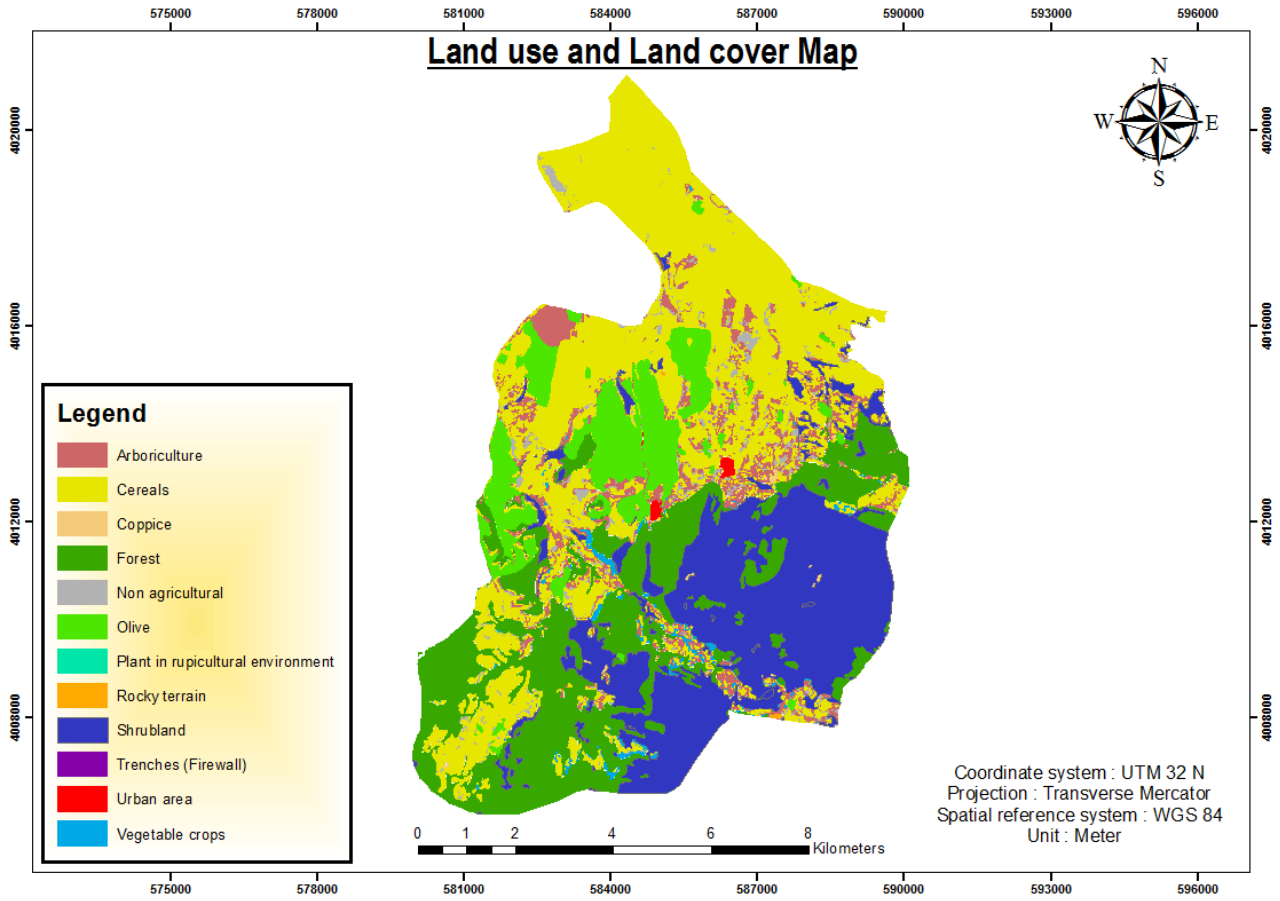

Figure 7: Land use/Land cover map of the environs of Bent Saidane, Zaghouan Governorate, Tunisia

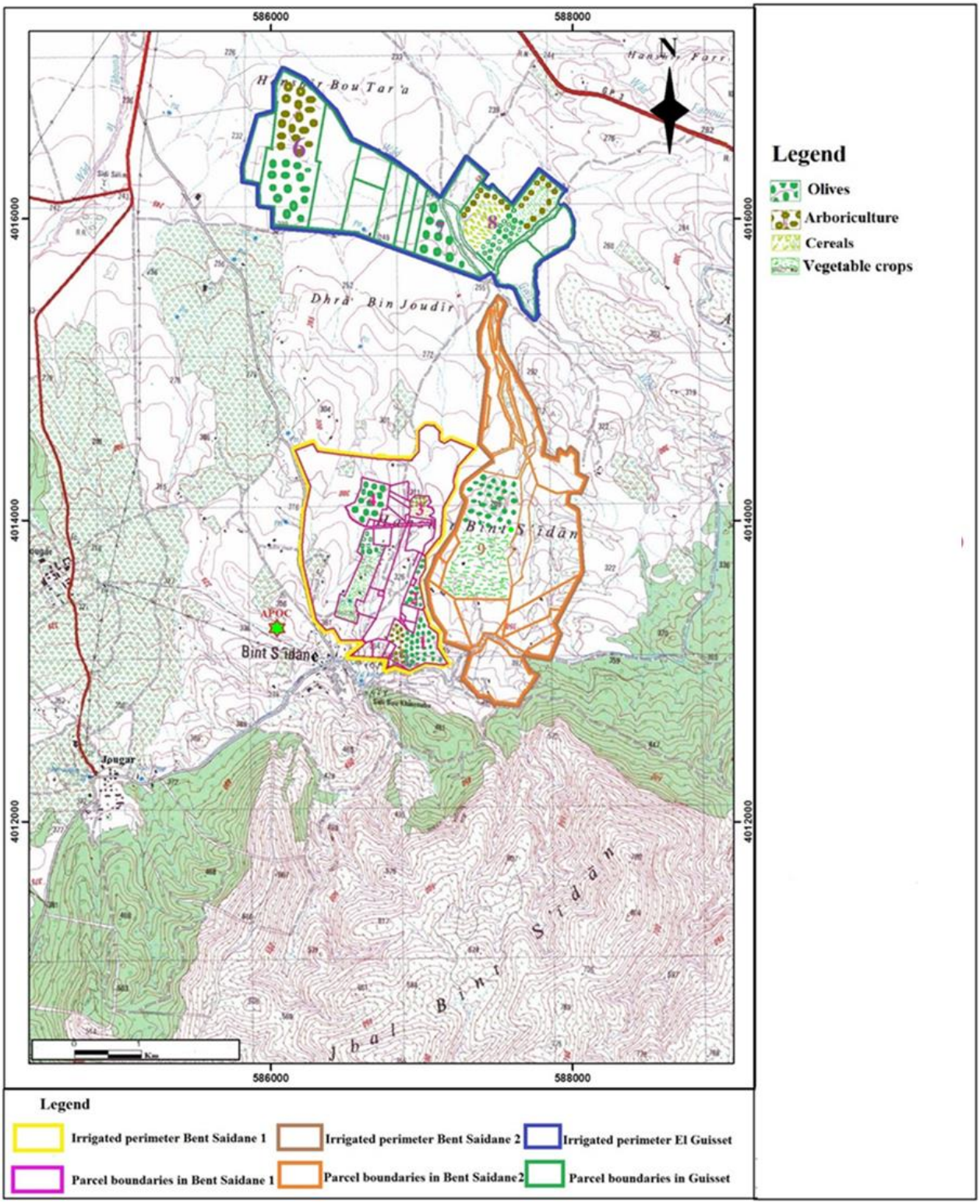

Figure 8: Irrigated perimeters and crop types in the environs of Bent Saidane, Tunisia

2.2 Demonstrating the high level of reuse of treated wastewater in the Murcia Region of Spain

From the outset, it was clear that the third workshop in Spain would bring the opportunity to showcase the very high level of reuse of treated domestic effluent that is achieved in the Murcia Region of Spain to stakeholders in the neighbouring province of Almería, and to other areas in Spain where the reuse of treated wastewater is still in its infancy, as is the case for the greater part across Europe as a whole.

