RECLAMO: Unlocking the potential of wastewater reuse for agricultural irrigation in Spain

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Abstract

Increasing water scarcity is encouraging the use of unconventional water resources. In recent years, the European Union has launched numerous initiatives to promote and facilitate water reuse for agricultural irrigation. Today, the use of reclaimed water for agriculture has become an alternative, reliable and safe source of water supply and an indispensable water planning tool, especially in the area of southern Europe. However, water reuse for irrigation is currently far below its potential. Numerous barriers prevent its development and call for a detailed analysis of the different aspects affecting reclaimed water reuse, through an integrated and multidisciplinary approach.

A multidisciplinary research team from Universidad Politécnica de Madrid, consisting of agronomists, hydrologists, chemists and agricultural economists, will work on the RECLAMO Project (https://blogs.upm.es/reclamo/), with the aim of providing solutions and recommendations aimed at promoting the full development and use of reclaimed water for irrigation in areas of Spain with marked water stress.

For this purpose, project activities will be developed in two selected case studies (the Segura Basin, leader in water reuse in Spain and the Guadiana Basin, with success stories, but low levels of water reuse) and organised according to five axes: 1) development of a comprehensive knowledge-base covering the regulatory, technical, socio-economic and environmental aspects of reclaimed water reuse in agriculture; 2) participatory development of future scenarios exploring possible strategies, barriers and

opportunities, in relation to the expansion of the use of reclaimed water for irrigation; 3) impact analysis of the strategies identified at different scales (crop, farm, (sub-)basin), through the development of an integrated modelling platform (hydrologic-agronomic-economic models); 4) Development of a roadmap and policy recommendations to achieve the full development and use of reclaimed water reuse for irrigation; 5) Dissemination of knowledge and promotion of science-policy-society dialogue.

To this end, RECLAMO will collaborate closely with experts and stakeholder groups that will play a key role in the project in co-creating the scenarios and modelling tools and validating the results. The project will also seek for synergies and complementarities with other similar projects and explore new ways of collaborating with companies and research groups that allow research to continue and expand beyond the spatial and temporal limits of the project.

RECLAMO's results will promote an integrated approach to the sustainable management of water resources in water-stressed areas, including reclaimed water management. The integrated modelling platform developed in the project will allow policy-makers and water users to benefit from an improved understanding of the interactions between the social, economic and environmental aspects of water systems, in the context of climate and socio-economic change that will lead to better informed decision-making to address future water challenges. In addition, RECLAMO is expected to contribute to raising awareness about the use of reclaimed water reuse in agriculture as a safe and sustainable practice and to improve its social acceptance by producing science-based knowledge that provide evidence on the benefits derived from its use.

Keywords

reclaimed water, reuse, agricultural irrigation, integrated modelling, water scarcity

S&T Excellence

Background and state of the art

Over the past decades, water scarcity has grown within the European Union (EU), becoming a major challenge to EU's society, economy and ecosystems. Increased water demand and climate change are putting a strain on the supply capacity of the natural system and giving rise to severe conflicts between different water users. Particularly in southern Europe, water scarcity is a frequently experienced and worrying phenomenon. In some Mediterranean areas, the amount of water abstracted each year largely exceeds the total long-term freshwater resources, which indicates severe water stress and clearly unsustainable use of the water resource.

European Environmental Agency (EEA) 2018). Already today, irrigated agriculture constitutes the largest consumer of freshwater in the Mediterranean Region, accounting

for up to two-thirds of total water abstraction. Irrigation water typically comes from groundwater (through springs and wells) or surface water (rivers, lakes and reservoirs). However, with increasing stress on these traditional water sources, it is becoming crucial to consider alternative irrigation sources.

One increasingly used alternative supply option is treated wastewater (TWW) for agricultural fields located near urban and peri-urban centres (Voulvoulis 2018). TWW reuse can improve the status of the environment, not only quantitatively, alleviating pressure by substituting abstraction, but also qualitatively, diminishing the amount of effluents discharged into water bodies (Gil-Meseguer et al. 2018). It consumes less energy and requires lower investment costs when compared to other alternative non-conventional water sources (e.g. desalination), which may result in a reduction of greenhouse gas emissions (Kirhensteine et al. 2016).

The reuse of TWW is often seen as a reliable source of water for agriculture, because it guarantees the continuity of supply at times of peak demand, reducing the risk of crop failure and income losses. Additionally, TWW may constitute a good source of basic nutrients (nitrogen, phosphorus and potassium), useful for improving the fertility and productivity of soils (Salgot and Folch 2018). In some cases, it can positively affect the growth and yield of crops and enhance the economic capacity of farmers due to savings in fertiliser application rates. However, health and environmental aspects are particularly sensitive issues and act as important prerequisites for the use of TWW in agriculture. The presence of salts, heavy metals and pathogens in TWW may cause adverse effects on humans, plants and soils. An imbalanced nutrient supply can create problems for agricultural production (e.g. excessive vegetative growth, uneven fruit maturity), soil and groundwater pollution. Furthermore, the presence of pathogenic microorganisms in crops may affect food quality and safety and pose a health risk to consumers. This has led many countries to develop strict regulations to ensure that TWW is adequately treated and safely applied (Salgot and Folch 2018).

