BONEX

NEXUS BRIDGING PLAN

Smart Reuse

Ouardanine **Tunisia**

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

This project is part of the PRIMA programme supported by the European Union.

NEXUS BRIDGING PLAN

Smart Reuse

in Ouardanine, **Tunisia**

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BONEX Project is funded by PRIMA program

BONEX Boosting Nexus Framework Implementation in the Mediterranean

PRIMA PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

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Executive summary

The reuse of treated wastewater (TWW) for agricultural irrigation has become strategic for ensuring water and food security while protecting the ecosystem. The reuse of reclaimed water in the area of *Ouardanine, Governorate of Monastir*, Tunisia, started in 1997 to reduce the discharge of effluents and to provide farmers with a reliable water resource for the agricultural activity to enhance ecosystem recovery and to guarantee the community's wellbeing. Despite the significant success, the irrigated area is facing several challenges related to availability and management of the resources, i.e. water and energy.

W**ithin the scope** of the BONEX Project, the present Nexus Bridging Plan (NBP) was developed for the seven Demonstration Projects across the Mediterranean Region. The NBPs are practical context-specific plans guiding the transdisciplinary implementation of the proposed WEFe solution approaches targeting policy makers and practitioners. The current plan outlines the WEFe Nexus Bridging strategy for implementing a SMART Water Reuse of TWW for agricultural irrigation, in *Ouardanine* area, Tunisia.

Within the BONEX project, participatory and transdisciplinary approaches were adopted to identify key WEFe Nexus challenges encountered in *Ouardanine*. National, regional, and local stakeholders of the water reuse sector were involved. Three workshops were organised, starting with a Participatory System Mapping approach leading to a Causal Loop Diagram. Through a systemic analysis, three key problems were identified, primarily concerning Water and Energy: i) Limited availability of the treated wastewater; ii) High cost of energy; iii) Inconsistent availability of energy.

The collaborative approach led to the identification and validation of the project's technological intervention and the co-development of an alternative solution. It has also facilitated the identification of problems across technical, economic, environmental, and societal dimensions, as well as at multiple governance levels. Two main solutions emerged from this process. The first focuses on **optimising irrigation water** use in line with the BONEX intervention "Smart Reuse" and aims to improve treated wastewater (TWW) and nutrient management through three technological components—a **smart weather station** for real-time monitoring of weather parameters to accurately estimate the water requirements of fig and other crops, and **smart low-cost soil moisture sensors** to improve irrigation scheduling. These smart technologies, when combined, enhance irrigation efficiency, addressing the qualitative aspect of water reuse. In addition, smart water quality sensors will be used for real-time monitoring of physicochemical parameters of TWW, including pH, electrical conductivity, salinity, total suspended solids, COD/BOD/TOC, turbidity, nitrate and ammonia nitrogen, and potassium. These sensors will be connected to the **nutrient-balance tool (Richwater)**, developed jointly by BIOAZUL and Smart Logger, and tested in the Tunisian context to improve nutrient management and reduce fertiliser use. The second solution—**photovoltaic-powered water pumping**—is an alternative strongly supported by the farmers. It involves the use of solar-powered pumps during power cuts, which typically occur during peak demand hours.

BONEX intervention and eventually the alternative solution would enhance the efficiency and sustainability of TWW reuse in agriculture, addressing both current challenges and future needs. In order to support end-users adopting the technological change brought by BONEX, complementary measures were identified. They include the management of the resources (management and distribution of water and energy), financial and economic measures (incentives and subsidies allowing more funds), institutional and regulatory measures (status and governance of the water users' association *i.e.* GDA), and the active involvement of the community (communication, training, share of success stories, leadership among farmers). Finally, several key stakeholders were identified to facilitate the adoption of these technologies and for scaling them up and out and paving the way for broader implementation in Ouardanine region and beyond.

Methodological approach

In Tunisia, the BONEX project is expected to support the national strategy on TWW reuse, more particularly for agricultural irrigation, and for its implementation in the *Ouardanine* region. Its primary goal is to improve the quantitative and qualitative management of TWW at the plot level, forecasting an endorsement at farm level, and at the regional level, while enhancing nutrient utilisation to minimise the environmental impacts. The implementation of BONEX methods and tools combined with the expertise of the multidisciplinary research team, have successively introduced innovative solutions to the irrigated area.