Figure 9 illustrates the clearly very high level of reuse of treated wastewater around the Blanca wastewater treatment facility in the Murcia Region of Spain.

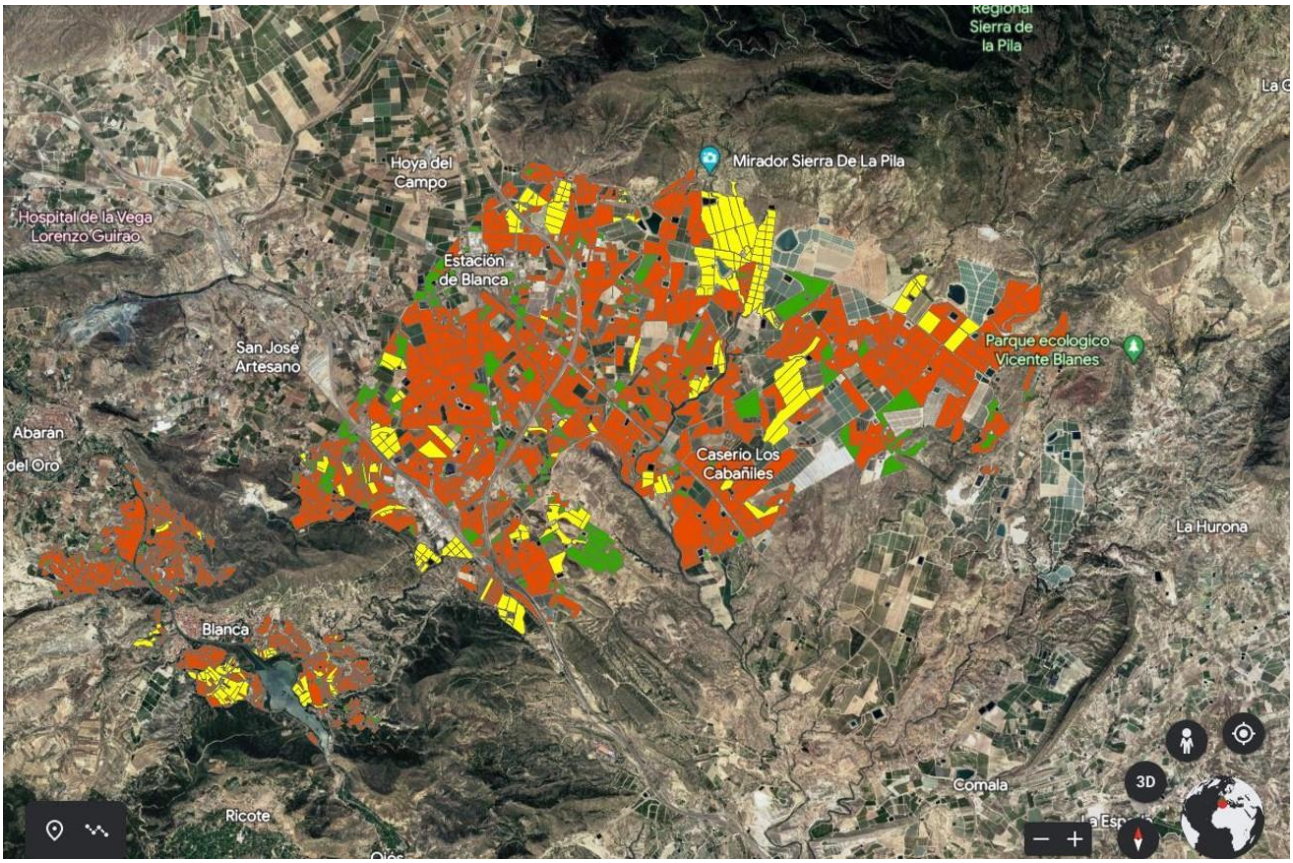

Figure 9: Actual reuse of treated wastewater in the environs of Blanca, Murcia Region, Spain

The total surface area that is being irrigated with treated wastewater is 2.798 Hectares (Ha). It is particularly noteworthy that this area is being supplied with 4.500 m^3/ha/year. Thus, the annual volume of treated wastewater being consumed is over **12.5 million m^3**!

3. Proceedings the third series of stakeholder workshops

3.1 Proceedings of the workshop in Lebanon

The workshop programme included interactive sessions during which civil society representatives, including members of the Municipal Council in Tripoli, the Union of Fayhaa Municipalities, the Union of Municipalities of Zgharta Al-Zawiya and local NGOs participated and expressed their perceptions and challenges related to wastewater reuse.

As part of the opening ceremony, Dr. Ahmad El Moll, Team Leader at the Lebanese University in the AQUACYCLE Partnership discussed about "the role of the European Union, through the ENI CBC Med Programme, in supporting projects in the field of water recycling and treatment, and the use of participatory geographic information systems to increase awareness and secure active participation in action plans, local investments, and the reuse of treated water." The project's main researcher, Dr. Tawfik Al-Nabulsi, gave a detailed presentation of the innovative technologies used in the AQUACYCLE project, in terms of operating the station based on renewable energy according to the principles of the circular economy and the workflow of the project according to a timetable for its implementation in the Deddeh Koura area of North Lebanon. Dr. Fatima Yahya followed up with a presentation on the importance of involving local communities in drawing up action plans for the reuse of treated wastewater by giving a detailed presentation of the MedAPOC Charter. Eng. Omar Nashar spoke about the importance of "using participatory geographic information systems (WebGIS) as a decision support for developing action plans for the reuse of treated water."

The closing session centred on the important features of the APOC technology that make it environmentally friendly and cost effective because it relies on natural systems, uses fewer chemicals, is powered by renewable energy (solar radiation), and produces biogas, fertilizer, and clean water for reuse in agriculture or other applications. Finally, the participants discussed the need for concerted efforts to develop the wastewater sector in Lebanon and the possibility of including eco-innovative wastewater treatment solutions in the national strategy for the water sector through the establishment of decentralized stations in many Lebanese towns because of the benefits in economic, environmental and social terms.

Figure 10: Participants in the workshop organized at Nawfal Palace, Tripoli, Lebanon on 18 May 2023
(Source: Group photo of participants featured on Lebanon's National News Agency, NNA, which can be accessed through this link)

3.2 Proceedings of the webinar in Spain

The online workshop started with the welcome from Dr. Isabel Oller, Team Leader of CIEMAT-PSA in the AQUACYCLE partnership, following an invitation for each of the participants to briefly introduce themselves.

