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# MEDITERRANEAN LIVING LABS FOR NON-CONVENTIONAL WATER REUSE AT LOCAL SCALE: MENAWARA PROJECT

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**Abstract**

Mediterranean countries are torn between old and new water policies, and water shortage experience is not related only to increasing demand and/or climate change, but also to poor infrastructure and management practices. This situation is aggravated in those rural areas where irrigated agriculture represents the backbone of the social growth and driving force of the economic activity.In this sense, the joint challenges of MENAWARA project consist of providing additional resources by recycling non-conventional water (drainage and wastewater), rationalizing water use practices and setting operational governance models in line with national and international plans. The project is designed to enhance access to water through the treatment of wastewater to be re-used as complementary irrigation and to strengthen the capacity of stakeholders, including local farmers. In the specific interventions in Spain, Italy, Tunisia, Palestine and Jordan, the actions are foreseen to turn into open living

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labs (for the co-creation, experimentation and evaluation of innovative products in the non-conventional water treatment and reuse sector); whereat small-scale innovative and technological solutions to encourage the end-use application of treated wastewater for agricultural irrigation and increase water efficiency and availability are being implemented, strengthening the promotion of synergies and the transfer of knowledge and innovation between the different stakeholders involved in the water governance.

# INTRODUCTION

The Mediterranean region is considered as one of the world's most water-stressed areas where some countries have less than 1000 $m^3$ /capita/year. A number of reasons are behind this situation, which includes, but are no restricted to, the relatively uneven distribution of precipitation, high temperatures, or increased demands of the population, and climate change is expected to aggravate the situation even more. More than 70 % of total water withdrawals are allocated to irrigated agriculture and water losses and leaks during conveyance and distribution, combined with inefficiency and waste in both irrigation and domestic use, are estimated at 45 % of total water demand for these two sectors.

Additionally, Mediterranean countries are torn between old and new water policies, and specifically, the agriculture sector has to adapt to the new political and institutional framework, both at the national and international level, where the synergy between Agricultural Policies together with Environmental Policies and Conservation of natural resources is taking place. More specifically, the above-mentioned situation is aggravated in those rural areas where irrigated agriculture represents the backbone of the social growth and driving force of the economic activity.

Under the above context, the use of non-conventional water, as drainage and wastewater, is one of the most sustainable alternatives to cope with water shortage. It would have a number of advantages that include closing the gap between supply and demand, stopping the pollution of freshwater resources, providing sound solutions to water scarcity and climate change, and helping to achieve Millennium Development Goals.

The EU funded project "MENAWARA – Non Conventional Water Re-use in Agriculture in Mediterranean countries" (ENI CBC Med program) is designed to enhance access to water through the treatment of wastewater to be reused as complementary irrigation and to strengthen the operational capacity of stakeholders of the quadruple helix (Cavallini et al., 2016), including local farmers. In the specific interventions in Spain, Italy, Tunisia, Palestine, and Jordan, the actions are foreseen to turn into open living labs; whereat small-scale innovative and technological solutions to encourage the end-use application of treated wastewater for agricultural irrigation and increase water efficiency and availability are being implemented, strengthening the promotion of synergies and the transfer of knowledge and innovation between the different

stakeholders involved in the water governance.

The actions developed in the MENAWARA project will reduce the stress on freshwater sources from the agriculture sector and will improve the quality of treated wastewater in agriculture. Clean and environmentally friendly technological, managerial, and operational innovation will be applied and results shared among relevant stakeholders. Also, it will play an important role in reducing water insecurity by designing the most suitable post-treatment and MAR systems for each intervention area and by promoting sustainable development in rural areas.

## LIVING LABS´S INTERVENTION SITES

Living labs are defined as "user-centered, open innovation ecosystems based on a systematic user co-creation approach in public-private-people partnerships, integrating research and innovation processes in real-life communities and settings" (Evans et al., 2017), (Water Europe, 2019).