To ensure the project's accomplishment, a Steering Committee (SC) comprising representative members from key national, regional, and local stakeholders of the WEFe Nexus of the reclaimed water reuse sector was actively engaged in activities. Members were trained on methods and tools to enable them to contribute effectively to the project. A Regional Working Group (RWG) gathering more than 50 members, representatives of various WEFe Nexus sectors, was established after the first workshop. The RWG, along with other regional and local stakeholders, took part in the participatory workshops to discuss and select interventions.

The BONEX project, through its participatory approach, served as a catalyst for introducing and implementing the WEFe technological innovation, bringing together farmers and other national, regional, and local stakeholders during three workshops. After the scoping assessment phase, the first workshop was organised based on a systemic analysis of the various challenges encountered in the area, their causes, and potential impacts. Three Causal Loop Diagrams (CLDs) were the main outcomes of this step, ensuring the comprehension of the WEFe framework in the region. The second workshop refined the CLDs and merged them into a single model, enabling the validation of the project intervention, as identified by the experts, *i.e.* the Smart Reuse, as well as the identification of an alternative solution within the CLD, *i.e.*, the photovoltaic water pumping. Participants also discussed the barriers and the opportunities for implementing both the project intervention and the alternative solution.

While the project introduced two primary solutions, these are not the only options for addressing the WEFe Nexus challenges in *Ouardanine*. Actually, a suite of complementary solutions tailored to the local context may exist, including those supported by BONEX. The complementarity of solutions is evidenced by the range of challenges encountered during the project course, spanning different levels and types. BONEX intervention has the potential to be scaled up and applied more broadly. However, the implementation of this innovation was affected, to a certain extent, by the new water pricing policy in 2021 - just prior to the project - for energy cost recovery, thus constraining the farmers to seek immediate resolutions with short-term impacts, like the solar pumping. Additionally, day-to-day technical issues related to irrigation water management emerged, including the distribution of TWW and the maintenance of the distribution and storage infrastructure. Solutions to other urgent problems, such as the clogging of the irrigation network and the decline of irrigation water quality, were investigated together with farmers.

Context description

The demo site, of Tunisia is located in the TWW irrigated area of *Ouardanine* (35° 44 '14.95"N 10° 40' 16.15"E), in the communal area of *Ouardanine*, 15 km northwest of *Monastir Governorate* *(Figure 1)*. Agriculture, as the main economic sector, is challenged by water scarcity. Therefore, farmers claimed the reuse of TWW to maintain the agricultural activity since 1994, thereby guaranteeing a decent income, and preventing the discharge of the WWTP of *Ouardanine* into the *Guelta* stream; the latter being at the origin of a noticeable environmental pollution. The TWW, as the only water resource in the area, has contributed to the high acceptance and buy-in of reuse by the community. Nowadays, the total irrigated area stretches over 75ha exploited by around 46 farmers. Fruit trees are the main crops, in addition to geranium, practiced as intercropping.

Due to recent pricing policy measures (March 2021) mainly related to energy cost recovery, the irrigation water management was disrupted, exacerbated by the power cuts occurring during the peak hours of energy consumption, *i.e.* from 11 am to 4 pm, during the summer season. The absence of alternative energy sources and the limited infrastructure capacity have worsened the existing institutional and management issues. From an environmental standpoint, effluents that are not pumped for irrigation are discharged in the El *Guelta* stream, which has literally become a stream of wastewater, crossing the agricultural area. The lack of dredging is significantly disturbing and negatively impacting the ecosystem services due to the invasion of wild plants, insects and wild animals, the rise of the saline groundwater table thus causing soil salinisation and perishing of orchards, contributing to the development of halophytes.

The prevailing conditions highlight the need for better management of the quantity of TWW by adopting best irrigation practices, on one hand, and of the quality, by optimising nutrients and mitigating pollution, on the other hand. The