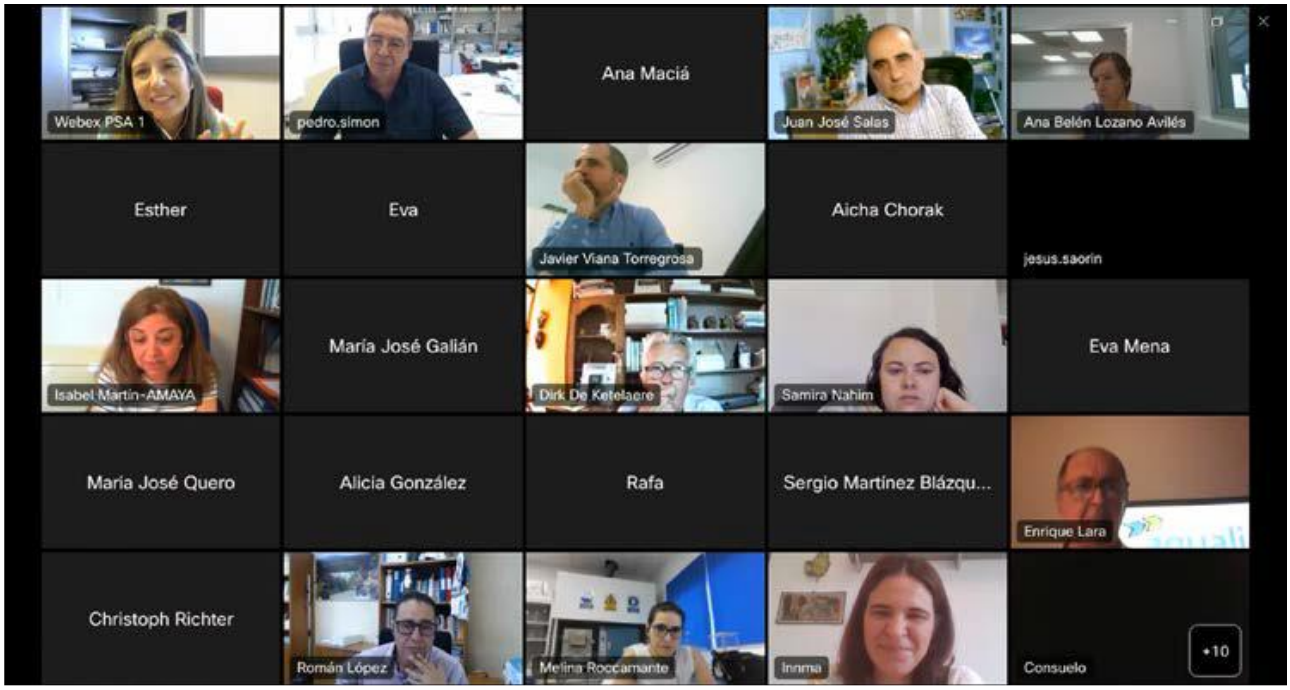

Figure 11: Screenshot of participants briefly introducing themselves at the start of the webinar

Prior to her introductory presentation on the ENI CBC Med Programme, Dr. Isabel Oller introduced the invited experts to the online workshop. Figure 12 brings a screenshot of the moment in which she introduced the four experts to the webinar together with their affiliation.

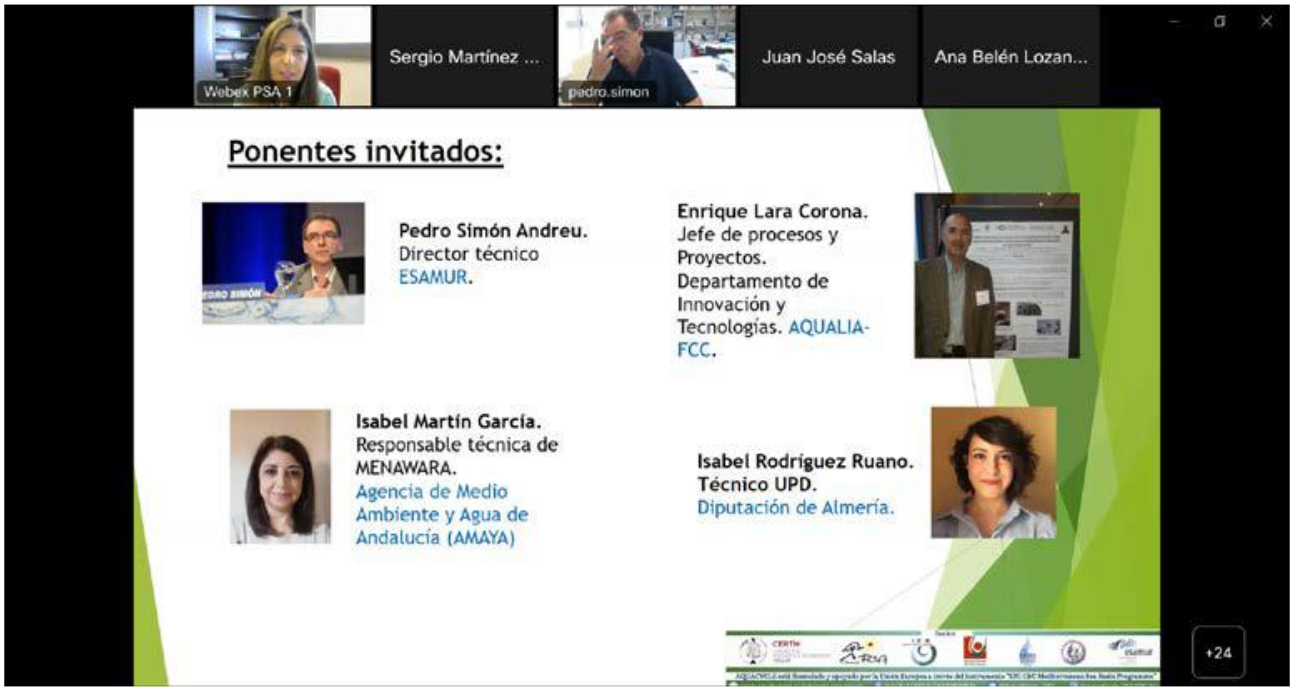

Figure 12: Screenshot introducing the four invited experts to the workshop and their affiliation

Dr. Isabel Oller continued with a short presentation about the Plataforma Solar de Almería (PSA), the largest scientific and technical facility in Europe devoted to Solar Thermal technologies and solar photochemistry applications. She then went on to explain in detail about the APOC technology, focusing in particular on the pilot demo site constructed by ESAMUR and CIEMAT-PSA at the Municipal Wastewater Treatment Plant in Blanca, a town in the Region of Murcia, Spain, as shown in Figure 13.

Figure 13: Screenshot introducing AQUACYCLE's APOC pilot demo unit at the Blanca Municipal Wastewater Treatment Plant in Murcia, Spain

Dr. Isabel Oller then continued with a review of the target groups and final beneficiaries at national and regional level who had joined the third series of workshops, a brief explanation of AQUACYLE's Capitalization Plan to ensure sustainability of outcomes of the project beyond end-of-project-lifetime and the project's cross-border cooperation achievements.

Next, Mr. Pedro Simón, Team Leader at the Sanitation Entity of the Murcia Region (ESAMUR), continued with a presentation showing the main results obtained by the APOC wastewater treatment system in Spain. He started off with a detailed description of the anaerobic biological reactor at Blanca which was constructed in the framework of an EU-funded LIFE project. In his presentation, he covered not only the main results that were obtained but also the recommendations about the parameters which are key for a good performance and design of this kind of bioreactors, as well as the challenges related with low temperatures and the presence of sulphates. Then, Mr. Simón presented the technological details of both the vertical and the horizontal wetland which were added to the existing anaerobic digester as part of the AQUACYCLE project. He drew the conclusion that the analyses of effluent had shown that the flow capacity of both wetlands had been underestimated and experts had recommended to increase it to improve the results obtained, in particular with regard to the elimination of nutrients. On the other hand, he drew the attention that the presence of ammonia or nitrate in the outlet could be of actual interest in view of reusing the treated wastewater for the purpose of crop irrigation.