The potential role of TWW reuse in agriculture is now widely recognised and embedded within international, European and national strategies. The UN Sustainable Development Goal on Water (SDG 6) has set a target to halve the proportion of untreated wastewater and increase recycling and safe reuse globally by 2030. This calls for greater cooperation in activities and programmes relating to water and sanitation, including desalination, wastewater treatment and recycling and reuse technologies (SDG targets 6.3, 6.5 and 6.7). In Europe, numerous initiatives have been recently put in place to foster water reuse, as it contributes to the political priorities set by the Commission to promote a more resource-efficient circular economy and to the creation of green jobs. The maximisation of TWW reuse for irrigation has been identified as a priority for action in the Strategic Implementation Plan of the European Innovation Partnership on Water (European Innovation Partnership (EIP) 2012) and new EU Circular Economy Action Plan (EC 2000). Recently, a new European Regulation has been published to define harmonised minimum quality requirements for water reuse in agricultural irrigation in the EU. This regulation shall apply from 27 June 2023 and completes the existing EU

legal framework on water (i.e. the Water Framework Directive (WFD), (EC Regulation 2020) and the Urban Waste Water Treatment Directive (UWWTD), (EC 1991).

While major strides have been made to boost TWW reuse in the EU, the uptake of water reuse solutions falls far below its full potential. According to the last official estimates, only a small part of treated wastewater is currently reused in the EU. The total volume of reused TWW amounts to 1,100 Mm^3/y, which accounts for 2.4% of the treated urban wastewater effluents and 0.4% of annual EU freshwater withdrawals (BIO by Deloitte 2015). The EU potential is, however, much higher. Overall, scientific estimations predict a wastewater reuse volume of 3,000 Mm^3/y by 2025, with some studies pointing at 6,000 Mm^3/y (six times the current volume). Such increase is primarily expected to come from water-scarce Mediterranean countries (e.g. Spain, Italy, Cyprus, Malta, Portugal and Greece), where the use of TWW as an alternative source of supply is well established and growing rapidly (Voulvoulis 2018).

Recent estimates put Spain as the EU leading country in terms of TWW reuse (BIO by Deloitte 2015). It alone accounts for almost half of the total volume of reused TWW in the EU (493 Mm^3/y) and represents nearly 40% of its projected potential in 2025 (TYPSA 2013). TWW reuse in Spain was legally recognised by the Water Act of 1985, but it was not until 2007 that it was really encouraged, coinciding with the adoption of the Royal Decree (RD) 1620/2007 which sets the legal framework for the reuse of treated wastewater. This RD, along with the National Plan for Sanitation and Treatment (new version known as 'Plan DSEAR' currently under development), is playing a crucial role in promoting and improving water recycling and reuse practices as essential parts of the integrated management of water resources and the Spanish Strategy for the Circular Economy ('España Circular 2030' launched in 2020).

The Spanish legislation refers specifically to 'reclaimed' water as the wastewater treated to the point where its quality meets the required standards for each specific use. The law also envisages multiple uses of reclaimed water (urban, agricultural, industrial, recreational and environmental). However, in practice, the main user is agriculture, accounting for 61.2% of total reused volumes in 2016 (INE 2018). This is particularly noticeable in water-stressed coastal regions, where water recycling has become a key resource to meet agricultural water demand and a fundamental component of long-term water resources management (Navarro 2018). In fact, two river basins, Júcar and Segura, located on the Mediterranean coast (Autonomous Communities of Valencia and Murcia), are at the forefront of TWW reuse in Spain. These two Basins, characterised by profitable irrigated fruit and vegetable production and by structural water deficit, are responsible for more than 60% of the total reused volumes in Spain (Navarro 2018). In these areas, the use of reclaimed water allows extended and, thus, more efficient use of freshwater by avoiding discharge to the sea. Furthermore, it contributes to stabilising water supply and increasing resilience to drought, improving water quality and reducing financial and environmental costs associated with water use (e.g. water transfers from distant sources or desalination) (Molina and Melgarejo 2016, Morote et al. 2019). In other water-stressed inland basins as Guadiana and Guadalquivir, reclaimed water reuse is much less developed (it represents only 2% of the national volumes), but it may play a key role for

protecting and restoring the regional water environment. For instance, in the Upper Guadiana Basin (Castilla La Mancha), reclaimed water can be used to irrigate crops and, at the same time, to alleviate pressure on the extremely degraded streams, aquifers and wetlands ('Tablas de Daimiel').

Despite the great development of reclaimed water reuse in Spain with respect to other EU countries, its prominence in the water sector remains limited (e.g. the share of TWW reuse has not clearly improved along the last decade, fluctuating between 9 and 11%) (INE 2018). Still, there is a great potential for improvement that calls for a detailed analysis of the barriers and drivers behind reclaimed water reuse for agriculture and its potential implications. Some aspects (quality and technological) have been better studied than others (economic, social and legal) and barely in an integrated manner. Recent research on the subject claim that, while technical factors of water reuse could largely be resolved (e.g. through adapted irrigation systems, improved storage and treatment methods), social issues related to public understanding, consumers' acceptance and farmers' reluctance may seriously condition the success of water reuse projects and yet they are poorly investigated (Smith et al. 2017). Similarly, some important economic issues have not been adequately addressed thus far, such as the establishment of appropriate water-pricing policies for promoting full cost recovery and the long-term sustainability of reclaimed water. Moreover, after the later proposals and decisions by the EU Commission and Parliament, key regulatory, administrative and governance aspects still remain to be solved, such as the lack of an integrated global vision of reclaimed water reuse that includes all the actors from the reclaimed water production to the final user, the need to develop risk management plans that include all actors and defined responsibilities, the establishment of water reuse rights/concessions and their potential impacts on the ecological flows and the adaptation of quality standards to the new EU requirements that are more restrictive than those applied in Spain (Fundación CONAMA 2019).