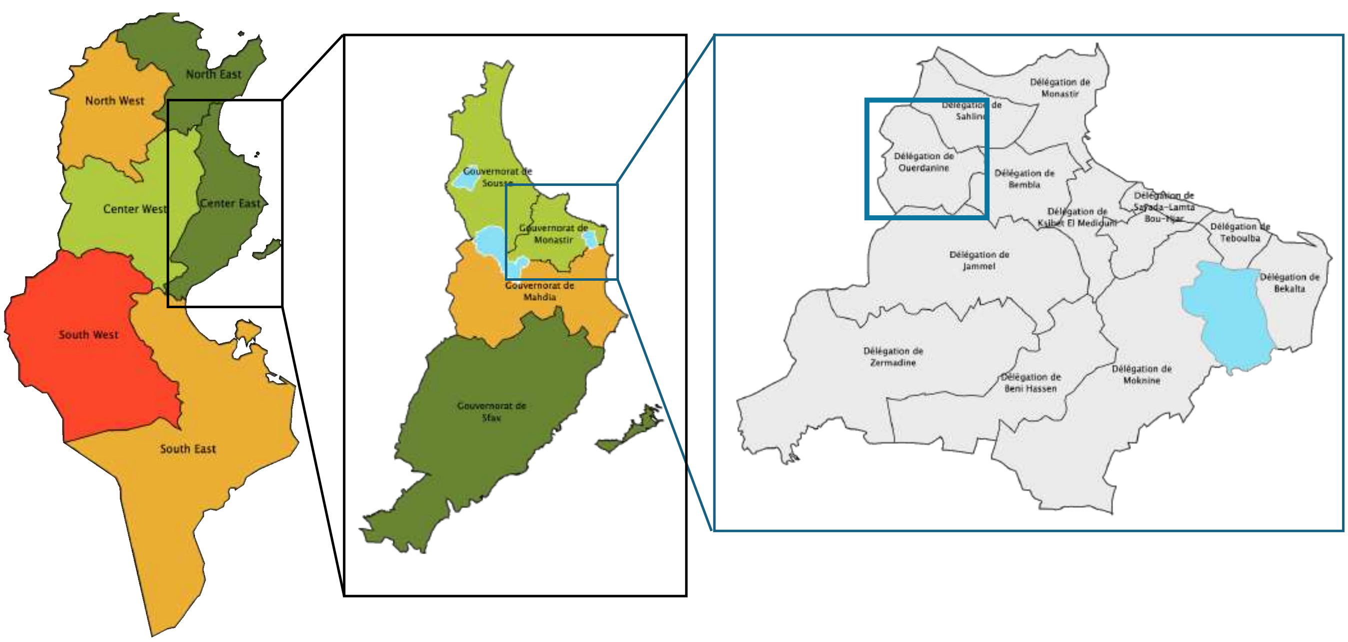

Figure 1 – Location of the delegation of 'Ouardanine' in Tunisia (Source: INS website)

WEFe Nexus intervention of BONEX aims to improve the overall TWW management at the plot, to be scaled out at the farm level, and, at a later stage, at the entire irrigated area. While the extension of the irrigated area is not anticipated in the upcoming years, crop diversification and upgrading of the pumping capacity are desired to reuse all the effluents, to reduce the discharge of TWW and minimise its negative ecological impacts. Additionally, the frequent heat waves and the emergence of new pests may undermine agricultural production through the spread of new diseases. The foreseen subsidised installation of solar panels - as the alternative solution identified by the stakeholders - is anticipated shortly to confer flexibility and to release the pressure related to water distribution by allowing water pumping, at peak energy demand. BONEX team will follow up on the potential impacts of this technology within the WEFe Nexus framework. In fine, the technical improvements are expected to impact positively water governance by enhancing communication among farmers. From a socio-ecological perspective, reducing effluent discharge will alleviate pollution and enhance the ecosystem services available to the community.

WEFe Nexus issue

During the first participatory workshop, the stakeholders identified the main WEFe-related problems, through a Causal Loop Diagram *(Figure 2)*, wich can be explained as follows:

1. Energy availability: the power cut, from 11am to 4pm, corresponding to the peak hours' demand in the area, is driven by the high cost of energy during this period of the day. The lack of alternative energy sources for water pumping, like PV panels, could result in the disruption of irrigation during the hot season, thereby jeopardizing the crop yield with a potential impact on farmers' income.

2. Energy cost: Since 2021, farmers have been called to cover the energy cost, the latter being proportional to the pumped TWW, which depends on its turn on the size of the irrigated land. Despite the high water demand, TWW pumping is interrupted to reduce the energy billing covered by the water users' association (GDA). This situation may cause an uneven distribution of the water among farmers and ultimately affect water availability and the crops production. Solar panels are sought as an alternative solution to offset the shortage of energy for water pumping and to alleviate conflicts among water users at the same time.

3. Limited availability of TWW: Based on farmers' sayings, the irrigated area is receiving only 30 to 50% of its actual water needs due to the limited capacity of the infrastructure and equipment for pumping and distribution. During the period of high water demand, poor water governance is noticed in addition to the power cut for water pumping. Moreover, TWW quality could be impaired by the release of industrial effluents (mainly from slaughterhouses) in the sanitation network due to the poor enforcement of the regulation. The degradation of TWW quality results in the interruption of the water distribution until restoration. The poor maintenance of the storage infrastructure could lead to the interruption of the supply in case of larger interventions, reduce the amount of TWW, and impair its quality.

