I-ReWater. Sustainable water resources management in irrigated agriculture in the SUDOE area

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ABSTRACT

I-ReWater analyzes the current state of water resources in the SUDOE area paying special attention to the use of reclaimed water in irrigated agriculture, and its effects on the production and quality of crops, promoting the resilience and security of water supply. The dynamics of available volumes of reclaimed water and its quality will be considered in the comprehensive analysis of water resources, evaluating their potential use in addition to the conventional water resources in irrigation (surface and groundwater). In this project a strategic plan at transnational level for the incorporation of reclaimed water for irrigation will be developed, which will release conventional water resources, reduce the pressure on the water bodies, improve the quality and water resources availability for other uses (circularity). The design of the strategy is based on the study of available water resources, potential demands and the evaluation of the environmental impact of irrigation with reclaimed water using the Life Cycle Analysis (LCA) methodology, paying special attention to the impact on eutrophication and acidification of waters, ecotoxicity and quantification of the water footprint. The socio-economic analysis will focus on explaining and describing decision-making processes in their technical, economic (comparison of the cost of water, willingness to pay and the price of water), regulatory and political dimensions. Two groups of pilot actions will be carried out to demonstrate the viability of reclaimed water in irrigation, in horticultural crops and woody crops, with a total of 15 experiments considering different sociocultural and environmental contexts. Different tools will be developed within the project to improve decision-making strategies, which will integrate

existing models/applications developed in previous projects. These tools will help farmers in the sustainable management of fertigation, considering deficit irrigation strategies and optimum fertilization, benefiting farmers and general population. The transnational approach with different kinds of irrigated crops in different locations, different water qualities and soil properties and the integration of previous experiences of the different research groups is one of the innovative aspects of the project.

Keywords: reclaimed water; strategy; action pilots; horticultural crop; orchards; decision support system; water cycle; resilience

BACKGROUND

The use of reclaimed water is currently in a phase of increasing implementation and demand, although one of the main barriers it faces to is the non-existence of global standards worldwide. As a global regulation or guideline, recommendations developed by the World Health Organization (WHO) for the use of reclaimed water for agriculture and aquaculture (WHO, 2006) have been largely adopted, as well as the guidance published later in 2017 for the safe production of drinking water both through direct and indirect reuse (WHO, 2017). At an international level, the ISO/TC 282 committee developed standards, including technical, economic, environmental and social aspects for any type of use of reclaimed water, however the levels and parametric limits of the substances to be controlled are not included, referring to governments or, in their absence, intentional organizations such as the WHO to establish them. More recently, the UNE ISO 16075 published the "Guidelines for the use of treated wastewater in irrigation projects", which provide specifications for the development and implementation of treated wastewater projects, design and quality criteria for agricultural irrigation. At European level there are multiple regulations that have been configured as the need to protect water bodies and establish reliable criteria for protecting health and environment as well as avoiding overexploitation of available resources has become evident. The Water Framework Directive (2000/60/EC, WFD), reformulated in 2014 (2014/101/EU), established in the Annex VI the reuse of water for environmental use, including the quality limitations set to protect the receiving water masses. Specifically, water reuse in agriculture in the EU will be regulated in the short to medium term by the recent EU Regulation 2020/741, which is currently being transposed in the different EU countries.

The main aim of this project is to increase the knowledge and experience on the **use of reclaimed water in irrigated crops**, to obtain a **transnational strategy** to implement by different entities (administration, companies, irrigation communities,…) throughout the SUDOE area.

PROJECT DESIGN

For the development of the I-ReWater project, the logical framework approach has been applied, as proposed by INTERREG SUDOE. For this reason, the final objective is the improvement of the current use of reclaimed water for irrigation within the SUDOE area. With this aim, the consortium is made up of 16 beneficiary partners (listed in the authors section), Spain – 9 beneficiaries, France – 2 beneficiaries, Portugal – 4 beneficiaries, and Andorra; in addition to a total of 39 associated entities, with different functions within the project (https://interreg-sudoe.eu/proyecto-interreg/i-rewater/).

The actions to be carried out have been divided into three work packages. The *first package* involves the implementation of pilot actions, expanding the experiments of irrigation with reclaimed water in several woody crops (vines, hops, olive and almond) and horticultural crops (Fig. 1). A total of 15 action pilots are implemented in SUDOE area. The pilot actions will feed into the *second* work *package*, where the implementation of the transnational strategy for increasing the use of reclaimed water for irrigation is carried out. Finally, the *third package* aims to create a HUB, with all the results derived from I-ReWater, and to consolidate it as a platform in the SUDOE area for the development of projects for the use of reclaimed water in irrigation.