Dr. Isabel Oller then continued with a presentation of the very latest results obtained in pilot scale experiments at the CIEMAT-PSA premises using different types of oxidant concentrations in the third and final component of the APOC system, i.e. the raceway pond reactor for solar disinfection of the treated wastewater. She duly noted that in these experiments, the actual effluents were being used of the anaerobic and wetland pilot demo system of the wastewater treatment facility in Blanca. She then explained how the main objective of these experiments is to verify whether the quality of the treated wastewater is in compliance with the recently introduced EU Regulation on the Minimum Requirements for Water Reuse, EU 2020/741. From these pilot scale experiments, the best concentration of oxidant will be selected to be applied in batch mode in the raceway pond reactor of the APOC pilot demo site in Blanca.

Prior to the end of the first session, Dr. Inmaculada Polo from CIEMAT-PSA presented a review about the potential of the webGIS based Irrigation Support Tool developed in the framework of the ENI CBC Med funded AQUACYCLE project. The prototype WebGIS decision-support tool targets public authorities and the associated sewerage companies at the National/Regional/Local level who wish to explore the optimum configuration of irrigation networks (in this instance irrigation with non-conventional water resources) based on criteria as defined by the user.

The second part of the online workshop invited the four invited experts to focus their talks on the action plans which Murcia and Almería are adopting to comply with the new EU Regulation on the Minimum Requirements for Water Reuse, which entered into force on 26 June 2023[1]. The experts were also invited to elaborate on the challenges that must be identified and faced when scaling up Nature-based Solutions such as constructed wetlands and the integration of different technologies (anaerobic digestion, constructed wetlands, solar disinfection) for achieving the required water quality of treated wastewater for reuse purposes such as crop irrigation.

Brief write-ups on presentations in second part of the workshop, entitled: "Water Regeneration in Murcia and Almería (Spain)"

"Action plans of ESAMUR to adapt to the new EU Regulation on wastewater reuse"
Mr. Pedro Simón (ESAMUR)

Mr. Pedro Simón, a distinguished expert on tertiary/quaternary treatment technologies for municipal wastewater reuse, provided a comprehensive overview, starting off with a comparison between the Spanish legislation in force on water reuse and the more stringent parameters established in the new EU Regulation. He gave specific importance to the fact that technologies to be implemented as tertiary/quaternary treatment must be validated and a risk assessment plan must be elaborated by the managers of municipal wastewater treatment plants. Mr. Simón also went through the different rules and documents legally stablished by the Spanish National Government to try to comply with the new EU Regulation by the 26th of June 2023, the date on which the new regulation entered into force.

Mr. Pedro Simón expressed the viewpoint that he considers the APOC system as a highly promising integrated technology that could easily allow complying with the new EU regulation for water reuse in crop irrigation.

> **"The APOC system is a highly promising integrated technology that could easily allow complying with the new EU regulation for water reuse in crop irrigation."**
>
> ***Mr. Pedro Simón, ESAMUR, invited expert to AQUACYCLE Webinar in Spain***

[1] Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse (OJ L 177, 5.6.2020, pp. 32–55)

"Experiences and Challenges in the up-scaled of wetlands as tertiary/quaternary treatments in Municipal Wastewater Treatment Plants. MENAWARA project"

Dr. Isabel Martín (AMAYA)

Dr. Isabel Martín is senior researcher in the Andalusian Public Foundation Centre for New Water Technologies (CENTA), Ministry of Agriculture, Livestock, Fisheries and Sustainable Development. She holds a PhD in Biology and has more than 20 years' experience on issues related to the treatment of urban wastewater and its reuse. She is United Nations expert and member of the ISO Technical Committee 282 on water reuse, and of the Global Wastewater Initiative (United Nations Environment Programme, UNEP). She has a broad experience in the design and assessment of different kind of wetlands for water treatment and regeneration and she is the principal investigator of CENTA (newly named as AMAYA) in the MENAWARA project, also funded by the ENI CBC Med Programme. Dr. Martín divided her presentation in two parts, first she gave a broad description of the main challenges faced nowadays with the upscaling of wetlands, which are mainly focused in energy recovery, reduction of the carbon footprint and the treatment of micro-contaminants and wastewater regeneration and recovery. In the second part, she presented different real-life cases and experiences concerning the implementation of wetlands for wastewater treatment in the frame of different projects: MENAWARA, LIFE INTEXT, SARASWATI 2.0, NatMed and NbSPRO-TE.

The MENAWARA project is focused on the improvement of access to water through the treatment of non-conventional water, as well as to strengthen the operative capacity of the quadruple helix actors (Fig. 14). In MENAWARA, wetlands are applied as a low-cost treatment to obtain non-conventional water for olive trees irrigation. One of the main challenges that are tackled by not only in the MENAWARA project but also in the LIFE INTEXT project is the intensification of wetlands traditionally considered as extensive technology. Thus, these projects are investigating possible modifications in the design of the wetlands and operational routines, which could influence the contaminant elimination or transformation rates so to make wetlands more efficient.

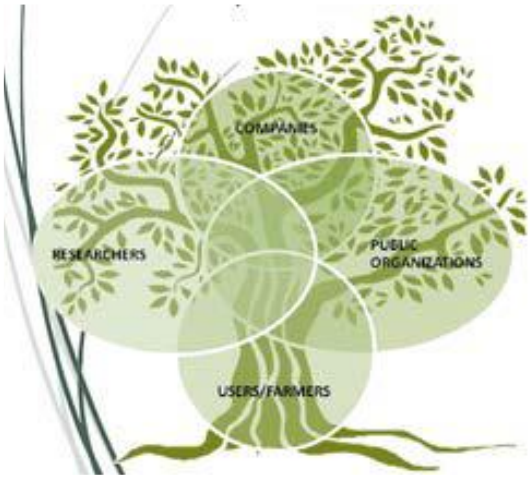

Figure 14: Actors of the quadrupole helix: Researchers, Companies, Public Organizations and users/farmers

"**In the ENI CBC Med funded MENAWARA Project, we are investigating possible modifications in the design of the wetlands and operational routines, which could influence the contaminant elimination or transformation rates so to make wetlands more efficient**."

Dr. Isabel Martín, AMAYA, invited expert to AQUACYCLE Webinar in Spain

"Experiences and challenges in scaling up innovative water regeneration technologies. PHOENIX project"

Mr. Enrique Lara (AQUALIA)

Mr. Enrique Lara is Head of Projects and Processes in the Innovation and Technology Department of FCC-AQUALIA. Mr. Lara gave a broad presentation explaining the experience of AQUALIA, as a worldwide water treatment Company, in respect of the challenges to be faced to implement the new EU Regulation on the Minimum Requirements for Water Reuse. This new regulation introduces greater restrictions on several parameters compared to the legislation that is currently in force in Spain. Specifically, for class A irrigation types, the BOD_5 is required to be below 10 mg/L, which implies a secondary biological treatment that at least reaches the values of directive 91/271 (Spanish law) (25 mg/L), since reaching these values via chemical/oxidation would not be sustainable. Therefore, a multi-stage treatment is clearly required, and Mr. Lara clearly explained about the design considerations as well as the parameters that must be taken into account to establish a successful and sustainable multi-stage integrated technology. He explained that this what AQUALCIA set out to investigate in the EU funded PHOENIX LIFE project, and he then shared all the technical details of the different stages that make up the complete treatment system proposed in this LIFE project that is already up-scaled to a pre-industrial phase.

