Towards Sustainable Treatment and Reuse of Wastewater in the Mediterranean Region

MedAPOC Charter

October 2023

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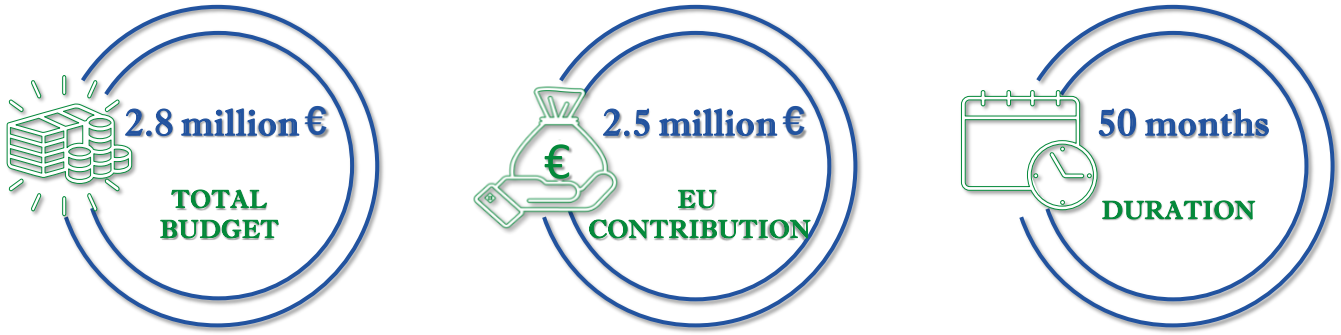

The 2014-2020 ENI CBC Mediterranean Sea Basin Programme is a multilateral Cross-Border Cooperation (CBC) initiative funded by the European Neighbourhood Instrument (ENI). The Programme objective is to promote fair, equitable and sustainable economic, social and territorial development, which may advance cross-border integration and enhance the territories and values of participating countries. The following 13 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestine, Portugal, Spain, and 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 composed of 28 Member States who have decided to progressively link their know-how, resources and destinies. Together, they have created an area of stability, democracy and sustainable development over a 50-year enlargement period, while preserving cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and values with the countries and peoples beyond its borders.

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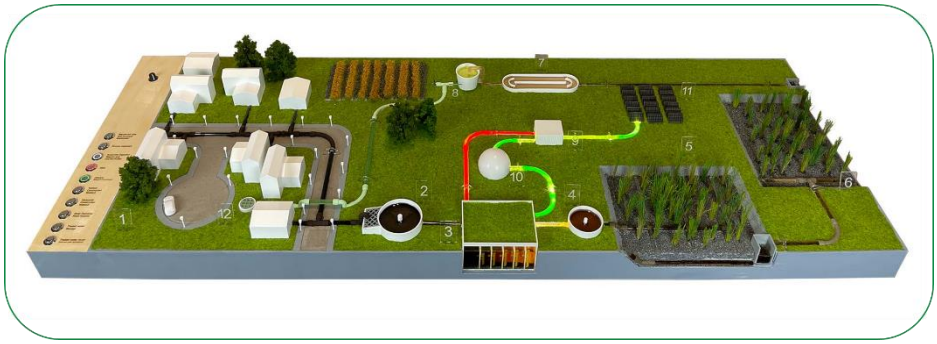

Figure 1: Miniature replica of AQUACYCLE's eco-innovative wastewater treatment system

This 3-dimensional miniature replica introduces AQUACYCLE's new "green" technological approach for wastewater treatment and reuse which is particularly suited to small and medium-sized towns and villages in rural areas under Mediterranean climate conditions.

1. Residential area and municipal wastewater
2. Primary treatment
3. Anaerobic Digestion Reactor
4. Clarifier/Settler
5. Vertical Constructed Wetland
6. Horizontal Constructed Wetland
7. Solar Raceway Pond Reactor
8. Treated Water storage
9. Renewable Energy storage
10. Biogas
11. Photovoltaics
12. Treated water reuse (rural and urban applications)

Figure 2: Geographic location of the APOC pilot demonstration sites in Lebanon, Spain and Tunisia

1 Scope of the MedAPOC Charter

The goal of the MedAPOC Charter is to promote the sustainable use of non-conventional water resources and to support the transfer and sharing of AQUACYCLE research results at the operational level. In doing so, the Charter aspires to create a shared vision for the establishment of a transboundary Mediterranean Wastewater Community.

The acronym APOC stands for "Anaerobic digestion", "Photocatalytic Oxidation" and "Constructed wetland(s)", the three components of an eco-innovative system for the treatment of domestic wastewater, as shown in the 3-dimensional miniature replica in Fig. 1. Although it is known that domestic wastewater treatment can provide a reliable, non-conventional source of water, statistics from the European Environment Agency show that actual reuse accounts for less than 2.5% of treated municipal wastewater in Europe (Source: https://ec.europa.eu/environment/water/reuse.htm, accessed on 11/10/2023).