Six intervention sites of MENAWARA project, for treating less than 2,000 $m^3$/d each one, in Tunisia, Palestine, Jordan, Spain and Italy, are foreseen to turn in open living labs, a peer-to-peer learning space where youths, technicians, water users' associations, local farmers and local authorities will be trained on capitalizing on innovative and user-oriented wastewater treatment, reuse and irrigation technologies. The engagement of stakeholders, based on a model of the quadruple helix will facilitate knowledge transfer regarding sustainable use of water resource and circular economy, fostering the dialogue, and developing national planning more responsive to the community's needs. Finally, MENAWARA project is expected to provide a "field lab" to develop, test, and validate a combination of solutions for sustainable wastewater treatment and reuse.

## RESULTS AND DISCUSSION

In Tunisia, two living labs are foreseen at the wastewater treatment plants (WWTP) of Choutrana II (extended aeration + secondary decanter + post-treatment train based on pressurised sand filtration followed by UV disinfection) and Borj Touil (2 horizontal flow constructed wetlands followed by maturation pond). Reclaimed water will be used for the irrigation of local plots.

In Palestine, the living lab is foreseen at the WWTP Beit Dajan, where aninnovative pre-treatment compact system will be implemented. For water reclamationis foreseen a post-treatment train based on a filtration process using pressure sand filters and a subsequent disinfection stage by application of hypochlorite as a disinfecting agent.Reclaimed water will be used for the agricultural irrigation in an experimental plot. (*Figure 3*).

In Jordan, the living lab is foreseen at the Ramtha Research Station,the reclamation train will be based on sand filtration followed by UV disinfection. Reclaimed water will be used for the irrigation of different crops in experimental plots.

In Spain, the living lab is foreseen at the Carrión de los Céspedes experimental center. The treatment train will be based on different kind and configurations of constructed wetlands (aerated, floating macrophytes, vertical flow, superficial flow), followed by a storage pond with ultrasound treatment and pressurised sand filtration. The reclaimed water will be used for the irrigation of a local olive grove plot.

In Italy, the Managed Aquifer Recharge (MAR) technique based on Forested Infiltration Areas (FIA) will be tested as a best practice to mitigate the groundwater nitrate contamination for the sandy phreatic aquifer (SHU) in the NVZ of Arborea (central-western Sardinia, Italy). The FIA system will be implemented in an area of around 0.4 ha and supplied with non-conventional water (drainage water), pumped from an existing dewatering pumping station. It will consist of six parallel recharge trenches placed between rows of white poplar trees (*Populus alba*) and equipped with an innovative Passive Treatment System, consisting of a mixture of inert and organic materials to attenuate organic and inorganic contamination and to prevent clogging processes at the infiltrating surface.


**Figure 1.** *Overview of the location of (6) living labs: (A) WWTP Choutrana II- Tunisia, (B) WWTP Borj Touil- Tunisia, (C) WWTP Beit Dajan- Palestine, (D) Ramtha research Sattion- Jordan, (E) Experimental Center of Carrión de los Céspedes- Spain, (F) Arborea intervention site- Italy.*

Target groups of the living labs will be farmer households living in the different intervention areas using TWW to irrigate olives trees, fodders and ornamental and fruits plants, technicians from local institutions, relevant local and national authorities involved in inter --/regional roundtables and very important, the women, considered the most vulnerable in fragile agricultural systems. In the frame of MENAWARA project, building women resilience through the proper reuse of better quality treated wastewater is one of the challenging objectives.

# CONCLUSIONS

The actions developed in the proposed living labs for non-conventional water reuse at small scale will reduce the stress on freshwater sources from agriculture sector and will improve the quality of treated wastewater in agriculture. Clean and environmental friendly technological, managerial and operational innovation will be applied and results shared among relevant stakeholders. Also, it will play an important role in reducing water insecurity by designing the most suitable post-treatment and MAR systems for each intervention area and by promoting a sustainable development in rural areas.

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