Mr. Lara ascertained that a successful implementation of a new integrated technology always requires its assessment in an environment that is as close to the reality as possible, and ideally a pre-industrial scale to be sure the techno-economic outcomes that are achieved would be sufficiently reliable.

> "**The successful implementation of a new integrated technology always requires its assessment in an environment that is as close to the reality as possible, and ideally a pre-industrial scale to be sure the techno-economic outcomes that are achieved would be sufficiently reliable.**"
>
> ***Mr. Enrique Lara, AQUALIA, invited expert to AQUACYCLE Webinar in Spain***

"Actions and funding plans for the regeneration of treated wastewater through an eco-innovative treatment"

Ms. Isabel Rodríguez (Diputación de Almería)

Ms. Isabel Rodriguez is a Chemical Engineer, working as a Technician at the Almería Provincial Council. She is highly conversant with the actions and funding plans which the government of Andalucía is launching so as to comply with the new EU regulation for treated water reuse in crop irrigation.

To start with, Ms. Rodríguez showed two maps, one depicting the Municipal Regeneration Wastewater Treatment Plants already installed, and under the service of the Province of Almería, and then those that are planned to be constructed. She provided specific technical details on the technologies, capacities and actual volume of water regenerated by those plants already in operation as well as those that are planned and foreseen to be funded by the Government of Andalucía within the Third Decree as a response to the severe water scarcity situation faced in the Southeast of Spain.

The Governing Council of Andalucía (southern region of Spain) approved the third Andalusian Drought Decree in April 2023, which includes measures worth 163 million Euro, and is aimed at tackling the complex situation which the autonomous community is going through as a result of the water scarcity. With this latest Decree, an aggregate of up to 300 million Euro has been allocated by the Andalusian Government to respond to the acute lack of water suffered in the region. Through this third Decree, new hydraulic works are promoted that are committed to the use of reclaimed water, the execution of irrigation networks, the improvement of supply, the search for new water sources, reduction of water losses and the digitization of water management.

Among other actions, the third Andalusian Drought Decree includes 25 new hydraulic infrastructures that seek to deal with the drought in the autonomous community and which, in total, entail an expense of 120 million Euro. Of these works, 40% are aimed at advancing tertiary wastewater treatment that make it possible to obtain reclaimed water for irrigating crops within the parameters set by the new EU Regulation. It focuses on tertiary actions for reclaimed water in existing wastewater treatment plants in the provinces of Málaga (Nerja in La Axarquía), Huelva and Almería (Cuevas del Almanzora; Mojácar; Vera; Balerma, in El Ejido; and El Toyo, in the capital Almería) and in Granada (Almuñécar and La Herradura).

At the end of her presentation, Ms. Rodríguez also showed the energy consumption that is expected to occur if all the new infrastructures and operation of new tertiary treatments will enter into operation. For the province of Almería an increase in energy consumption from 640 GWh to 985 GWh is estimated.

"**The third Andalusian Drought Decree issued in April 2023 brings measures worth 163 million Euro as a response to the new EU Regulation on the minimum requirements for water reuse and to the severe water scarcity situation faced in the Southeast of Spain. 40% of the investment will be aimed at advancing tertiary wastewater treatment at existing municipal wastewater treatment plants. The resulting increase in energy consumption is estimated to rise from 640 GWh to 985 GWh**."

Ms. Isabel Rodríguez, Diputación de Almería, invited expert to AQUACYCLE Webinar in Spain

3.3 Proceedings of the workshop in Tunisia

The workshop in Tunisia was joined by representatives of four ministries including the Ministry of Local Affairs and Environment, the Ministry of Agriculture, the Ministry of Higher Education and Scientific Research, and the Ministry of Economy, Finance and Investment Support, the Non-Governmental Organization, GDA Sidi Amor, and by a radio journalist from Radio Zitouna FM.

The workshop programme alternated between round table discussions and other interactive sessions during which the participants discussed and exchanged ideas concerning the challenges related to the reuse of treated wastewater in Tunisia and presented their views on the eco-innovative wastewater treatment technology promoted by the AQUACYCLE project, abbreviated as the APOC technology.

The event kicked off with an opening ceremony which was provided by Dr. Hamadi Kallali, Team Leader of CERTE in the AQUACYCLE Partnership and Prof. Ahmed Ghrabi, Director General of CERTE and Legal representative of the Project. During this opening session, Dr. Hamadi Kallali welcomed the guests and provided an overview of the AQUACYCLE project as well as the general framework of the workshop.

Ms Saloua Chatti, national contact point for the ENI CBC Med Programme within the Ministry of Economy, Finance and Investment Suport then introduced both the ENI CBC Med and the upcoming NEXT 2021-2027 programme. Next, Dr. Hamadi Kallali provided more details on the APOC System and the analysis of the results of treated wastewater obtained from the APOC pilot demo unit in Blanca, Spain which had been provided by Pedro Simón Andreu, Team Leader at ESAMUR in the AQUACYCLE Partnership. Dr. Yasmin Cherni spoke on the results obtained from an APOC pilot at the laboratory scale at CERTE laboratory for the valorisation of research, while Dr. Mohamad Ali Wahab, introduced the project's e-learning platform on the design, operation and maintenance of the APOC system. Dr. Samira Melki, also from CERTE, presented the project's WebGIS as a decision support tool for the development of action plans for the reuse of treated wastewaters: case of the Bent Saidane region. Finally, Mrs. Khitem Mensi, researcher at CITET provided insights on the training and certification of users of the APOC system in Tunisia and gave a presentation on scope and content of the MedAPOC Charter.

Figure 15: Participants in the workshop organized at the Golden Tulip El Mechtel Hotel, Tunis, Tunisia on 10 May 2023

Figure 16: Photomontage of the third workshop in Tunis, Tunisia on 10 May 2023

4. Outcomes of the third series of stakeholder workshops

4.1 Participant's viewpoints in Lebanon

The salient points discussed by the participants during the workshop in Lebanon included the following:

Who will be operating the pilot demo plant in Lebanon beyond the end of the foreseen project duration?

The participants acknowledged the efforts of the Lebanese University to have opened the way for training engineers and technicians from all over the country to be trained in an eco-innovative wastewater treatment technology. However, in the light of Lebanon's dire economic situation, participants voiced their concern as to who would operate the pilot demo plant beyond the end of the foreseen project duration. It was clarified that the demo plant is designed to treat only a relatively small volume of between 5 to 9 cubic meters per day of sewage. In practice, this means that the demo plant is exclusively treating the effluent of the Sanabel residential complex, i.e., 7 residential buildings. Moreover, a survey conducted among the residents informed that the local community in Sanabel paid water taxes, waste services and other fees, but they proved also willing to pay a small amount as a subscription to continue operating the pilot demo plant.

How to attract investments to construct an eco-innovative wastewater treatment system?

The discussion then steered towards the broader question of how to attract investments for an innovative wastewater system. It was opined that this would require the continuous coordination and collaboration with the concerned authorities such as the ministry of environment, the ministry of energy and water, and the municipalities, the union of municipalities, and investment companies, and by showing them the effectiveness of the plant. It was acknowledged that the demo plant could serve as a perfect environmental model that works successfully at local and national levels.

