AGREEMed

Innovative Aquifers Governance for Resilient Water Management and Sustainable Ecosystems in Stressed Mediterranean Agricultural Areas

Demonstration site factsheeet

Hammamet, Tunisia

Description

Hammamet is a Mediterranean coastal area located in the Cap-Bon region of Tunisia (Gouvernorate of Nabeul). The touristic development has stimulated the urbanization extension and has deeply changed the original agricultural character of the region leading to water conflicts between sectors (agriculture, touristic, urban). The local water resources cannot meet the local demand, and the region should rely on the water transferred from other areas of the country to fulfil water needs. The groundwater is overexploited and suffers in some places from salt-intrusion. Due to this situation, agriculture abandon in favor of urbanization is more and more observed. 4500ha could be submerged under the effects of climate change and the actual situation is likely to increase the vulnerability of the region and limits the possibility of sustainable agriculture and water management.

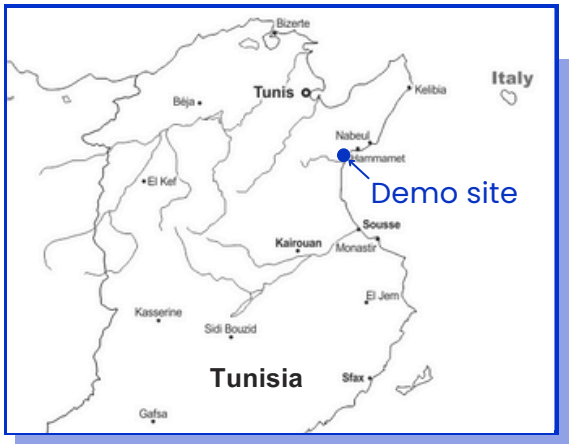

Figure 1. Hammamet demo site

Specific problems

In the Hammamet region of Tunisia, limited water resources are under increasing pressure due to competing demands from tourism and agriculture. Tourism, especially during peak seasons, requires large volumes of high-quality water, while local farmers depend on the same water sources often overexploited groundwater for irrigation.
This has led to aquifer depletion, saline intrusion, and growing conflicts between sectors.

Stakeholder mapping

National Sanitation Utility	National Water Distribution Utility	National Sanitation Utility Nabeul Directorate	Researchers	Citizens
Ministry of Local Affairs and Environment	Ministry of Health	Tourist Facilities	Industries	Ministry of Environment, Coastal Protection and Planning Agency
Municipalities	Tunis International Center for Environmental Technologies	National Environnemental Protection Agency	Hammamet Environmental Education Association	Tunis Directorate for Hygiene and Environmental Protection
Tunisian Union of Agriculture and Fisheries	Ministry of Agriculture, Water Resources and Fisheries	Agricultural Development Groups	Regional Development General Commission	Farmers

Stakeholder expectations

- **Water-Saving Equipment:** Deploy specialized equipment for sustainable water use in irrigation practices.
- **Technological Enhancements:** Implement complementary technologies to improve treated wastewater quality.
- **Alternative Water Solutions:** Explore alternatives to supply farmers with irrigation water.
- **Community Behavior Change:** Encourage behavioral shifts among the local population regarding water usage.
- **Industry Accountability:** Enforce efficient penalties for industries to encourage responsible water usage.
- **Educational System Update:** Revise the education system to include environmental topics, particularly on water resource preservation.
- **Collaboration Improvement:** Enhance cooperation among various stakeholders within the water sector for effective management.

S O L U T I O N # 1

REVERSE OSMOSIS-BASED DESALINATION SYSTEM FOR FARM WELL GROUNDWATER

Description

The module implemented at Mr Mahfoudh's farm, it is Vontron ULP21-2540. The ULP series of ultra-low pressure aromatic polyamide compound membrane element newly developed by Vontron Technology Co, Ltd can work under ultra-low pressure to reach as high permeate flow and salt rejection.

The active membrane area is 2.8 m2, the average permeate is 2.84 m3/d and the rejection rate is about 99% which supposed guarantee a high salt retention rate of the main ions of the brackish water, like Na+ and Cl-.

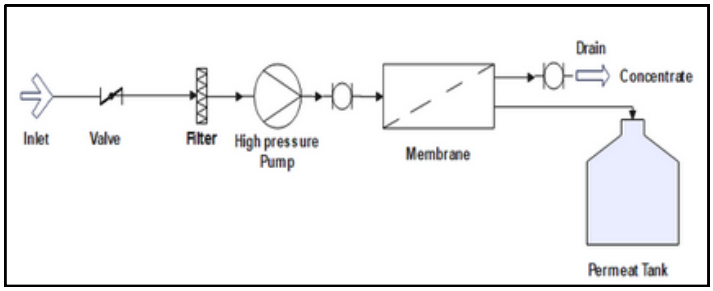

Figure 2. Example of process flow sheet to be implemented

Methodology

The system was installed and supplied with water from the well. Sampling campaigns were conducted in order to characterize the water feed (water from the well), concentrate and permeate in order to evaluate the performance of the RO unit and to develop an optimised treatment solution including for the discharged brine by our partners (GJU, TUB and DELTA Umwelt Technick)

Figure 3. RO unit in the farm

Latest outcomes

RO Feasibility Study for Small-Scale Irrigation

A pilot RO system was tested to assess its feasibility for reducing groundwater salinity for small-scale farming. The system showed a 97.95% salt rejection rate, but with a low recovery rate (10%) and a permeate flow of 120 L/h, below expectations.