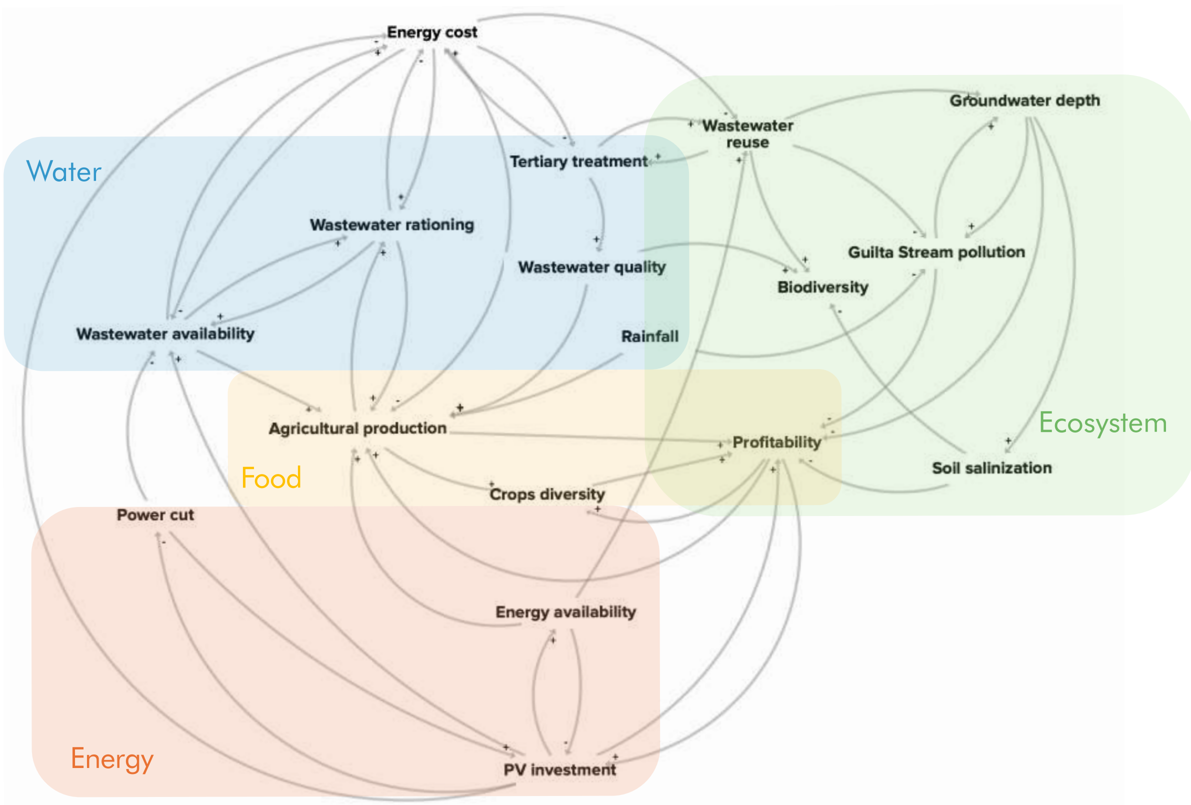

Figure 2 – Causal Loop Diagram including the main WEFe Nexus related problems in the irrigated area of 'Ouardanine'

Farmers are the stakeholders most affected by the WEFe-related challenges as they are the unique end-users' of TWW. Uneven water supply could further affect crop production among other factors like pests, lack of pollinators, etc. Since only a proportion of TWW is reused, the rest is discharged into the stream, resulting in the rise of the saline groundwater level and the loss of soil fertility. Additionally, limited availability and uneven distribution of TWW create tensions among stakeholders.

Non-monetary benefits

The main objective of this method is to identify and assess the various types of values and dimensions of human-nature connections, which extend beyond the monetary or market-based values associated with WEFe components. It seeks to uncover the additional benefits that the WEFe Nexus can generate within a specific social-ecological context or local community. For this purpose, 11 interviews were conducted with stakeholders from agriculture and water sectors in *Ouardanine*. Interviewees were 46 years old on average, with 64% relying on agricultural activity, either exclusively or as secondary job. Postgraduates represent 55% and 45% have a high school degree. Women represent 18%.