What is the operational cost of the plant?

Since the demo-plant was still under construction, the operational cost of the APOC could not be fully assessed. However, it was noted that the process treatment of the raceway pond reactor should not take longer than 30 minutes. This had been verified by means of a monitoring system control (concentration of H2O2), equipped with a sensor for pH and UV light. This demonstrated that to remove E. Coli, 25 mg/l of H202 were needed, and a treatment time of 30 minutes. Especially since the raceway pond reactor works on solar energy, the operational cost will not be high. Furthermore, in respect of the constructed wetland the operational maintenance, according to the training-of-trainers event in Spain, would only require for the reeds to be cut once a year, while the roots remain in the constructed wetland to maintain the efficiency to absorb fine micropollutants.

Which type of crops can be safely irrigated with the treated wastewater?

The treated wastewater was ascertained to be safe for the irrigation of all types of forest and fruit trees, ornamental trees and plants, and vegetables that are cooked. However, following the demo-plants coming into operation it is envisaged that the treated water will be analysed and if it meets the requirements of the new EU regulation pertaining to the minimum requirements for the reuse of treated wastewater, it would be safe to irrigate all vegetables and leafy vegetables (lettuce, spinach, parsley, etc.).

In addition to this approach, the participants suggested to irrigate vegetables that are eaten raw (tomatoes, cucumbers, etc.) with treated wastewater, and to then subsequently analyse the quality of the vegetables so as to check whether the produce is of good quality and free from any pollutants. This approach was encouraged, especially since the effluent is subjected to solar disinfection in the raceway pond reactor.

Questions pertaining to the pilot demo unit installation in Spain

A first point of interest to the participants was to know why the APOC pilot demo plant in Spain was built next to an existing wastewater treatment facility, and whether this was due to the existing plant being out of operation or it what the added value of having an APOC system was to the existing facility.

It was ascertained that the existing plant in Blanca takes the form of anaerobic digester which remains fully functional. As part of the research being conducted in AQUACYCLE, the aim was to add the two further components, i.e. constructed wetlands and a raceway pond reactor, so as to complete the set-up to mimic the APOC system. The objective is to investigate to what extent a further reduction in pollutants in the final effluent could be achieved. Obviously, this research effort should also be in seen in the context of the new EU Regulation which sets very stringent requirements for reuse, particularly in case of uncooked vegetables (less than 10 E. Coli per litre of treated wastewater).

Is the pilot demo plant in Lebanon to be an exact replica of the pilot demo unit in Spain?

No, there will be differences, such as the type of reactor and the type of constructed wetland. For example, in Lebanon the constructed wetland is horizontal while in Spain they have 2 types of constructed wetlands (horizontal and vertical), and the reactor in Spain needs agitation while in the case of the demo plant in Lebanon, there is no need for agitation in the reactor.

The Lebanese University Team wished to stress their appreciation of the efforts of the Spanish research teams in the AQUACYCLE Partnership through the following statement:

> **"To us, the Spanish research teams in AQUACYCLE are acting as expert trainers in wastewater treatment. We are confident they will accompany and guide us in all stages of the plant's construction, operation and maintenance in Lebanon, by sharing their expertise and the results they have achieved with the pilot demo plant in Spain."**
>
> ***Heartfelt appraisal of Lebanese University Team towards the research teams ESAMUR and CIEMAT-PSA in Spain, Third Stakeholder Workshop in Tripoli, Lebanon***

Further notions regarding sustainability beyond the end of the project duration

What is the reason that in Lebanon, when people hear about the topic of sewage water, it draws fear, especially the idea of reusing it?

We have in Lebanon a lack of awareness about wastewater treatment, because most of the wastewater treatment plants that have been built over the years initially worked well, but then stopped functioning, mostly due to the lack of funding. For this reason, in our region we do not have a culture of wastewater treatment, which leads to an insufficient understanding of the principles of wastewater treatment and the reuse of treated wastewater.

How can the Tripoli region benefit from the treated water from the pilot demo unit in Deddeh, especially since the required irrigation infrastructure and irrigation network connections are expensive?

The treated water can only benefit the neighbouring residents of the Deddeh area due to the small amount of wastewater that is treated. The idea of the project is to spread the project culture on the widest scale in Lebanon and present it as an environmental model based on a small or large scale.

Do you expect that at the end of the project and the start-up of the pilot demo unit in Deddeh Koura, the farmers and the local community will be fully satisfied with the use of treated water?

After the successful implementation and operation of APOC system, we will carry out a weekly analysis of treated wastewater with a view to further improve the quality of the treated wastewater. In addition, next to the pilot demo unit, we have a garden planted with ornamental plants, together with forest and fruit trees that will serve as an actual model for the reuse of water in irrigation.

Dr. Fawaz Al-Omar from the Lebanese University concluded the exchange of viewpoints with an emphatic call:

> "**With regard to sustainability, we do not want the project to become a burden on the residents of the Sanabel residential complex. Therefore, the Lebanese University must involve and cooperate with several universities, associations, stakeholders, and the municipality to secure sufficient funding to continue operating the plant and achieve its sustainability. The plant can also become a training and research centre for all.**"
>
> ***Dr. Fawaz Al-Omar, Lebanese University, Third Stakeholder Workshop in Tripoli, Lebanon***

4.2 Participant's viewpoints in Spain

WEBEX output on the most used words throughout the entire webinar

One of the tools of WEBEX allows to summarize in a graphic format the most frequent words and messages mentioned throughout the entire session, including words mentioned in questions and during exchange of views among the participants.

Figure 17 shows that the words "project, implement, data and people" were mentioned most frequently. This clearly indicates that the need for research and projects for the implementation of new or integrated technologies is very high as well as the need for data availability and increased societal awareness creation related to treated wastewater reuse.

Figure 17: WEBEX output on the most used words throughout the online webinar on 6 June 2023

Participant's appraisal of the WebGIS and associated action plans for the reuse of treated wastewater

To all the participants the WebGIS tool was considered highly interesting, though it must be taken into account that end users from the region of Murcia and Almería have already clearly defined the surface dedicated to agricultural activities and finding the space for new action plans is almost impossible, not least due to the difficulty to obtain the required permissions for new actions plans.

Editor's note: this particular notion about the situation on the ground in the south-eastern part of Spain with regard to new action plans had been duly acknowledged early on in the project. As explained (in Chapter 2), rather than engaging the water stakeholders in Spain to draw up new action plans, it was opted to bring into focus the very high level of the actual reuse of treated wastewater in the Murcia Region of Spain (see Fig. 9).

4.3 Participant's viewpoints in Tunisia

The main results of the roundtables and interactive sessions during the workshop in Tunisia included:

Roundtable 1: challenges encountered in encouraging the reuse of treated wastewaters in Tunisia and pathways of investment opportunities (*moderated by Dr. Hamadi Kallali)*

Participants raised the following challenges in encouraging the reuse of treated wastewaters:

- The fluctuation of the quality of treated wastewater, which has higher salinity levels than river water,
- Treated wastewater competes with the availability of conventional water, which takes preference,
- Legal texts that govern the field of treatment and reuse of wastewater are not updated,
- Discharge of industrial wastewater in plants destined to for (only) domestic wastewater treatment,
- High cost of wastewater treatment,
- Lack of training and capacity building in the field of reuse of treated wastewater,
- Hydraulic and organic overload of plants which influences the quality of treated wastewater produced,
- Difficulties in monitoring and managing innovative technologies after the completion of research or cooperation projects,
- Lack of processing technologies that aid in energy recovery and nutrient recovery,
- Lack of visibility and acceptability of wastewater reuse,
- Lack of funding for the management and maintenance of irrigation networks supplied with treated wastewater, and
- Lack of information and trust in water authorities administering non-conventional water recycling projects.