Overall, a broader analysis is needed to evaluate the true benefits and costs of reclaimed water reuse in Spain. A major gap in current research is the relative lack of integrated modelling analyses that document the potential of reclaimed wastewater reuse for irrigation and its likely impacts, as well as of well-designed studies tailored to the particular needs and specificities of different regions and agricultural uses (Beveridge et al. 2017). An important reason behind this is the lack of comprehensive and up-to-date data on water reuse practices and volumes, some of which date from 2006 (BIO by Deloitte 2015) .

The RECLAMO project will review/update available data and literature and generate new knowledge and integrated modelling applications useful to support the development, use and management of reclaimed water for agricultural irrigation in Spain. Our hypothesis is that the expansion of reclaimed water reuse for irrigation, supported by an integrated assessment that account for stakeholders' views, may promote a more efficient and sustainable management of water resources in water-stressed areas.

In order to test this hypothesis and implement the project, RECLAMO counts on an experienced team of interdisciplinary experts in the field of agronomy, hydrology, water economics and policy, chemistry and water quality, with skills in hydrologic-agronomic-economic modelling, environmental and climate evaluation, policy analysis, scenario development, public participation and stakeholder involvement. Previous research activities have provided the research team with a dense network of collaborators in Spain, the EU, North Africa and USA, which are actively engaged in the debate surrounding reclaimed water reuse development for irrigation. Particularly, the team builds upon previous experience in the following EU and national research projects: MADFORWATER (EU H2020 2016-2020 ongoing), on the development and application of integrated technological and management solutions for wastewater treatment and efficient reuse in agriculture tailored to the needs of Mediterranean African Countries. MERCAGUA (Spanish Ministry of Economy and Competitiveness-National Plan R+D+i, 2015-2017) on the design of new water markets in Spain, to improve efficiency and contribute to climate change adaptation; DURERO (EU-2013 Halting Desertification in Europe Pilot projects, 2014-2015) focusing on the development of target sustainability indices, based on water resources balances for the identification of best strategies to address water scarcity; AGRISOST (Community of Madrid, 2014-2017) aiming at ensuring sustainable agricultural systems through carbon, nitrogen and water management to optimise production and quality; MEDPRO (EU FP7, 2010-2013), including prospective analysis for the use of water in Mediterranean countries; MEDIATION (EU FP7, 2010-2013), on methodologies for effective decision-making on impacts and adaptation in the water and agriculture sector in Spain and Europe; SCENES (EU FP6, 2007-2011), on the development of water scenarios for Europe and for Neighbouring States; and the several projects carried out under the Botín Foundation Water Observatory since 2009 on water footprint and prospective water policy in Spain.

Particularly, previous experience of the team in the EU MADFORWATER Project has provided insights into the potential role that reclaimed water reuse may play in alleviating water stress and scarcity in Mediterranean irrigation contexts (Morroco, Tunisia and Egypt) and on the support that agro-economic models may offer to the management of conventional and unconventional water resources. The RECLAMO project will build on the achievements of the MADFORWATER project and will advance it, by developing and co-designing new modelling tools (a more integrated model with hydrologic-agronomic-economic elements) with the stakeholders and providing a water reuse roadmap that facilitates the full development of reclaimed water reuse for agriculture in Spain.

Project scope and contribution to societal challenges

The RECLAMO project is framed under Objective IV of the Spanish Strategy for Science, Technology and Innovation 2013-2020 “Research oriented towards societal challenges” and aims to contribute particularly to Societal Challenge 2 (SC2), specified in the Spanish National Plan for Scientific and Technical Research and Innovation 2017-2020 as “Bioeconomy: sustainability of primary production and forestry systems, food safety and quality, marine and maritime research, and bioproducts”. Amongst the priorities of

SC2, the RECLAMO project contributes to the identification of solutions for a sustainable integrated management of water resources in agriculture and to an improvement of socio-economic and environmental sustainability of agricultural systems in the context of climate change. In addition, the project deals with key aspects highlighted by the Spanish Strategy of Bioeconomy 2030 by contributing to the adequate management and reuse of TWW in water-stressed regions, where water is a key resource for agricultural production systems, promoting socio-economic development in rural areas and also the interaction between rural and urban areas.

Moreover, the RECLAMO project addresses the research lines identified in the strategic document of the National Programme on Agrifood and Forestry Research and Innovation (MAGRAMA 2015) with respect to improving water use efficiency, particularly in relation to TWW reuse for irrigation, by developing analytical methods for the assessment of economic aspects of water use, water pricing, cost recovery and adaptation to climate change. Additionally, the project scope is within the priorities identified in the Document of Strategic Lines for Research and Innovation in the Water Sector (IDi-Agua 2015).

RECLAMO is also in line with EU research priorities as reflected in different initiatives. It contributes to Societal Challenges 2 (Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy) and 5 (Climate Action, Environment, Resource Efficiency and Raw Materials) of the EU Commission H2020 Framework Programme for Research and Innovation. The project contributes to one of the four Focus Areas of the H2020 2018-2020 Work Programme, Focus area 2 “Connecting economic and environmental gains – the Circular Economy”, which builds on the EU Commission package on Circular Economy and considers water management a key element in European society and recognises the potential contribution of reuse of reclaimed water to sustain economic growth and green jobs creation (e.g. it is estimated that a 1% increase in the rate of growth of the water industry in Europe could create up to 20,000 new jobs).

Finally, the objective of RECLAMO is also central to other EU research and innovation initiatives, such as the European Innovation Partnership on Water (EIP-Water), where water reuse and recycling is one of the eight priorities and the Joint Programming Initiative – Water JPI that includes water reuse in irrigation as a relevant topic within its Strategic Research and Innovation Agenda. The project is also in line with the Food 2030 Initiative on European Research and Innovation for Food and Nutrition Security, in relation to priorities on climate-smart and environmentally-sustainable food systems and on circularity and resource efficiency of food systems.