The distinctive features of the APOC technology make it environmentally friendly, efficient, and cost-effective because it is based on natural systems, uses fewer chemicals, is powered by renewable energy (solar irradiation), produces biogas, fertilizer, and clean water for reuse in agriculture or other applications, such as urban landscaping. Moreover, the constructed wetland component of the wastewater treatment system helps mitigate climate change. Since the focus of the ENI CBC Med Programme is on the Mediterranean Region, the acronym '**MedAPOC**' captures both the targeted geographic reach and the acronym of the project's eco-innovative technology.

Rather than bringing the voices of the research teams who designed, tested, and validated the APOC technology, the present Charter foremost brings the voices of farmers and local communities from the three geographic locations, shown in Fig. 2, where a pilot demonstration unit of the APOC technology has been installed: (1) a site owned by the real estate company SANABEL in Deddeh, south of Tripoli in North Lebanon; (2) at the existing anaerobic wastewater treatment facility of Blanca in the Murcia Region of Spain; and (3) at the existing wastewater treatment facility of Bent Saidane in the Zaghouan Governorate of Tunisia. The three sites have in common that they represent small to medium sized communities whose livelihoods depend primarily on agriculture.

To start with, through this Charter, farmers alert to a dire future to sustain their livelihoods in the face of ever dwindling freshwater supplies. Next, local community representatives share their views on the reuse of treated wastewater and their expectations of the APOC treatment system. The research in AQUACYCLE also provided an opportunity to demonstrate that it is entirely possible for local communities to take an active role in the drawing up of action plans for the reuse of treated wastewater. This is followed by the appraisal of farmers and local communities who participated in Participatory GIS (PGIS) Practice sessions that were organized in Lebanon and in Tunisia for this purpose. These initial chapters were issued as a semi-final version of the present Charter, to mark World Water Day in 2023, which ran with the theme *accelerating change to solve the water and sanitation crisis*.

The added chapters in this final version of the Charter, bring the views of policy- and decision-making authorities in the water, agricultural, sanitation and health-related sectors on the functionality of an online Irrigation Support Tool. The latter guides on the generation of optimal action plans for the reuse of treated wastewater, based on economic, environmental and social criteria of the user's choice. It also proved opportune to dedicate a chapter to the level of satisfaction expressed by farmers around the Mediterranean with the current measures put in place by public authorities to combat land and water degradation. Last but not least, the Charter brings the viewpoints expressed by experts and trend-setters in Spain on the reuse of treated wastewater and on the prospects for the APOC technology to meet the recently introduced EU Regulation on the Minimum Requirements for Water Reuse.

Figure 3: Hasnia Hamrouni tilling her land which is nowadays irrigated only with groundwater due to the scarcity of rain

Figure 4: Cover image of news post to bring farmer interviews to mark World Water Day in 2022

Figure 5: Sergio and Maria Isabel tending to their cucumber cultivation in greenhouses in Almeria, Spain (left), Mohamed Bahri tending to lettuce in one of his greenhouses during wintertime in North Lebanon

2 Farmers alert to ever dwindling scarcity of fresh water supplies

Sergio

"At the moment we have water available, but we are afraid that the aquifer which we depend on will be depleted in the near future."

Hasnia Hamrouni

"In the past, there was water thanks to the availability of rainwater, but now it is reduced under the effect of climate change. In recent years we have noticed that the soil has become dry and the water table has lowered: sometimes we cannot irrigate the entire field given the low flow of water."

Mohamed Bahri

"We used to benefit from the water of springs and wells, and enjoy a strong water abundance. Nowadays however, we are witnessing desertification. For example, it used to snow seven times a year, but now it only snows once. We are here in a large agricultural area, and we need water all year round."

Figure 6: Participants in workshops addressed to local communities (from top) in Spain, Tunisia and Lebanon

3 Viewpoints of farmers and local communities on the reuse of treated wastewater

As evidenced by the statements by farmers and local communities captured below, the idea of reusing treated wastewater met with opposing viewpoints: Green light to reuse in the Almería Province of Spain, Orange light to reuse in Bent Saidane, Tunisia and Red light to reuse in North Lebanon.

"The reuse of treated wastewater for irrigation purposes is necessary and essential to maintain water sustainability in the future as well as of great agronomic, environmental, and economic value."	Unanimous viewpoint of participants in Almería, Spain
"Treated wastewater is safe for reuse in agriculture if it conforms with the EC regulation in force and a strict and complete surveillance plan is in place."	Majority viewpoint of participants in Almería, Spain
"Our reluctance to reuse treated wastewater is motivated by the fact that the practice carries a variety of public health risks. Moreover, we are concerned about the potentially harmful substances found in treated wastewater, the exposure of the farmworker to these substances, and the risks to soil properties and groundwater quality".	Majority viewpoint of farmers in Bent Saidane, Tunisia
"Society's lack of trust in various levels of government and in the private companies that are involved with the operational running, maintenance and monitoring of wastewater treatment facilities in Tunisia is a major obstacle in gaining acceptance for the reuse of treated wastewater".	Farmers' viewpoint on public acceptance of treated wastewater reuse, Bent Saidane, Tunisia
"When people hear about the topic of sewage water, it draws fear, especially the idea of reusing it".	Unanimous viewpoint of participants in Tripoli, North Lebanon

Figure 7: Viewpoints on reuse of treated wastewater resemble traffic lights!