As such, these reservations are clearly not new to the barriers and obstacles that were identified during the first stakeholder workshop in Tunisia. This is hardly surprising, since the latter workshop was joined by a very similar audience in terms of make-up, i.e. mostly representatives from public entities involved with water, agriculture and sanitation. In fact, the representatives of these public entities take it on themselves to bring the 'voices' of farmers in Tunisia (who were not represented as such during on the occasion of this workshop):

> **"The "yuck" factor is a major roadblock to encourage the reuse of treated wastewater. This refers to the stigma and apprehension associated with wastewater treatment and a disgust towards recycled water despite knowing that it is safe for reuse, particularly in areas where conventional water is as yet available in sufficient quantity. Farmers in these areas are afraid that the reputation of their products will be damaged."**
>
> ***Representatives of public entities responsible for water and sanitation, agriculture and education, Third Stakeholder workshop in Tunisia***

At the same time, the participants acknowledge that the treatment of wastewater and its reuse in agriculture offers several avenues and opportunities for investment in Tunisia. They offered the following suggestions:

- Construction of wastewater treatment plants for localities under 5000 persons-equivalent (PE) and in rural areas (under 1000 PE): There is a growing demand for the construction of decentralized wastewater treatment plants. Investments can be made in projects for the construction, operation and maintenance of wastewater treatment facilities, using technologies adapted to local needs.
- Irrigation systems based on treated wastewater: The use of treated wastewater for agricultural irrigation is an efficient method of reusing water resources. Investments can focus on setting up appropriate irrigation systems, such as drip or micro-sprinklers that allow precise and controlled water use. The Tunisian Water 2050 strategy emphasizes on the assurance and the monitoring of treated water quality.

- Research and development projects: Investments in research and development of advanced wastewater treatment technologies can provide opportunities for growth and innovation. Initiatives focused on improving treatment processes, reducing costs and increasing energy efficiency can be supported.
- Public-private partnerships: Partnerships between the public and private sectors can be an effective way to invest in wastewater treatment in Tunisia. Investors can collaborate with local authorities to set up wastewater treatment projects, benefiting from favourable regulations and financial support.
- Wastewater Reuse Technologies: Investing in advanced technologies that enable safe reuse of wastewater in agriculture can be a promising opportunity. This can include advanced treatment technologies, water quality monitoring systems and health risk management solutions.
- Training and awareness: Investments in training and awareness raising for farmers, facility managers and the general public can help promote the adoption of sustainable wastewater treatment and reuse practices in agriculture. Vocational training programs and awareness campaigns can be implemented.
- It is important to note that investments in wastewater treatment and its reuse in agriculture must comply with the environmental and health regulations in force in Tunisia. These regulations have to be upgraded in order to cover the non-restrictive use of treated wastewater, provided its quality is equivalent (or better) as compared to the quality conventional water resources.

Participants' viewpoints on investment routes to implement the action plans for wastewater treatment and reuse in Tunisia varied, based on their backgrounds, roles, and perspectives. Among other, these included:

- **Public Sector Investment**: Some participants advocate for increased public sector investment in wastewater treatment and reuse. They argue that the government should allocate sufficient funds to support the development and implementation of reuse action plans. These participants emphasized the importance of government-led initiatives in addressing water scarcity and environmental concerns.
- **Private Sector Engagement**: Other participants highlighted the role of the private sector in financing and implementing wastewater treatment and reuse projects. They emphasized the need for public-private partnerships (PPPs) or incentives for private investors to participate in the development of infrastructure and technologies. These participants argued that private sector involvement can bring efficiency, innovation, and sustainable financing options.
- **International Funding and Aid**: Some participants suggested seeking international funding and aid to support the implementation of reuse action plans. They advocate for collaboration with international organizations, development banks, or bilateral partnerships to secure financial resources and technical assistance. These participants consider that international cooperation can leverage additional funding and expertise.
- **User Fees and Tariffs**: Certain participants proposed the establishment of user fees or tariffs to generate revenue for wastewater treatment and reuse projects. They argued that users, such as industries or the agricultural sector benefiting from reclaimed water, should contribute financially to cover the costs. These participants emphasized the importance of cost recovery and creating sustainable financing mechanisms.
- **Innovative Financing Models**: Some participants advocated to explore innovative financing models, such as green bonds, impact investments, or crowdfunding platforms. They proposed leveraging new financial instruments to attract investments from environmentally conscious investors or engage the public in supporting the projects. These participants highlighted the potential of novel funding approaches to complement traditional financing sources.
- **Local Community Participation**: Certain participants stressed the importance of involving local communities in financing and implementing wastewater treatment and reuse projects. They argued for community-based initiatives, crowdfunding campaigns, or cooperative models that empower local stakeholders to contribute financially and take ownership of the projects. These participants emphasized the social and economic benefits of local involvement.

- **Blended Financing Approaches**: Some participants advocated for a blended financing approach that combines different funding sources and mechanisms. They suggested a combination of public funds, private investments, international assistance, and community contributions to create a diversified and sustainable financing portfolio. These participants emphasized the need for a flexible and adaptable financing strategy.

It is essential to consider these various viewpoints and engage in discussions among the participants to find common ground and explore the most feasible and effective investment routes for implementing the action plans for wastewater treatment and reuse in Tunisia. The diversity of perspectives can lead to comprehensive and well-rounded strategies that address the financial challenges and maximize the potential for successful implementation.

Roundtable 2: Viewpoints on APOC technology (*moderated by Mrs. Khitem Mensi and Dr. Hamadi Kallali*)

The participants' appraisal of the wastewater treatment technology promoted by AQUACYCLE included the following:

- ✓ Capable of producing good quality treated wastewater,
- ✓ Capable of eliminating pathogenic germs,
- ✓ Consumes less energy,
- ✓ Reliable source of non-conventional water, all-year-round,
- ✓ Minimizes pollutants and promotes the recovery of treated wastewater,
- ✓ Based on a process that works efficiently and at low cost,
- ✓ Easy to operate, easy to implement, and easy to maintain.

The participants suggest developing a Memorandum of Understanding on wastewater treatment and reuse that is focused not only on the APOC technology and invited for a content which could be developed jointly as a follow-up to the workshop. The participants suggested the following content of the Charter to be developed:

- ❖ Legislative Framework
- ❖ Wastewater reuse as a component of the Integrated Water Management
- ❖ Infrastructure Development
- ❖ Research and Innovation
- ❖ Public Awareness and Participation
- ❖ Capacity Building and Cooperation
- ❖ Monitoring and Reporting
- ❖ Financial Support

The Memorandum of Understanding, drafted by Dr. Hamadi Kallali is provided in Annex 1.

5. Concluding remarks

5.1 Achieving good levels of attendance

In similar fashion to the first and second series, also the third series of workshops was joined by a very respectful number of participants, comfortably exceeding the originally foreseen target of 75 participants across the three workshops:

In Lebanon, 18 participants were welcomed by the members of the research team at the Lebanese University team. Especially noteworthy is the interest that was generated among the Unions of Municipalities, research organizations and other entities, as well as participants who attended in an individual capacity, as illustrated in Table 4.