Objectives

The general objective of the RECLAMO Project is to provide solutions and recommendations aimed at promoting the full development and use of reclaimed water for irrigation in areas of Spain with marked water stress, under the context of global (socio-economic and climate) change.

RECLAMO's general objective will be attained by achieving the following specific objectives (SO):

- SO1: To build and update a comprehensive knowledge-base on reclaimed water reuse for irrigation in water-scarce areas of Spain, including technical, environmental, economic, social, management and regulatory aspects.
- SO2: To develop stakeholder-driven scenarios for exploring the future of reclaimed water reuse in a creative and policy-relevant way, identifying key barriers and opportunities and building robust strategies for developing the full potential of reclaimed water reuse for irrigation.
- SO3: To evaluate the multidimensional effects of robust strategies (identified in SO2 under different scenarios) at different scales (crop, farm, (sub-)basin), through the development of an integrated modelling platform, based upon the combination of hydrologic-agronomic-economic models.
- SO4: To provide policy recommendations and an action plan to support the full development and use of reclaimed water reuse for irrigation in Spain's semi-arid river basins.
- SO5: To communicate new knowledge and promote the science-policy-society dialogue for raising awareness and improving the social acceptance of water reuse in agriculture.

In the achievement of the above-mentioned specific objectives, the project will implement a multidisciplinary approach that allows for the consideration of the multiple dimensions of water resources management in agriculture, including the hydrological, agronomic, socioeconomic and policy/institutional dimensions, fuelled by an active involvement of stakeholders at different stages of the research. Particularly, SO1 will set the basis of the multidisciplinary methodological framework by ensuring the collection of qualitative and quantitative data and information about different aspects, including economic, social, environmental, technological and legal elements. SO2 will ensure the inclusion of stakeholders' views into this research and will require improved coordination and communication amongst disciplines and researchers from different fields in the project to ensure a meaningful engagement and a proper understanding between scientists and stakeholders in the project. Finally, SO3 will be at the core of the multidisciplinary philosophy of the project, by ensuring integration amongst the different dimensions interacting in water resources management in agriculture, i.e. agronomic, hydrologic, socio-economic and, therefore, amongst different disciplines involved in the assessment of such interactions.

For achieving the above project's objectives, RECLAMO will implement a case study (CS) approach. Specifically, two case studies have been selected to illustrate very different contexts for reclaimed water reuse:

1. the Segura River Basin (CS1), which is at the forefront of water reuse for agriculture in Spain (and in Europe) and
2. the Upper Guadiana River Basin, with some success stories, but little experience and low levels of water reuse.

This comparative approach will allow the identification of barriers and opportunities for the implementation of reclaimed water reuse practices and of adequate water policy instruments to support it.

CS1. The Segura River Basin

The Segura River Basin is the leading Spanish system in terms of TWW reuse. This Basin is one of Spain's most water-stressed basins with an annual deficit of around 400 Mm3. In this Basin, around 78 Mm3 of reclaimed water are reused yearly, 89% of which is devoted to agriculture. TWW reuse in the Basin has importantly contributed to increase resilience to drought and climate change and to restore water ecosystems in the Basin (e.g. in Campo de Cartagena). The joint implementation of subsidies to reclaimed water conveyance infrastructures and of a 'purification tax' in the domestic users' water bill, has promoted the adoption of this alternative water source amongst farmers at low cost. However, the convenience of such policy instruments is questioned under the principle of cost recovery, in particular, when it accounts for environmental and resource costs.

CS2. The Upper Guadiana River Basin

In the Upper Guadiana Basin, intensive irrigated agriculture at the end of the twentieth century resulted in the overexploitation of the Western La Mancha aquifer and the subsequent degradation of the highly valuable RAMSAR listed wetlands of Las Tablas de Daimiel. Since then, a number of policy interventions have been put in place to revert the environmental degradation and to reduce social conflict in an area where irrigation agriculture is at the core of rural economy. In this context, the reuse of reclaimed water, which is currently negligible (around 2 Mm3 in 2016), with the exception of two successful cases (Los Auriles and La Serna irrigation projects), may play an important role in the future offering an alternative source of water for irrigation and contributing to preserve groundwater resources and aquatic/wetlands ecosystems.

Impact

Scientific-technical impacts

The project will generate the following scientific and technological impacts:

- RECLAMO has been designed to address Societal Challenge 2 "Bioeconomy: sustainability of primary production and forestry systems, food safety and quality, marine and maritime research and bioproducts", by contributing to the identification of solutions for a sustainable integrated management of water resources in agriculture and to an improvement of socio-economic and environmental sustainability of agricultural systems in the context of climate change. It will provide a comprehensive analysis of the current and future situation of reclaimed water reuse for irrigation in Spain and an action plan to

achieve its full potential, guiding policy- and decision-makers in the achievement of SDG6 targets and of the main EU and national policy initiatives for integrated water management in the context of the bioeconomy and circular economy.

- Based on the development of multidisciplinary research, including scientists from different research fields, combining biophysical with economic models and bringing stakeholder perspectives into model-based assessments, the project will contribute to advance understanding of a complex water issue and respond to the need for an integrated approach to the management of water resources, including reclaimed water management. This will also promote future trans-disciplinary research and further improvements to model-based and participatory analysis tools.
- The integrated modelling platform developed in RECLAMO will permit policy-makers and water users to benefit from an improved understanding of the interactions between the hydrologic, agronomic and socio-economic aspects of reclaimed water reuse in the context of socio-economic and climate change that will lead to better informed decision-making to address future water challenges.