Figure 8: Eco-innovative features of the wastewater treatment technology placed in the context of participatory water governance and sustainable development and economic growth

© Poster design by Eleanna Pana, CERTH

Figure 9: Participants in workshop bringing together the research teams involved in three water-related EU funded research projects in Lebanon

4 Expectations of farmers on the APOC treatment technology in Tunisia

In view of the reluctance to reuse treated wastewater observed in the workshop in Tunisia, presentations on the APOC treatment technology by the Tunisian CERTE and CITET research teams provided an opportunity to document the expectations of farmers' and local communities with regard to a domestic wastewater treatment technology.

"In order for us to consider reusing the treated wastewater, the system promoted by AQUACYCLE must produce a very good water quality, permitting the cultivation of more economically productive crops such as vegetables and be provided at a cheaper cost as compared to conventional sources of irrigation water".	Farmers' expectations of AQUACYCLE's wastewater treatment system in Bent Saidane, Tunisia

5 Changing local communities' viewpoint on the reuse of treated wastewater in Lebanon

Meanwhile, the research team at the Lebanese University invited their workshop participants to reflect on how to bring about a paradigm shift that would overcome the objections of farmers and local communities in northern Lebanon to the use of treated wastewater for irrigation purposes. Based on the unanimous opinion that society rejects the reuse of treated wastewater, the participants decided that it was time to join forces to find a way to improve the poor situation in the country's water and sanitation sector.

"Together we are stronger, hence our call for joint collaboration between universities, municipalities and NGOs for the benefit of all and especially the local community. Working together on the common ground of our EU-funded research projects will benefit us all".	Outcome of Workshop in Tripoli, North Lebanon

In follow-up to this outcome of the event in Tripoli, efforts intensified to create synergies between water-related EU-funded research projects in Lebanon. Aside from AQUACYCLE, on the topic of domestic wastewater treatment and reuse, research results on micropollutants in seawater and regarding the treatment of wastewater streams from hospitals were also on the agenda. Joined by 45 researchers, the workshop participants affirmed that when addressing water and sanitation related challenges: "***Together we are stronger***".

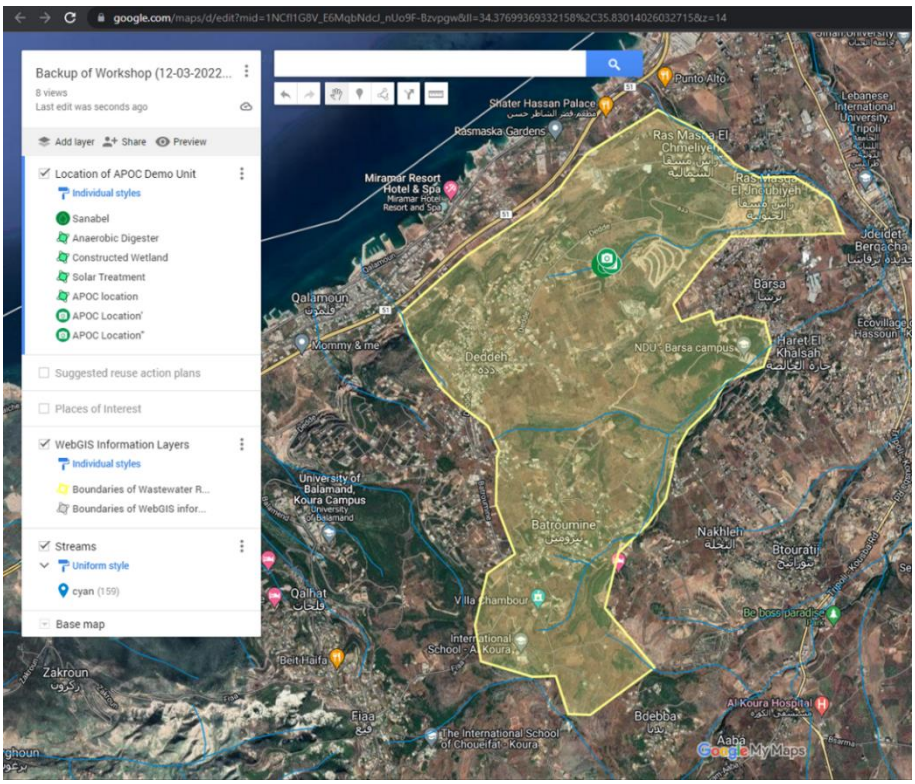

Figure 10: PGIS Landing Page for Deddeh, North Lebanon

Surface water draining network (cyan), boundaries for the drawing of proposed reuse action plans (yellow shaded area) and location of the APOC system components (green icons)