The findings highlight a strong emphasis on the practical importance of natural resources, particularly water and energy, deemed as essential for sustaining agriculture, ensuring food security, and supporting economic stability. Given water scarcity, maintaining access to these resources is a critical priority for local livelihoods. While economic and survival needs shape most perceptions, stakeholders also recognise the connection between communities and the natural environment, particularly in relation to agricultural traditions and local development; the appreciation of nature's intrinsic value is limited. Hope, happiness, safety and optimism were redundant expressions, but also concern, frustration, and disappointment. *Ouardanine* provides valuable insights into the WEFe nexus under water reuse, illustrating how local communities perceive their environment. A strong reliance on material and economic aspects of socio-ecological systems is observed. The experiential and emotional dimensions reflect a positive relationship with the environment, with an attachment to the land. The cognitive dimension shows a solid understanding of socio-ecological systems, though there is potential to strengthen education and awareness. The philosophical dimension reveals a widespread belief in the importance of nature and resources. These insights can contribute to a more integrated approach to managing the WEFe nexus in *Ouardanine*, ensuring that economic priorities are balanced with long-term environmental resilience and cultural considerations. Commitment, gratitude, and peace were expressed despite anger, sadness, and anxiety *(Figure 3)*.

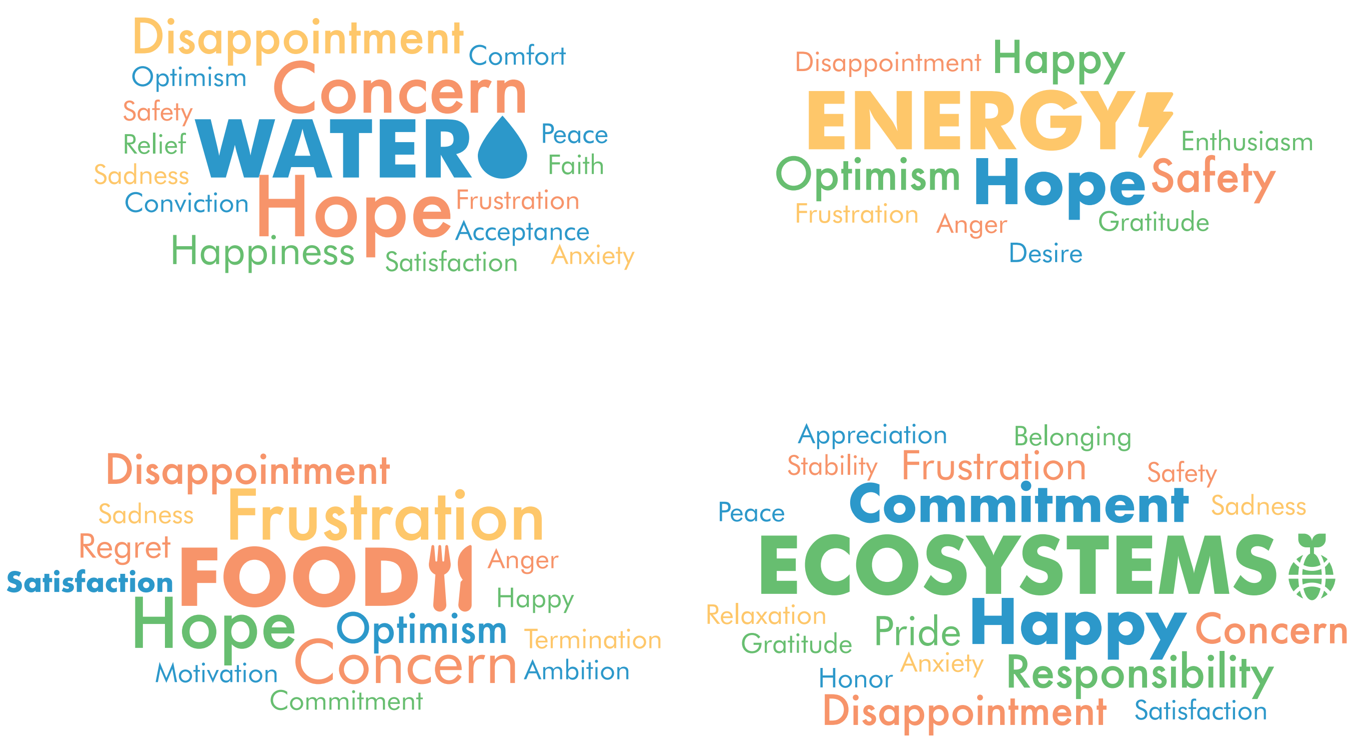

Figure 3 – Word cloud expressing the stakeholders' opinions and perceptions of the resources related to the WEFe Nexus.