Socio-economic impacts

RECLAMO is expected to result in four main socio-economic impacts:

- Through an active involvement of stakeholders, including policy-makers, reclaimed water users (farmers), environmental groups and civil organisations and researchers/experts, RECLAMO will deliver results that are pertinent, relevant and accepted by stakeholders. Stakeholders invited to the process will be carefully selected in order to give voice to all different views in reclaimed water reuse and management, paying special attention to gender and group balance. All project results will be made available to participants and to the entire society through perdurable open access publications.
- The project is expected to foster the exchange of knowledge and expertise amongst scientists and stakeholders and provide a discussion forum to promote the science-policy-society dialogue. It will offer consensual, innovative and cost-effective strategies to promote the use of reclaimed water for irrigation, contributing to enhanced social acceptance of the strategies implemented and the use of these resources.
- RECLAMO will promote an efficient and sustainable use of reclaimed water for irrigation. This will save water and nutrients and ensure a reliable water supply for irrigation and will contribute to reduce water pollution and aquifer overexploitation, improve rural economy and create green jobs (e.g. it is estimated that a 1% increase in the rate of growth of the water industry in Europe could create up to 20,000 new jobs).
- The project will contribute to bringing the water balances and irrigation performance optimally, which will lead to progress in sustainable water use and water levels protection in rivers and aquifers, as it is estimated that reusing more than 50% of the potential water volume available for irrigation from wastewater

treatment plants in the EU could reduce more than 5% direct abstraction from water bodies and groundwater, resulting in more than a 5% reduction of water stress.

Measures to maximise impacts

Impacts will be maximised through the implementation of a plan for an effective dissemination and communication of the project's activities and results. This plan includes four axes for action:

- **Stakeholder dialogue:** One of the core values of the project is to open up science to the public and especially to stakeholders and decision-makers, so that knowledge and experiences flow from science to society and vice-versa, enriching knowledge production and maximising impact. For this purpose, it is amongst the project priorities to establish a stakeholder dialogue along the project duration underpinned by different stakeholder activities. First, a stakeholder mapping, selection and first contact to communicate the project scope and ambition and engage stakeholders in the project activities. Second, a participatory scenario development process in which the first project advances will be presented and discussed, to enrich modelling activities. Finally, a workshop will be carried out to present modelling results and discuss policy implications and an action plan with stakeholders and policy-makers. Beyond these specific activities, project communication will ensure a periodic communication with stakeholders that will receive updates on project activities. Stakeholder groups include policy-makers, firms related to the water industry, farmers, researchers and the civil society (environmental NGOs and other civil organisations). Preliminary contacts have already been established and the project consortium can count on 12 support letters from key stakeholder representatives (see Table 1).
- **Production of scientific and divulgative materials**: the project advances and results will be published and disseminated to the scientific community, stakeholders and the general public, through different channels and materials:
    - Web-page: that will show the scope and ambition and will be updated with project activities and results.
    - Audiovisual materials: Audiovisual materials will be also generated and organised in two products: (i) a short video explaining the state-of-the-art, the project objectives, a summary of the activities carried out and the main results, conclusions and policy implications of the project; (ii) an extended video of about 30 minutes to document all the research processes, with a special focus on the modelling activities and the participatory process carried out and the results obtained. The former product will be used for broad dissemination amongst scientific groups and stakeholders and the general public. The latter product will be used for an enhanced knowledge transfer targeted to selected stakeholders and policy-makers, as well as to scientific groups. It is also expected that the video will be used for

educational purposes in the context of graduate and postgraduate courses where the researchers of the consortium give lectures, for example, 'Wastewater management in agriculture' in Agri-environmental Engineering UPM BS Degree, ' Crop Production Technology' in Agricultural Engineering and Science UPM BS Degree; 'Management, treatment and use of wastewater and organic waste in agriculture' in Agronomic Engineering UPM Masters Degree, 'Agricultural, Food and Natural Resource Economics' in Agro-Environmental Technology for a Sustainable Agriculture (TAPAS) UPM Masters Degree and 'Integral Water Cycle' UPM Masters Degree.

- Scientific articles: it is expected that the project will produce at least four scientific articles to be published in indexed journals relevant to the area (two of them are included as project deliverables). All scientific articles will be published in open access and project documents and datasets will be uploaded to web repositories (e.g. Archivo Digital UPM, E-cienciaDatos) to ensure open access and perdurability of the project's results
- Outreach articles and brochures: two project leaflets will be released: one at the beginning of the project presenting the project objectives, case studies and expected impacts; a second one at the end of the project summarising the main project results, conclusions and implications. Additionally, brief articles will be resealed to provide information about the project activities and results. These materials will be disseminated through UPM Scientific Culture Unit, social networks (LinkedIn, ResearchGate etc.), specialised online forums (Ecoagra, iAgua etc.) and the project and institutional web-pages.
- Policy brief: addressing stakeholders, policy-makers and representatives from institutions involved in water resources management and agricultural and irrigation policies, the policy brief will include the main conclusions of the project and policy recommendations.

- **Project participation in relevant events related to the topic of the project:** in line with multidisciplinary nature of the project, results will be presented in congresses and national and international conferences of varied topics (e.g. Spanish/European Congress of Agricultural Economics, IWRA/IWA/EWRA Water World Congresses, European Geosciences Union General Assembly etc.), as well as in broader brokerage events for dissemination, networking and search for new funding and project opportunities to continue and extend the project's research (e.g. EU Water Innovation Conference, Brokerage Event Water Reuse Europe)
- **RECLAMO Scientific seminar**: A high-level scientific seminar will be organised with scientists and experts in wastewater treatment and reclaimed water reuse in irrigation, to discuss recent developments in the field, methodologies and project advances and to establish new collaborations and develop a work plan for future research proposals/projects. National and international experts (e.g. from the MADFORWATER and SUWANU projects) will be invited to the seminar, which will be divided by having a first closed meeting between the project scientists and

invited scientists and experts and a second part open to all interested scientists, experts, stakeholders and the general public. The event will be co-organised with the Botín Foundation Water Observatory.