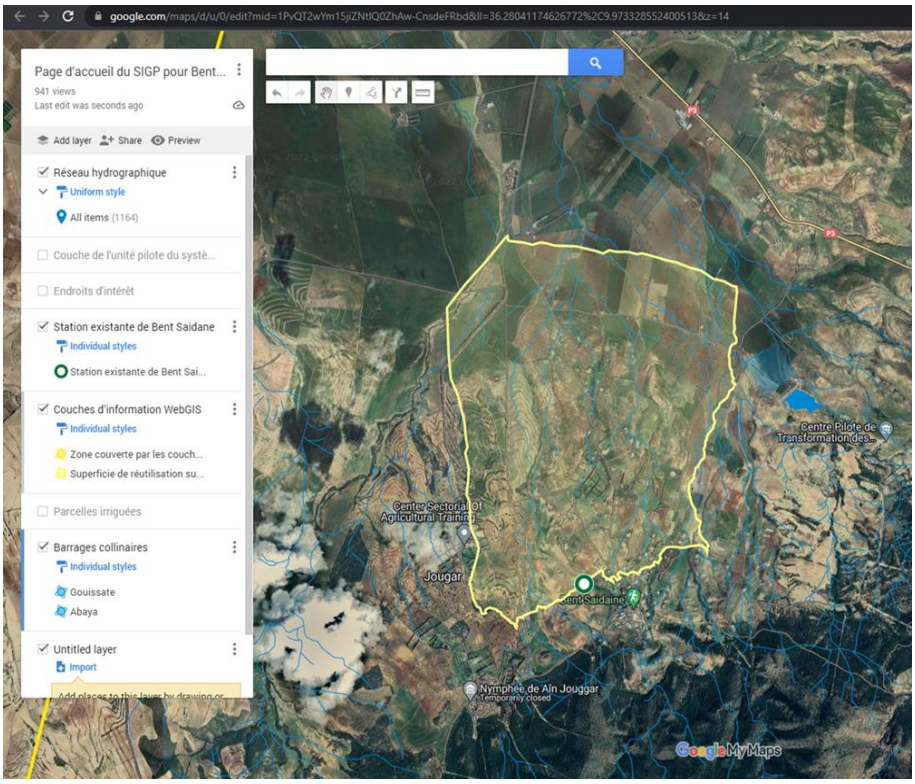

Figure 11: PGIS Landing Page for Bent Saidane, Tunisia

Surface water draining network and hillside reservoirs (cyan), boundaries for the drawing of proposed reuse action plans (yellow shaded area) and Bent Saidane wastewater treatment facility (green icon)

6 Engaging local communities to draw action plans for the reuse of treated wastewater

"Our goal is to convey the key message that not only is all water too precious to waste, but also that **local communities can – and should – be engaged in all planning decisions that may have an impact on their well-being**."

Anna Spiteri and Dirk De Ketelaere, IRMCo, Malta

The AQUACYCLE project provided the opportunity to demonstrate that it is perfectly feasible for local communities to actively participate in the development of action plans for the reuse of treated wastewater. This was achieved through Participatory GIS Practice sessions in workshops for farmers and local communities in Lebanon and Tunisia. The participants were invited to draw their proposals for the reuse of treated wastewater either on a printed satellite image or online. The latter option was facilitated by the preparation of PGIS Landing Pages prior to the workshops (see Fig. 10 and 11).

An example of the PGIS entries proposed by the participants in the PGIS Practice session in Tunisia is illustrated in Fig. 12. Aside from the areas proposed for the irrigation of cereals (shown in yellow), the entries show that the local community is keen to create 'green spaces' in their town (shown in red). Another worthwhile observation is that one farmer personalised his plots by adding his initials (shown in orange). This is not an unexpected outcome when using Participatory GIS, and can easily be attributed to the fact that people want to delineate their 'property' or, as in this case, the land owned by the farmer thereby claiming 'ownership of such property or land'.

Figure 12: Sites for reuse of treated wastewater proposed by the participants in Bent Saidane, Tunisia