Brine quality was similar to well water, posing no immediate disposal issue but requiring further consideration.

To improve performance, optimization measures were proposed :

- Integration of a pretreatment stage to protect the membrane and improve flow rate.
- Replacement of the current pump with a more suitable model to enhance pressure and system efficiency.

These upgrades aim to increase recovery and reduce energy use, enhancing the system's viability for agricultural use.

- Provide a supplementary quantity (more than 30% of needs by adding additional units)of NCWR to farmer.

S O L U T I O N # 2

PRODUCING NON-CONVENTIONAL WATER (NCW) BY UPGRADING SECONDARY-TREATED URBAN WW FROM THE SE04 (ONAS) OUTLET

Description

A Managed Aquifer Recharge (MAR) system based on constructed wetlands (CW) followed by infiltration through wet and dry ponds was designed to treat secondary effluent from the wastewater treatment plant (WWTP) near the farm at our Tunisian demo site.

The system is designed to handle 10,000 m³/day of secondary effluent. The feasibility study was conducted following a participatory process involving key stakeholders and local actors.

Figure 4. Location of the WWTP (SE04) and conceptual layouts of the MAR

Methodology

A sampling campaign was carried out to collect secondary effluent for quality assessment. In parallel, a technical meeting was held between the national coordinator of the project, and representatives from ONAS Nabeul to strengthen cooperation between the AGREEMed team and local stakeholders.

Following this meeting, historical data on secondary effluent quality were gathered to support the site-specific design of the Nature-Based Solution (NbS).

Figure 5. 2nd workshop:Co-design and feasibility study of NBS system to adapt quality to the use, 06032023, Hammamet.

Expected results / latest outcomes

The additional treatment using Nature-based Solutions (NbS) will serve ; (i) to improve NCW quality available for irrigation to farmers in the upstream area (ii) for aquifer recharge, and /or to create a barrier against saline intrusion

Moreover, the Managed Aquifer Recharge (MAR) system will help reduce the daily volume of effluent discharged into the sea, contributing to better coastal water quality, particularly during the summer months.

S O L U T I O N # 3

NBS PROTOTYPE FOR THE LOCAL TREATMENT OF SECONDARY EFFLUENT AT MAHFOUDH'S FARM

Description

The treatment system is a hybrid process that combines biological treatment using a Nature-Based Solution (constructed wetland - CW) with advanced oxidation (AOP) using titanium dioxide (TiO_2). The aerated constructed wetland pilot was designed as a portable solution, enabling potential replication in the future. It has a daily treatment capacity of 1 m^3/day of secondary effluent.

An aeration system will be installed beneath the gravel substrate at the bottom of the wetland bed, applying Forced Bed Aeration (FBA) technology. The introduction of air enhances the oxidation process, significantly improving pollutant removal efficiency. This approach reduces the land area required by a factor of 4 to 5 compared to conventional passive constructed wetlands.

Gravel and biochar will serve as filtration media. Additionally, the wetland effluent will percolate over an inclined surface coated with titanium dioxide, promoting further oxidation. The treated water is then collected in a small reservoir, from which it can be reused for irrigation purposes.

Methodology

Data related to the quality of secondary effluent of the WWTP bassin ref SE04 (ref given by the national sanitation office) were used to design the mobile prototype.

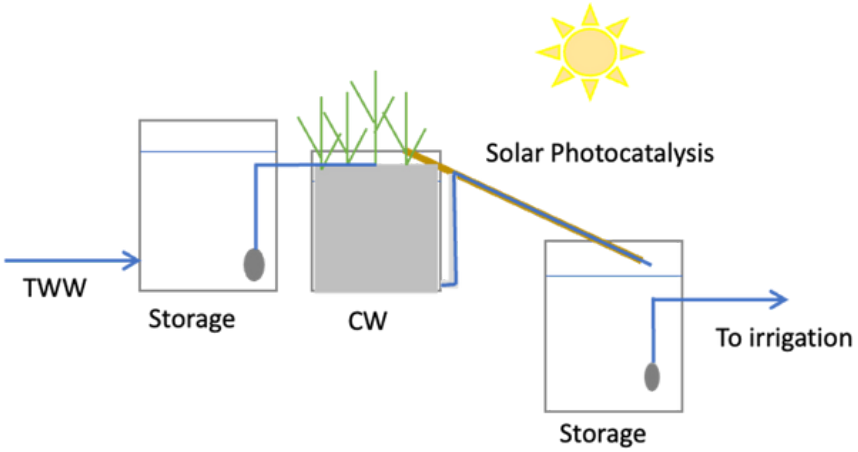

Figure 6. Illustrative image of the hybrid treatment system based on NbS and AOP.

Expected results / latest outcomes

The prototype will improve the quality of the secondary treated wastewater received by farmers from station SE04. Currently, the quality of the secondary effluent is unstable and may be affected by the operating conditions of the pumping station. The CW+AOP process will ensure a consistently high quality of the resulting tertiary treated wastewater.