Implementation

Description of the Work Plan

Five Work Packages will ensure the successfully completion of RECLAMO project goals.

A PERT diagram is shown in Fig. 1 and a Gantt chart in Fig. 2

Work Package 1 (WP1): Knowledge base

Objectives

Review of the use and management of reclaimed water in Spain and development of a knowledge base for reclaimed water reuse in irrigation in the two selected case studies. This WP will contribute to attaining SO1.

Description

Current information and data on reclaimed water reuse is not comprehensive and barely updated. Trying to address this knowledge gap, this work package will review the reuse of reclaimed water in Spain across sectors, with a special focus on irrigation for agriculture and its current consideration within the water management policies and approaches in Spain and at the case study level.

Tasks

Task 1.1: Analysis of regulatory and policy frameworks. The aim of this task is to review all existing regulations, policy documents and strategies that determine the adoption of reclaimed water reuse practices, especially in agriculture. Documents to be analysed include the European regulations (e.g. proposal on requirements for the use of reclaimed water reuse in agriculture, WFD); National legislation and policy frameworks (e.g. RD 2007 on requirements for TWW reuse, National Plan for Water Treatment and Sanitation); River Basin Management Plans; and other Regional policy documents. Other non-water-specific strategies and policy frameworks will be also reviewed, such as the Spanish Strategy for Bioeconomy 2030 and the corresponding regional strategies, to consider additional constraints and/or supporting mechanisms for the adoption of reclaimed water reuse and their differences across regions and basins in Spain.

Task 1.2: Analysis of the dimension of reclaimed water reuse in Spain and in selected case studies. This task aims at reviewing and updating data on the current and potential volumes of treated wastewater and reclaimed water reused in different sectors, hectares irrigated with reclaimed water and costs associated with reclaimed water reuse at national level and at the case study level (river basin). Official data sources, public studies and previous research works will be consulted. Detailed information on current/ future practices, needs and gaps will also be obtained through interviews to experts (those identified in Task 5.1). A more detailed analysis will be performed in two study areas: the irrigable area of Campo de Cartagena (Segura) and the irrigable areas of Los Auriles (Western La Mancha Aquifer in the Upper Guadiana), where preliminary data and information have been already collected and contacts with key stakeholders made.

Task 1.3: Analysis of technical and quality requirements and risks of reclaimed water production and use. This task will review wastewater treatment processes and quality of the reclaimed water produced, the fulfilment of EU quality standards and their implications in terms of cost and impacts on health and the environment. Special attention will be paid to the development of water reuse risk management plans. A detailed analysis of the specific case study characteristics, such as the origin of wastewater, treatment processes, features of the reclaimed water produced (quality, cost etc.) and irrigation technologies applied, will be performed.

Task 1.4: Review and analysis of current management approaches for reclaimed water allowances and rights. This task will review the current management and governance approaches for reclaimed water, including procedures for application and allowance of reclaimed waters, public procedures and control, public/private contracts, formal and informal arrangements etc.

Deliverables

D1.1. Baseline report on the current state of reclaimed water reuse for irrigation in Spain and in selected case studies (M12, M38). The deliverable will present a series of factsheets providing general information about recent trends on reclaimed water volumes, their use (and potential use) across sectors, management approaches and main policies addressing reclaimed water reuse. These baseline reports and factsheets will be updated in the last year of the project.

Milestones

MS1.1: Policy documents and strategies reviewed (M7)

MS1.2: Data on reclaimed water use, technical and quality requirements and management collected (M9)

MS1.3: Updated information on policy strategies and data (M36)

Work Package 2 (WP2): Participatory scenario development

Objectives

The objective of this WP is to develop stakeholder-driven scenarios to identify robust strategies that serve as a useful guidance for closing the gap between the current and potential use of reclaimed water reuse in the two selected case studies. This WP will contribute to attaining SO2.

Description

This WP will be devoted to the development of scenarios with the active participation of stakeholders. Stakeholders have frequently been neglected in development planning for reclaimed water reuse in agriculture. However, their involvement is essential to ensure local legitimacy, expand the knowledge base and develop more creative solutions and opportunities for social learning. This WP will develop participatory scenarios in which a normative objective (e.g. 'achieving the potential of reclaimed water reuse for irrigation in 2030') is backcast within the context of exploratory scenarios that sketch different plausible futures. The integration of both scenario approaches (exploratory and backcasting) is rarely seen, despite recognition that such integration can help in the effective co-production of development plans. The technique allows stakeholders to outline barriers and opportunities, define milestones and describe actions required for the achievement of these visions. More importantly, it makes it possible to study the robustness of the developed strategies.

Tasks

Task 2.1: Select and define exploratory scenarios to characterise several alternative future developments. This task aims at reviewing foresight studies currently used to analyse the future of the water and agriculture sectors in Europe over the next 10-30 years (2030-2050). In consultation with experts (defined in Task 5.1), two representative exploratory scenarios will be selected. These scenarios will incorporate socio-economic story-lines and climate change predictions (RCP2 and SSP3). Special emphasis will be given to the analysis of future resource governance models and their impacts in the transition to an EU resource-efficient economy.