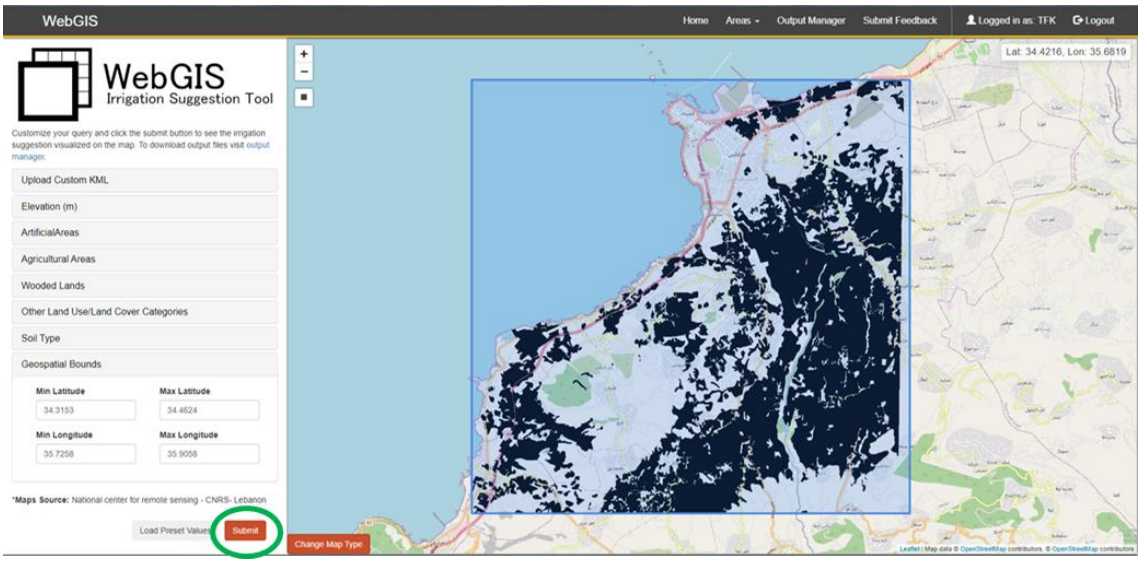

Figure 13: WebGIS displays pixels (in black) that satisfy all the example criteria

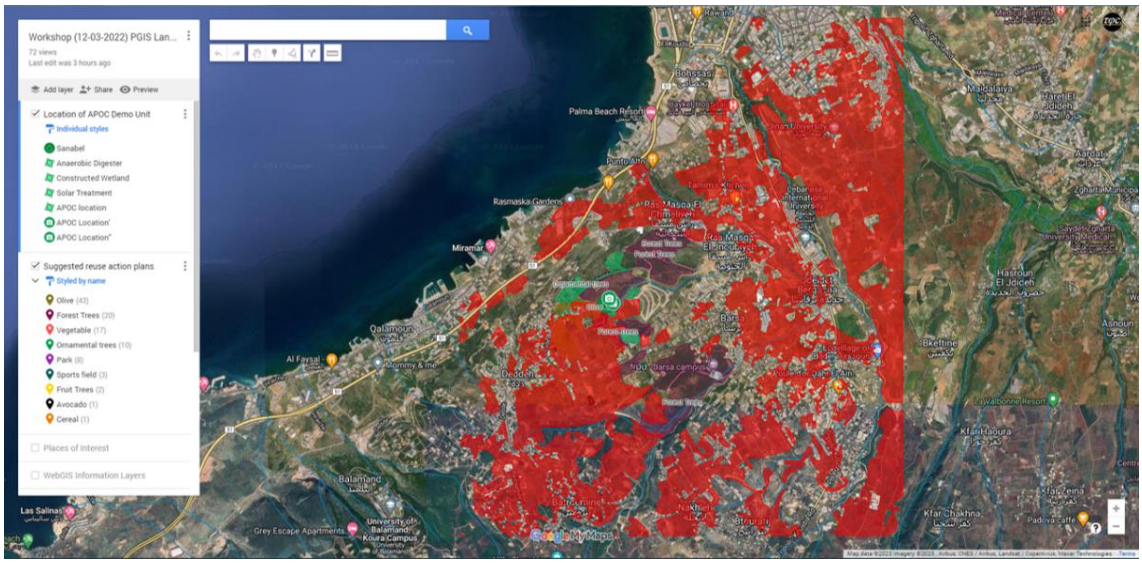

Figure 14: WebGIS output imported onto PGIS Landing page for Deddeh Koura, North Lebanon

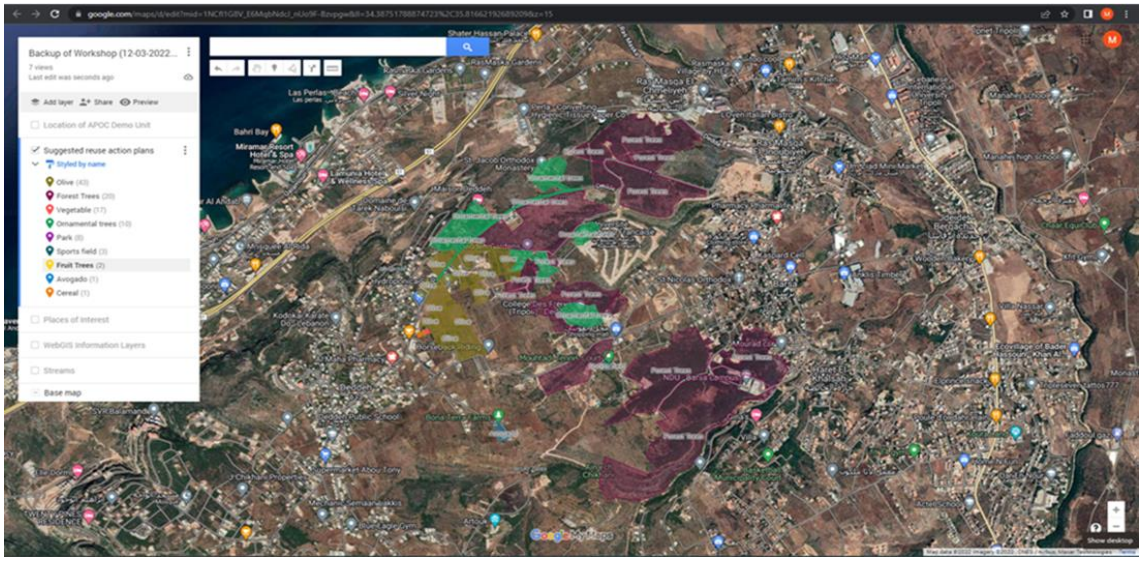

Figure 15: Currently irrigated areas and type of irrigation in the environs of Deddeh Koura, North Lebanon

7 Integrating bottom-up inputs in action plans for the reuse of treated wastewater

As demonstrated in the previous chapter, it is perfectly feasible for local communities to have a voice in the drawing up of action plans for the reuse of treated wastewater through the use of Participatory GIS. This finding was shared during the Third Series of Stakeholder Workshops which targeted national and local entities involved in the water and sanitation sectors. One of the main objectives was to show how inputs provided by farmers and local communities can be integrated into optimal action plans for the reuse of treated wastewater.