Table 4: Make up of the audience in Lebanon

Organization type	Organization
Municipality	Union of Zgharta Municipalities Akkar al-Atika Municipality Fnaydek Municipality Tripoli Municipality
Research organization	American University of Technology (AUT) Beirut Arab University (BAU) Lebanese University (UL) Université Libano-Française (ULF)
Association	Association Libanaise pour le développement
Institution	Istituto Per la Cooperazione Universitaria (ICU)
Individual capacity	Koura resident Sanabel resident Doctor in Medicine Social activist MSc student Civil Engineer

In Spain, 55 participants joined the event along the duration of the webinar, a mixture of municipal wastewater treatment plant operators and managers, students, scientists and professors from research institutions and academia. Thus, the majority represented both private and public entities involved with the treatment of wastewater. Aside from the participation of representatives from AITEX - Research & Innovation Center, Alquds University, Aqualia, BIOAZUL SL, Cajamar Innova, COBET TRATAMIENTOS DEL AGUA SL, EMUASA, ESAMUR, FACSA-INAM, Hidrogea, IFMEREE, Solarway SLNE, TYPSA, the event was joined also by persons in their individual capacity and a journalist.

In Tunisia, 39 participants joined the event. The majority of the participants represented organizations under the supervision of four distinct ministries as shown in Table 5, who were joined by representatives of the NGO SIDI Ben Amor and a journalist from the radio station Zitouna FM.

Table 5: Representation from organizations under the supervision of four distinct ministries in Tunisia

Ministry	Organizations under supervision
Local Affairs and Environment	Le Centre International des Technologies de l'Environnement de Tunis (CITET)
Agriculture	Le Commissariat régional au développement agricole de Zaghouan (CRDA de Zaghouan) Institut des Régions Arides (IRA) Médenine Institut National de Recherche Agronomique de Tunis (INRAT) Agence Foncière Agricole (AFA) Institut National de Recherches en Génie Rural, Eaux et Forêts (INRGREF) Bureau de Planification et des Équilibres Hydrauliques (BPEH) Direction Générale du Génie Rural et de l'Exploitation des Eaux (DGGREE) Agence de Vulgarisation et de la Formation Agricoles (AVFA)
Higher Education and Scientific Research	Institut National Agronomique de Tunisie (INAT) Centre des Recherches et des Technologies des Eaux (CERTE) Institut National des Sciences Appliquées et de Technologie (INSAT) Faculté des Sciences de Tunis (FST) Faculté des Sciences de Bizerte (FSB)
Economy, Finance and Investment Support	National Contact Point for ENI CBC Med Programme

5.2 Achieving wide media coverage

In Lebanon, the event received ample media coverage, including by the National News Agency (NNA), with a feature entitled "Lebanese University organizes the third workshop within the European AQUACYCLE project in Nawfal Palace, Tripoli," which can be accessed from this link.

In Tunisia, the media coverage of the workshop was ensured mainly by the radio station Zitouna FM, through Mr. Taoufik Ben Abdallah a, journalist on environmental issues, who attended the workshop. Dr. Hamadi KALLALI of CERTE had a 30 minute interview on the Zitouna FM Radio on 14 May 2023, which can be accessed through this link.

Figure 18: Dr. Hamadi Kallali (to the right) being interviewed on Radio on 14 May 2023
(source: https://www.facebook.com/taoufik.benabdallah.7/videos/778450080492580/)

Annex 1 Memorandum of Understanding drawn up as a follow-up to the workshop in Tunisia

(Draft) Memorandum of Understanding (MoU) on the Treatment and Reuse of Wastewater

Preamble:

Recognizing the importance of sustainable water management and the need to address the challenges related to wastewater treatment and reuse, this MoU aims to promote the efficient and responsible use of water resources, protect the environment, and improve the quality of life for all citizens in the region. Through collaborative efforts, the signatories commit to implementing and upholding the principles outlined below.

1. Objective: The objective of this MoU is to develop a comprehensive framework for the treatment and reuse of wastewater. The signatories shall work together to establish common standards, share best practices, and foster cooperation to achieve sustainable water management and promote the reuse of treated wastewater.

2. Legislative Framework:

2.1. The signatories shall enact and enforce legislation and regulations that promote the treatment and reuse of wastewater, in accordance with international and regional agreements, while considering national circumstances and priorities.

2.2. Legislative frameworks should establish clear guidelines for the quality standards of treated wastewater, the conditions for safe reuse, and the responsibilities of relevant stakeholders.

3. Integrated Water Management:

3.1. The signatories shall adopt an integrated approach to water management that includes wastewater treatment and reuse as an essential component.

3.2. Integrated water management plans should consider the entire water cycle, from source to consumption, and incorporate measures for wastewater collection, treatment, and safe reuse in various sectors, such as agriculture, industry, and urban development.

4. Infrastructure Development:

4.1. The signatories shall invest in the development of adequate infrastructure for wastewater treatment and reuse, taking into account population growth, urbanization, and changing climate conditions.

4.2. Infrastructure projects should prioritize the use of environmentally friendly technologies, such as decentralized treatment systems, water-saving measures, and energy-efficient processes.

5. Research and Innovation:

5.1. The signatories shall promote research and innovation in wastewater treatment and reuse technologies - the eco-innovative wastewater treatment technology developed in the ENI CBC Med funded project AQUACYCLE as an example - aiming to improve efficiency, reduce costs, and minimize environmental impacts.

5.2. Cooperation in research and development efforts, including the sharing of knowledge and expertise, should be encouraged among signatories to accelerate progress and achieve technological advancements.

6. Public Awareness and Participation:

6.1. The signatories shall raise public awareness about the importance of wastewater treatment and reuse through educational programmes, campaigns, and community engagement initiatives.

6.2. Citizen participation and stakeholder engagement should be encouraged in decision-making processes related to wastewater management, fostering a sense of ownership and responsibility among the public.

7. Capacity Building and Cooperation:

7.1. The signatories shall strengthen institutional capacities and promote knowledge exchange among relevant stakeholders, including government agencies, water utilities, research institutions, and civil society organizations.

7.2. Cooperation with and among Mediterranean countries should be enhanced through joint initiatives, capacity-building programmes, and the establishment of regional networks to facilitate the exchange of experiences, expertise, and best practices.

8. Monitoring and Reporting:

8.1. The signatories shall establish monitoring and reporting systems to assess the implementation and progress of wastewater treatment and reuse initiatives.

8.2. Regular reporting on key performance indicators, including water quality, treatment efficiency, and reuse rates, should be conducted to ensure transparency and accountability.

9. Financial Support:

9.1. The signatories shall seek financial support from international organizations, development agencies, and other funding mechanisms to implement wastewater treatment and reuse projects.

9.2. Adequate financial resources should be allocated by signatories to support the implementation and maintenance of wastewater treatment infrastructure, ensuring long-term sustainability.

10. Review and Revision:

10.1. The signatories shall periodically review the effectiveness of this MoU and revise its provisions as necessary to reflect emerging challenges, technological advancements, and evolving regional priorities.

10.2. The revision process should involve consultation with relevant stakeholders and the incorporation of lessons learned from successful initiatives.

In witness whereof, the undersigned signatories hereby adopt this MoU for the Treatment and Reuse of Wastewater, committing to its principles and objectives for the benefit of present and future generations.