Task 2.2: Develop local-specific scenarios using participatory backcasting. This task will be devoted to the development of participatory backcast scenarios at the case study level. A stakeholder workshop will be organised and conducted in each case study, making use of the stakeholder analysis performed in Task 5.1. The first section of the workshop will be devoted to the discussion of the current state and BAU situation (results of Tasks 1.1 and 3.2) and the two exploratory scenarios selected in Task 2.1. Using brainstorming and narrative descriptions, the exploratory scenarios will be specified (downscaled) at local level and a desired future goal will be defined (e.g. 'achieving the potential of reclaimed water reuse for irrigation in 2030'). Then, stakeholders will be divided into two groups to develop backcast scenarios. Each group will work on the same

desired goal within the context of different exploratory scenarios. Thinking backwards, stakeholders will identify milestones, barriers, opportunities and actions in relation to achieving the desired goal. In addition, they will define strategies (possible ways to achieve the desired future), which summarise the backcasting timeline. These scenarios will serve as a basis for the simulation work in WP3 (Task 3.3).

Task 2.3: Identify robust strategies across the scenarios. The aim of this task is to analyse the participatory backcast scenarios developed in Task 2.2 and identify robust strategies across the scenarios. The backcast scenarios will be analysed using complex network parameters. The analysis will assist in determining the key barriers, opportunities, milestones and actions, as well as finding similarities and differences between backcasts. In particular, a robust mix of policy actions and strategies will be identified as common features to all backcasts in the context of all exploratory scenarios. This task is crucial for assessing the performance of key policy actions in WP3 (Task 3.3) and for advancing an action plan in WP4 (Tasks 4.1).

Deliverables

D2.1. Report of the stakeholder workshop process and outcomes. This deliverable will describe stakeholder views on the current and future situation of reclaimed water reuse in agriculture (M26)

D2.2. Research paper: 'Identifying robust strategies for boosting the use of reclaimed water reuse in agriculture in water-stressed basins'. This deliverable will be a scientific paper dealing with the development of participatory scenarios and robust strategies to promote the use of reclaimed water reuse for irrigation. (M32)

Milestones

MS2.1: Exploratory scenarios defined and selected (M15)

MS2.2: Stakeholder workshops held in each of the case studies (M20)

MS2.3: Backcast scenarios analysed (key barriers, opportunities, milestones, actions and robust strategies in relation to reclaimed water reuse for irrigation identified) (M22)

Work Package 3 (WP3): Integrated modelling

Objectives

The objective of this WP is to develop an integrated modelling platform to analyse the multidimensional impacts of different robust strategies under different scenarios in the selected case studies. This WP will contribute to attaining SO3.

Description

This WP aims to deliver a truly integrated assessment of reclaimed water reuse by developing hydrologic-economic-agronomic models that permit accounting for all water

sources and water uses and to simulate the interactions and feedbacks between the hydrological (basin level), economic (farm level) and agronomic (crop level) systems. Hydro-economic models are useful tools for supporting water policy-making as they are capable to consider hydrologic aspects in a spatially-explicit manner and the economic principles that govern the water sector. Its combination with agronomic models permits the inclusion of crop processes in the analysis and the capture of the multi-dimensional nature of water and climate aspects. This modelling approach has been widely applied for the analysis of different water and agricultural issues and for the assessment of climate change impacts and adaptation 4,5. Building on previous experience of the research team, hydrologic-agronomic-economic modelling will be applied to assess reclaimed water reuse for irrigation in the framework of sustainable integrated water resources management. The applied integrated modelling framework will be used to analyse the socio-economic and environmental impacts of different strategies (identified in WP2) aimed at an optimal exploitation of TWW, irrigation efficiency and enhanced reclaimed water reuse in agriculture.

Tasks

Task 3.1: Database collection. This task will allow collecting all data required for the hydrologic-agronomic-economic model. This includes data on hydrology and water management infrastructures from the river basin authorities, wastewater production and potential reclaimed water generated, climatic data from AEMet, irrigation data from SIAR6 and agronomic, socio-economic and policy-related data collected from public documents and statistics and through fieldwork developed in the case study areas

Task 3.2: Model development and business as usual (BAU) scenario simulation. This task will include the development of the model, its calibration and validation in the two selected case studies. The development of the model will be carried out following a co-design process with the consultation of selected stakeholders (Task 5.1). The integrated model will include different modules to account for the hydrologic, agronomic and economic aspects. For this purpose, the WEAP model (Water Evaluation and Planning System 7) will be used for the hydrology/water balance simulation and one of its built-in agronomic modules will be implemented (e.g. MABIA, PGM…) to account for crop growth processes. The hydrology model simulates catchment hydrology, river runoff, water supply to demand nodes, operation of hydraulic infrastructures, environmental flows etc. The agronomic module allows for the simulation of crop growth, crop water requirements, irrigation scheduling and crop yields under given water availability and climatic conditions. The hydrologic and agronomic models used will be combined with an economic mathematical programming optimisation model. The economic model represents farm-level decision-making by maximising farmers' utility subjects to a set of structural, technical, agronomic, economic and policy constraints. Model outputs include cropping pattern (crop choice and techniques), farm income, water use per source, water marginal values, labour use etc. Model integration allows for the simulation of farm-level decisions on crop production and selection of technologies and water sources, the effects on the water system, water storage demand reliability and unmet demand. Once the integrated model is calibrated and validated, a 'business as usual' scenario (BAU)

simulation will be carried out to assess the effects of current socio-economic, policy and climatic drivers on reclaimed water reuse and its effect at farm and (sub-)basin level. The task builds on data collected in Task 3.1 and on the knowledge base generated in WP1. Results from the BAU scenario will be presented to stakeholders in the workshop carried out in Task 2.2 to set the frame and key drivers to be considered in scenario definition and development.