The process starts by importing into an online Irrigation Support Tool, accessible through this link, all such layers of information for which the user can then define appropriate criteria. This first step is illustrated here for the pilot demonstration plant in Deddeh Koura, North Lebanon.

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

Layer name	Example Criteria (applied to environs of Deddeh pilot demo unit in North Lebanon)
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/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. 13)

After defining the criteria, the WebGIS generates the matching output in seconds (see Fig. 13), which the user can then import as a shape file (.kml format) onto the PGIS Landing Page (see Fig. 14) and compare with areas already irrigated with conventional water resources (see Fig. 15).

Optimum action plans can now be determined, while taking into consideration the maximum volume of treated wastewater that can be made available on a given time basis, through the following sequence of steps:

1) replace areas shown in the WebGIS that match areas already irrigated (= with the basic idea of replacing current irrigation using conventional water resources with treated wastewater),
2) add areas as suggested by the local community that are consistent with the output of the WebGIS, with the objective of fostering a sense of ownership of the resulting action plan, and
3) include additional areas in the action plan that are in close proximity to the outlet of the treatment plant (resulting in the most cost-effective irrigation network), up to the maximum volume of treated wastewater that can be provided in a given period of time, e.g., per year.

"Placing a user-friendly platform in our hands to develop cost-effective action plans is one thing. Showing us how we can also include areas, as suggested directly by farmers for the reuse of treated domestic wastewater has taken us to another level, this is what good governance is about".	Appraisal of WebGIS by municipalities in North Lebanon

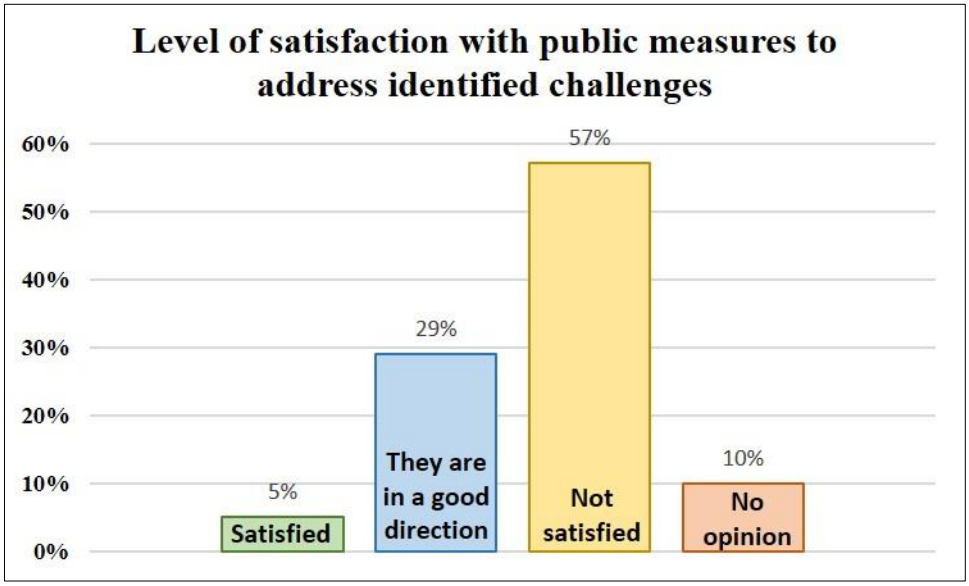

Figure 16: Level of satisfaction among farmers with public measures in place to address identified challenges across 5 hotspots of land and water degradation in Algeria, Egypt, Greece, Lebanon, and Turkey
Source: Outcome of survey conducted through the PRIMA funded Mara-Mediterra project "Safeguarding the livelihood of rural communities and the environment in the Mediterranean through Nature-based Solutions"[1]