WEFe solution: Intervention and complementary measures

The intervention of BONEX in the irrigated area of *Ouardanine* consists in three AI-based tools, described below, that will be connected to a platform to contribute to solving the WEFe Nexus problems in the fig plot.

BONEX intervention: Smart Reuse

An IoT-based agro-weather station for the real-time monitoring of weather parameters like temperature, rainfall, solar radiation, etc. *(Figure 4)* with a simulator for an accurate estimation of the crops water requirements. The tool will reduce water and energy consumption, decrease the release of nutrients and pollutants into the environment, increase yield, and preserve the ecosystem.

Figure 4 – Connected agro-meteorological station with integrated simulator for real-time monitoring of the weather parameters and automated calculation of the crops' water requirements.

Figure 5 – Low-cost sensors for real-time monitoring of soil moisture in the fig plot.

Low-cost sensors for real-time soil moisture monitoring aiming at improving irrigation scheduling *(Figure 5)* and water use efficiency. In combination with the weather parameters, crops will receive the exact amount of water.

Specific sensors for a real-time monitoring of TWW water quality parameters including pH, electrical conductivity, temperature, salinity, total dissolved solids, turbidity, total suspended solids, chemical and biological oxygen demand (COD and BOD), total organic carbon (TOC), nitrates, ammonium, and potassium *(Figure 6)*. With measurements taken up to every 5 min, the tool will improve the management of TWW quality by facilitating stakeholders' decision-making and accessing data to support further fertigation program. Indeed, data will feed the Richwater nutrient-balance tool developed by BIOAZUL/ Smart Logger. These tools are expected to lower the cost burden of the analysis performed by the regional authorities.

Figure 6 – Water sensors for the real-time monitoring of TWW quality

Obstacles and Facilitating Factors

The main obstacles that may hamper the implementation of BONEX project solution were identified and discussed by the stakeholders during the 2nd workshop. They are classified as follows:

- Technical:
- Poor timeliness TWW supply for irrigation
- Limited capacity of the irrigation network.

- Financial:
- Possible high cost of the instruments.
- Current lack of funding/subsidies to use IoT-driven tools in the agricultural sector.

- Social and institutional:
- Lack of incentives to invest in technology.
- Poor water governance at local level.
- Lack of training-for-purpose.
- Lack of communication among stakeholders and conflicting relations within the local community.

Conversely, **several opportunities** were also highlighted resource by the REUSE2050 Master Plan for the year 2050 as the national strategy on water reuse for various purposes, including agricultural irrigation.

1. Technical:
- Training of the new generation of young farmers on innovative technologies.
- Integration of capacity building as a package within the solution.
- Existence of public training structures and extension services to carry out outreach activities.
- Availability of research institutions to support the implementation of the solutions and follow up on outcomes.

2. Financial:
- Estimated low cost and affordability of the developed tool and its rapid availability on the market.
- Presence of local companies that could provide an integrated solution.
- Involvement of SMSA (Agricultural Services Companies) to take the lead in promoting the intervention among farmers.

- Possible involvement of NGOs to fund the tools.
- Availability of funding by training centers or research projects.

3. Social, administrative, and political:

- Coordination between stakeholders such as the GDA, the National Sanitation Utility (ONAS), the Regional Department for Agriculture Development (CRDA), and the Extension and Vocational Training Agency (AVFA).
- Incentives and support from the government for the reuse of reclaimed water are highly relevant.
- High acceptance and interest of the farmers in innovative solutions.
- Potential availability of reclaimed water through improved governance.

The alternative solution: Photovoltaic-powered water pumping

In addition to the three major technological innovations described above, the RWG has identified an alternative solution consisting in the installation of photovoltaic panels to guarantee the availability of energy during peak hours' demand, thus allowing water pumping for irrigation. This solution arose in recent years due to the increase in energy and water pricing policies. However, this alternative solution goes beyond the project framework and can only be subjected to explored by the research team. Recently, a solar power-based water pumping system was subsidised in the irrigated area. The photovoltaic-powered water pumping would largely support the implementation of the WEFe Nexus intervention.
It becomes obvious that both technological solutions would jointly contribute to solving the existing technical problems faced in the area. Additional complementary measures that go further beyond the technical aspects are also needed to improve the overall situation in the irrigated area of *Ouardanine*.

Complementary measures and actors to be involved

In order to facilitate the implementation of the WEFe Nexus technological intervention, complementary measures were identified by the stakeholders in response to the main obstacles identified beforehand.