The strategy is based on an holistic approach, where the following aspects are mandatory: governance, financial sustainability, social aspects and risk management (Fig. 2). The development of the strategy requires basic studies prior to its final design. I-ReWater has proposed three key blocks to be included. On one hand, a study of the water resources potentially available for irrigation, using databases available in the SUDOE area, have been considered and have been cross-referenced with the irrigated areas within the SUDOE area, analyzing several case studies at the river basin level. On the other hand, the life cycle analysis is addressed, including the

processes of generating reclaimed water for the I-ReWater pilot actions, allowing the evaluation of the different impacts of its application, and contrast with conventional irrigation systems. Finally, a socio-economic analysis is carried out, based on structured interviews with all the stakeholders involved, in those regions where the use of reclaimed water is consolidated. The aim is to obtain a roadmap to avoid future problems in the new areas in which reclaimed water is incorporated as a new alternative resource.

Fig. 1. Location of the pilot actions in the SUDOE area

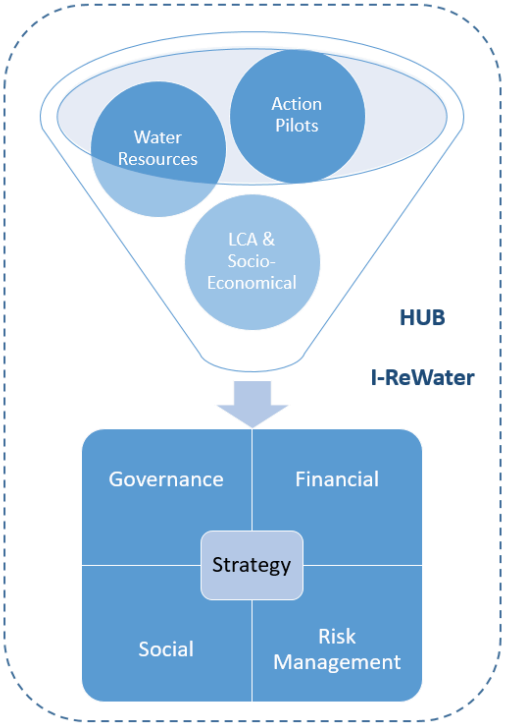

Fig.2. Schematic design of the I-ReWater project structure

Within the framework of the I-ReWater project, the preliminary selection of the main aspects or categories on which to build the strategic plan is initially raised. To do so, the approaches proposed in previous studies and projects have been analysed and it has been decided to carry out a combined approach of the PEST analysis together with the opportunities and threats identified in the SWOT analysis, in order to define the main aspects on which to address this transversal strategy (Neri et al., 2024).

Other key advance is the development of a decision support system for irrigation management, using reclaimed water. This tool will be implemented in I-ReWater HUB, and into other global platforms such as: SIAR, RuralCat, COTR,.. This tool uses previous apps or models, which are currently available (Reutivar- https://reutivar2.eu/ and IrriDesk- https://irridesk.ddns.net/). Low-cost sensor nodes have been developed to feed the DSS, which allow obtaining real-time data on soil and plant variables for efficient and sustainable irrigation management. In addition, data from nearby weather stations, or those installed for this purpose, will be used to carry out the soil water balance and establish the most appropriate irrigation schedules for the different crops under study. The tool will suggest optimum fertilization strategies for complementing the nutrients, such as phosphorus and nitrogen, that are already present in the reclaimed water. The analysis of the irrigation water, soil, plant material, production and quality parameters will be crucial for the final evaluation of the results obtained into the action pilots.

All tasks are currently in their preliminary stages, with the first irrigation season with reclaimed water completed in the pilot actions, and the first studies carried out. All the results will be available at the end of 2026, and all external contributions will be incorporated into the result of the project: the strategy.

FINAL TARGETS

It will consist of an integrative document including multi-level governance (local, regional, national and European). The strategy aims to improve the efficiency of water use, as well as the sustainable management of water resources, considering reclaimed water as an alternative water resource that must be studied and mobilized for efficient and integrative management in the SUDOE area, focused on its use for crop irrigation. The development of a joint, transnational strategy will be obtained from an integrative vision (water resource modelling, life cycle analysis, and socio-economic analysis) with which an improvement in irrigation management is achieved, and therefore reducing the impact of irrigation on water resources, releasing the pressure on the drinking water system in global terms in the SUDOE area.

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