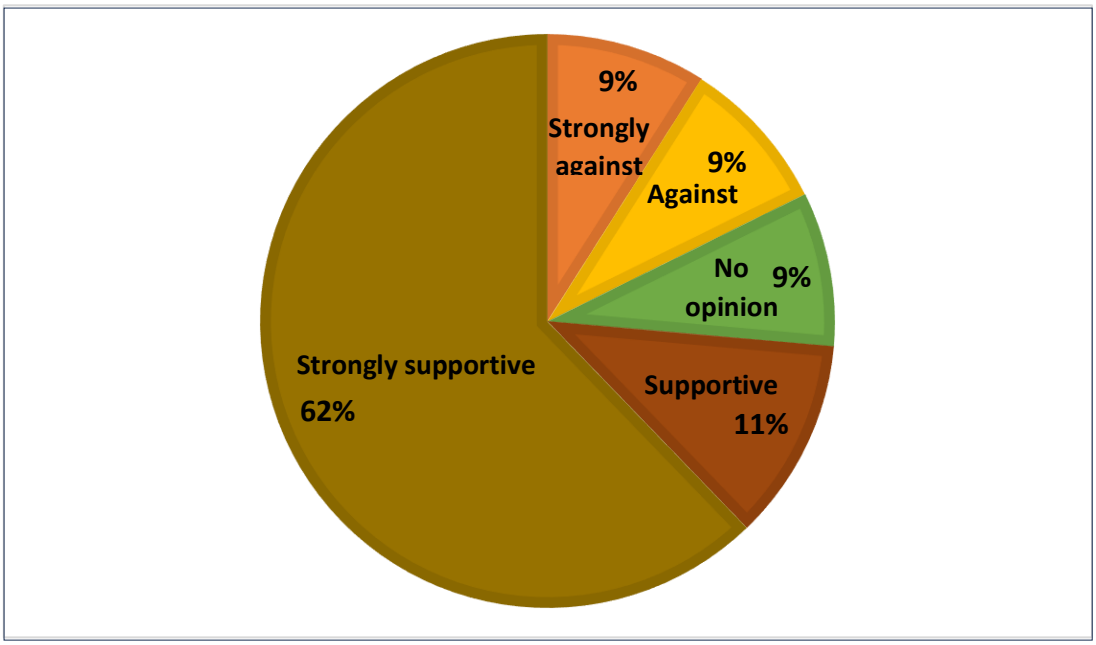

Figure 17: Residents viewpoint on the reuse of treated wastewater in North Lebanon and Akkar Governorates
Source: Outcome of survey conducted by Dr. Tawfil Al-Naboulsi in framework of AQUACYCLE Project

[1] https://mara-mediterra.com/documents/second-e-newsletter/

8 When policy- and decision-makers claim they know what farmers need …

When asked for their feedback on the Semi-Final Version of this Charter, presented at the Third Series of Stakeholder Workshops, representatives of Unions of Municipalities as well as community representatives in Lebanon wanted to know why "***When people hear about wastewater, it scares them, especially the idea of reusing it***" as stated in an earlier Chapter of this Charter (see Chapter 3). Concurrently, representatives of national entities in Tunisia dealing with water and sanitation, agriculture, and education, stated that in their opinion:

> **"The "yuck" factor is a major barrier to the reuse of treated wastewater. This refers to the stigma and fear associated with wastewater treatment, as well as the disgust with reused water even though it is known to be safe for reuse, particularly in areas where conventional water is still available in sufficient quantities. 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***

As we learned in the interview with the Tunisian woman farmer, Hasnia Hamrouni, her main concern is that she is no longer able to irrigate all the land she tills due to her ever-decreasing access to fresh water as a result of a changing climate in the region of Bent Saidane (see Chapter 2). Admittedly, during the interview, she blamed her predicament on not having access to a nearby hillside reservoir that collects rainfall. Yet, when presented with the alternative solution of irrigating with treated wastewater, she lost no time to give this her thumbs up, … at least as long as … the authorities would assure her that this non-conventional source of water would be safe to irrigate her crops. In fact, there are numerous indications in her testimony that she is not quite sure she would be willing to trust the authorities to guarantee an all-year-round supply of treated wastewater and monitor its quality regularly to ensure that it meets the regulations in force in Tunisia for safe reuse in agriculture.

Through synergy between AQUACYCLE and the Mara-Mediterra project[2] funded by PRIMA, an effort was made to explore farmers' perspectives in other areas around the Mediterranean. A survey conducted in hotspots of land and water degradation in Algeria, Egypt, Greece, Lebanon, and Turkey, yielded an exceedingly clear message. As illustrated in Fig. 16, a clear majority of farmers are not convinced that the current measures taken by the respective public authorities are sufficient to combat desertification, soil erosion, and water quantity and water quality deterioration, which represent some of the main challenges affecting the Mara-Mediterra case studies.

Meanwhile, Dr. Tawfik Al-Naboulsi (Lebanese University) collected the viewpoint from society at large in northern Lebanon. His initiative met with a 99% acceptance rate from the society to participate in the survey, which reached a total of 800 respondents. An overwhelming majority of respondents expressed approval, with 62% of respondents strongly supporting the reuse of treated wastewater. This is especially noteworthy since as many as 42% of those who knew of the existence of a nearby wastewater treatment plant reported that it was not in operation at the time of the survey.