Resource management-related practices: Due to technical limitations, farmers have access only to 30-50% of their water needs. Therefore, upgrading the pumping capacity of the irrigation network would allow the exploitation of the whole amount of available TWW; crops diversification was also recommended. Enforcing the pre-payment of the subscription fees was strongly supported, together with the adjustment of the pricing policy to cover the cost of energy and maintenance of the network and to guarantee sufficient funding sources to the GDA. The rationalisation of TWW was underscored along with the use of water-saving irrigation techniques, especially for smallholders.
As for communication, improving water-saving governance was largely approved by the installation of water meters for promoting more transparency. For this purpose, hiring and training permanent technical staff is expected to improve the delivered water services. By the same token, information sharing among the community members and the use of digital communication tools were proposed.

Economic and financial issues: Dedicating specific funding (loans) and incentives/subsidies were suggested to support investment in IAtechnology-based solutions. All the stakeholders agreed that the GDA should play a key role in guaranteeing additional financial sources to support the farmers' community and to access innovative technologies. In this regard, upgrading the status of the GDA was proposed. Besides, for scaling out the intervention, the diversification of the funding sources based on the target beneficiaries and specific technologies was proposed. Hence, loans or private funding could be available for individuals, while joint private funding, subsidies from the government, twinning with international organisations/associations, and international funding could support larger groups of beneficiaries. Other solutions with a positive financial impact were proposed, like dedicating specific funds for sensitisation and training on new technologies and creating a local market to enhance commercialisation of the produce.

The community engagement covered various suggestions. Sharing information and knowledge among the farmers came through to enhance feedback for further guidance and extension to other areas. The organisation of events was highly supported (info days, field visits, joint meeting between the policymakers and farmers, hands-on field school, extension campaigns for trainers and end-users, *etc.*). Audience-targeted events, like conferences to disseminate scientific results and workshops for more practical impacts were proposed. The use of all available communication tools and media channels was suggested to promote the project intervention, make it visible to the general public, and raise awareness among farmers about new technologies. To enhance education and build capacities of potential technologies' end-users and beneficiaries, it was suggested to develop a year-around training program to trigger the change and share successful experiences. Professional unions and extension services should be involved in promoting the technologies, training facilitators and trainers, and building the capacity of local leaders to support and guide their peers. In this regard, boosting the role of the GDA in the communication for endorsing the technologies of BONEX was largely approved.

Institutional and regulatory measures: Raising awareness of the community about water scarcity in the region was the first measure to tackle the lack of incentives/subsidies and the prevailing water management practices. Accordingly, a fair distribution of water was called for by encouraging farmers to stick to the allocated amount of TWW, based on their farm sizes and cultivated crops. Support from the public sector was requested to improve governance and management by adopting a new regulatory framework for the GDA. Good governance came along with using relevant indicators for water resources and energy management and reinforced administrative and financial control of the GDA. In addition, the revision of the water pricing policy was suggested to allocate more funds for the maintenance of the infrastructures and for introducing innovative technologies.

Performance of the intervention

Smart Water solution combines three core technologies to optimise TWW and nutrients management based on AI-driven agrometeorological station, advanced IoT water quality sensors, and smart irrigation systems with real-time data integration.

AI-optimised agro-meteorological station: The agro-meteorological station installed in the demo site (fig plot) is connected to a centralised system that collects real-time weather data. This system uses AI algorithms to analyse climatic conditions to estimate water requirements accurately. Compared to traditional irrigation methods, this predictive capability will improve irrigation scheduling accuracy, ensuring that water is applied only when necessary, preventing over-irrigation and reducing water losses.

Water quality sensors: To monitor some of the main TWW quality parameters, advanced water quality sensors are installed in the pumping station receiving the effluents directly from the WWTP. These sensors track key parameters in real-time. The RichWater simulator integrates these readings with automated adjustments to irrigation and fertilisation schedules, enabling farmers to optimise nutrient recovery and reduce fertiliser usage. In practice, this is expected to result in more efficient use of TWW and higher crop yield, as farmers can precisely tailor water and fertiliser.

Smart irrigation with real-time monitoring: Soil sensors are placed throughout the field at different depths to measure real-time soil moisture. These sensors communicate with the digital simulator, which processes data on moisture levels, weather forecasts, and crop water needs to create a dynamic irrigation schedule. Preliminary results showed that sensors were efficient and accurate at around 20 cm depth vs. conventional methods; sensors placed at 60-90 cm depth are being tested to improve accuracy.