> **From the outset, the AQUACYCLE Partnership was well aware that around the Mediterranean, the operation and maintenance costs of municipal wastewater treatment facilities are currently not fully recovered. Particularly in the southern-rim countries, this has resulted in a lack of maintenance, that poses environmental and health risks as wastewater is often not treated adequately.**

[2] https://mara-mediterra.com/

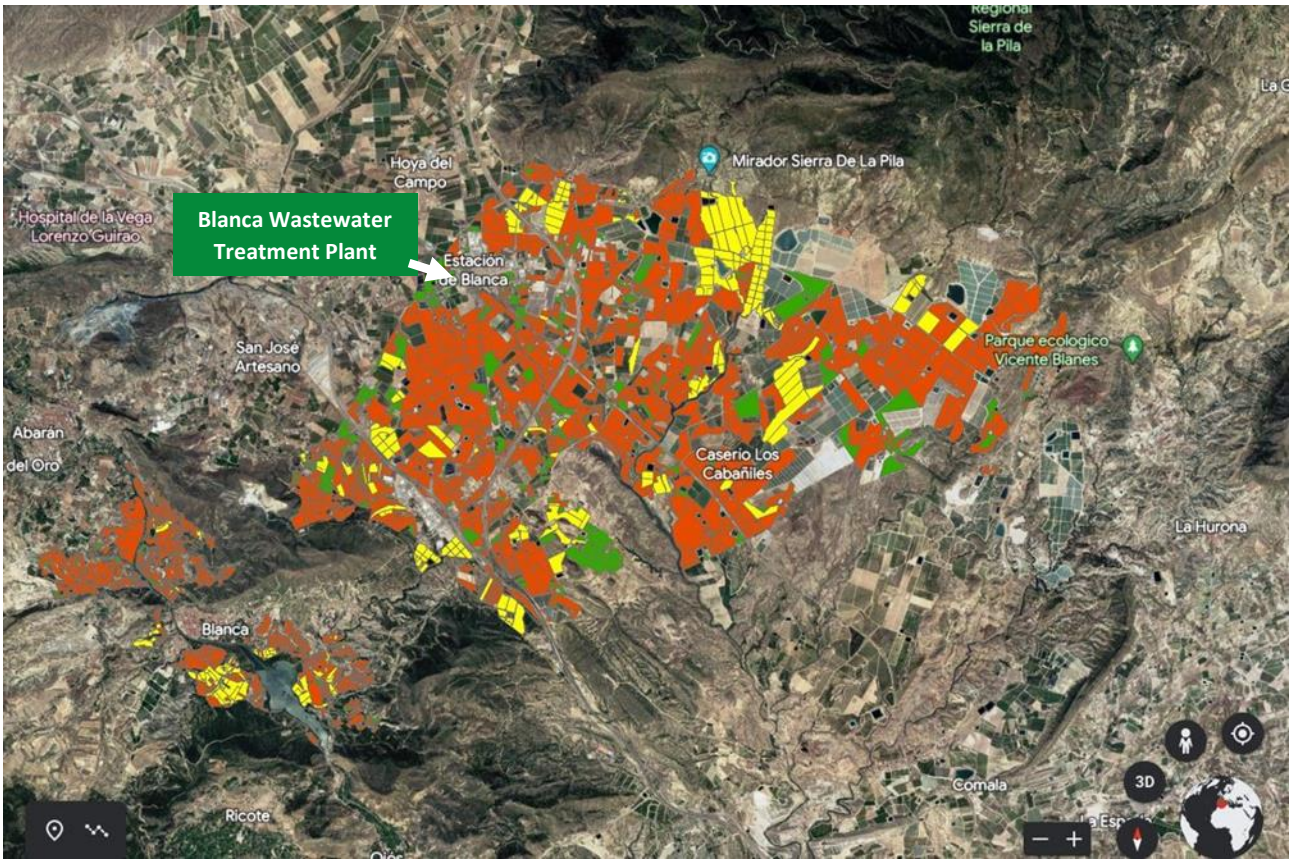

Figure 18: Actual reuse of treated wastewater in the environs of Blanca, Murcia region, Spain

Figure 19: The most frequently used words during the online webinar on June 6, 2023

9 A final word from experts and trend-setters in Spain on the reuse of treated wastewater

It was clear from the outset that the third workshop in Spain would be an opportunity to showcase the very high level of treated domestic wastewater reuse achieved in the Murcia Region of Spain to stakeholders in the neighbouring province of Almería and in other areas of Spain where the reuse of treated wastewater is still in its infancy, as is the case throughout Europe. Fig. 18 illustrates the very high level of treated wastewater reuse around the Blanca wastewater treatment facility in the Murcia Region of Spain.

The workshop itself was organized as a webinar in which key-experts on the reuse of treated wastewater were invited to focus their talks on the action plans that 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[3]. The experts were also invited to elaborate on the challenges that must be recognised and overcome in scaling up Nature-based Solutions, such as constructed wetlands, and when integrating different technologies (anaerobic digestion, constructed wetlands, solar disinfection) to achieve the required water quality of treated wastewater for reuse purposes such as crop irrigation. Several key quotes of their interventions are being shared through this Charter.

> "**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 to make wetlands more efficient.**"
>
> ***Dr. Isabel Martín, AMAYA, invited expert to AQUACYCLE Webinar in Spain***

> "**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***

> "**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***

> "**AQUACYCLE's eco-innovative (APOC) wastewater treatment 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***

[3] 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)

MedAPOC Charter

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