REWEFe

To assess the status of water, energy, food and ecosystem resources, both individually and jointly, the REWEFe (Rapid Evaluation of Water-Energy-Food-ecosystem nexus) tool was used as it provides quantitative insights on the balance and resource use (production, consumption, incoming and outgoing) of water, energy and food. It also accounts for the main positive and negative ecosystem impacts in monetary terms.

Based on three scenarios *(Figure 7)*, it was observed that with the implementation of improved nutrient management and a soil moisture monitoring system, a positive impact on the ecosystem is evident, especially in S2 and S3. This is because there are greater outflows from the irrigated area because of reduced irrigation requirement (and consumption), leading to environmental flows required to sustain the ecosystem (S2 and S3). Similarly, no fertilisers are applied as the nutrients are supplied through reclaimed water (S3), thus minimising nutrient leaching which adversely impacts the environment. A reduction in water consumption is also seen in S2 and S3 (6% and 11%, respectively) as the water demand for irrigation decreases due to an improved understanding of soil moisture conditions.

Observed synergies and trade-offs: While the implementation of a nutrient management and soil monitoring system leads to lower water consumption, higher food production and a healthier ecosystem, the upscaling scenario shows a slightly lower food production as the crops experience nutrient stress. This is due to the amount of nutrients available in the reclaimed fraction (90%) and the nutrient uptake fraction (95%). To maximise food production without the application of fertilisers, the reclaimed water should be able to supply 100% of the nutrients required and the uptake by the crops must also be 100%. However, if this is not achievable due to technological constraints, then the deficit can be met by applying fertilisers. Therefore, the transition from using fertilisers to adopting a zero-fertiliser approach comes with a set of trade-offs.

Figure 7 – Results of the different scenarios. ***Baseline (B)*** *- Use of reclaimed water for irrigation and excessive fertiliser application by farmers;* ***Scenario 1 (S1)*** *- Higher nutrient uptake fraction thanks to improved nutrient management;* ***Scenario 2 (S2)*** *- Improved demand-driven irrigation application as a result of soil moisture monitoring; and* ***Scenario 3 (S3)*** *- Upscaling and higher adoption of the BONEX technology.*

Conclusion

The reclaimed water irrigated area of *Ouardanine* stands out as a success story in Tunisia, having addressed numerous challenges through over 30 years of treated wastewater (TWW) reuse. This long-standing practice has played a vital role in sustaining farmers' livelihoods and promoting agricultural resilience.

However, in recent years, the area has faced emerging challenges, particularly in the management of TWW and rising energy costs issues that have been identified and validated by local stakeholders. To tackle these challenges, the BONEX innovative intervention aims to enhance TWW management in both quantity and quality by introducing smart tools that address the interlinked challenges of the Water-Energy-Food-ecosystems (WEFe) Nexus. These smart tools are designed to optimise irrigation scheduling, improve nutrient use efficiency, and ultimately reduce water and energy consumption. As a result, the initiative is expected to boost crop yields, lower operational costs, and strengthen ecosystem services.

The endorsement of BONEX solutions by farmers requires coordinated efforts and several measures to be undertaken by stakeholders at national, regional and local levels to pave the way to a more sustainable water reuse sector. Most importantly, financial, institutional, educational and social, and technical measures have been identified.

The project intervention has solicited strong interest among stakeholders. Apart from soil moisture sensors for use at the individual farmer level, the agrometeorological station and the water quality sensors will benefit the entire region. These tools will be adopted and managed by the regional stakeholders to monitor, collect, interpret and disseminate the information. The partnership between BONEX researchers and the regional stakeholders is expected to further advance the project. The water quality sensors will align with the cornerstones principles of the contemplated regulatory framework on water reuse for the promotion of transparency and data sharing within the reuse sector. This framework supports the obligation of making good use of nutrients, when applicable. This approach is in line with the National Strategy on reuse for the year 2025 (REUSE 2050), the Water Code (under validation), and the national Water Strategy on Water for the year 2050 (EAU 2050). Furthermore, data generated by the agrometeorological station will extend benefit to other irrigated crops in the region of *Ouardanine*.

The optimisation of water and nutrients management in *Ouardanine* through BONEX project will support the WEFe Nexus approach implementation. It requires a full commitment of the public, private, and the society structures to contribute to the transformation of the reuse sector from the technical, regulatory, institutional and environmental perspectives. The research team is committed to pursuing the work on the technological innovation within the WEFe Nexus framework to support the study of the impact of solar pumping to prove that there are no unique and one-size-fits-all solutions but integrated and complementary solutions to achieve sustainability.

The optimisation of water and nutrients management in 'Ouardanine' through BONEX project will support the WEFe Nexus approach implementation.

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