Task 3.3: Analysis of socio-economic, climate change and water policy scenarios. Simulation modelling will be used to analyse the socio-economic, agronomic and environmental impacts of robust strategies under different scenarios provided by WP2 (Tasks 2.2 and 2.3). The scenarios (Task 2.2) will provide information for the model about the future development of key drivers, such as population, economic development, water consumption patterns, wastewater treatment technologies and climate change. Strategies will be analysed through selected policy and management actions that will determine, amongst other factors, water availability at farm level, the cost of water use for different water sources or the need for specific irrigation technologies and will come from Task 2.3. They will refer to different water economic instruments (e.g. quotas for different types of water, cost-recovery prices, taxes or subsidies) and other actions intended to promote the expansion of reclaimed water reuse for irrigation (e.g. development of more efficient irrigation technologies, full-scale implementation and operation of water reuse schemes). Impacts will be analysed at crop-farm level (e.g. farm income, labour use, fertilizer use, crop yields, crop water requirements) and at (sub-)basin level (e.g. water demand, level of cost-recovery, environmental protection, water stress and water supply reliability). The results of this task will contribute to produce policy recommendations in Task 4.2.

Deliverables

D3.1. Model database. Compilation of all data gathered for modelling purposes. (M14).

D3.2. Report on the setting up of the integrated hydrologic-agronomic-economic modelling platform. This deliverable summarises the integrated modelling platform and describes the simulation results of the BAU scenario. (M22).

D3.3. Research paper: ‘Optimising reclaimed water reuse for irrigation in Spain under different scenarios: An integrated modelling approach’. Scientific paper in which the integrated model exercise is presented and used to simulate policy and management strategies aimed at promoting the expansion of reclaimed water reuse for irrigation under different scenarios. (M39)

Milestones

MS3.1: Fieldwork in case study areas (M10)

MS3.2: Full database uploaded to an open repository (M14)

MS3.3: Integrated model ready and first simulations (BAU) accomplished (M18)

MS3.4: Simulation of stakeholder-based scenarios and strategies finished (M35)

Work Package 4 (WP4): Strategic planing and policy recommendations

Objectives

Develop an action plan to support the policy challenge of increasing the use of reclaimed water reuse for irrigation and derive policy recommendations for overcoming the constraints identified. This WP will contribute to attaining SO4.

Description

The aim of this work package is to produce an action plan for encouraging the exploitation of the full potential of reclaimed water reuse for irrigation, while mitigating foreseen threats to successful implementation. While some research activities have been raised in order to explore future developments of water reuse, these efforts remain vague and imprecise, since they lack a clear and comprehensive plan of action that involves all major stakeholders for implementation. As a support to decision-making, a SWOT8 analysis will be carried out to better understand the strengths, weaknesses, opportunities and threats of the action plan. This WP makes use of the results obtained in previous WPs (WP1, WP2, WP3) to provide policy recommendations and high-level information for decision-makers in industry and policy.

Tasks

Task 4.1: Develop an action plan to promote the expansion of reclaimed water reuse for irrigation. This task will be devoted to the organisation of a second stakeholder workshop in each case study for the development of a participatory action plan and a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis. To the extent possible, the same stakeholders (or group of stakeholders) involved in the first workshop (Task 2.2) will be here engaged. Stakeholders will discuss the model-based assessment of the robust strategies obtained in Task 3.3 and develop an action plan (including a roadmap) to achieve the full potential of reclaimed water reuse in agriculture in the selected case studies. Special attention will be given to key policy actions, in which different aspects (synergies, budget, preferences/priorities, task allocation - who does what, when, indicators to monitor progress etc.) will be deeply analysed. In addition, the strengths, weaknesses, opportunities and threats of the action plan will be explored using the SWOT analysis.

Task 4.2: Policy synopsis. This task will provide key messages for decision-makers in industry and policy. It summarises the most relevant results obtained in previous WPs in relation to the potential role reclaimed water reuse for irrigation. The synopsis shall point out aspects like farm income, resource efficiency, water and environmental protection, awareness and attitudes towards reclaimed water reuse. Furthermore, policy recommendations on key policy options will be derived for overcoming the constraints identified.

Deliverables

D4.1. Report on the action plan. (M41). Description and analysis of the action plan developed with stakeholders to promote the use of reclaimed water reuse for irrigation.

D4.2. Policy brief. (M47). Policy brief that will synthesise project results and will provide a set of policy recommendations building on results and conclusions obtained in previous WPs.

Milestones

MS4.1: Stakeholder workshops held in each of the case studies (M39)

MS4.2: Assessment of the action plan carried out (M40)

MS4.3: Policy brief release (M48)

Work Package 5 (WP5): Stakeholder dialogue, dissemination and networks

Objectives

The aim of this work package is to provide an active dissemination of the project activities and main outcomes and to communicate project results and findings:

1. to maximise the project scientific impacts and internationalisation and
2. to raise awareness and improve the social acceptance of water reuse in agriculture.

This WP will contribute to attaining SO5.

Description

This work package will contribute to creating and promoting dialogue between the project and relevant stakeholders, policy-makers and general public, ensuring the project's impact on society. Additionally, it will contribute to the scientific international impact by supporting the publication of journal articles and through the presentation of the project activities and outcomes in scientific conferences and international brokerage events. The work package is in line with the Dissemination and Communication Plan.

Tasks

Task 5.1: Stakeholder engagement. This task deals with the identification, selection and contact of key stakeholders groups and experts, including representatives from the water and agriculture administrations, farmers, business and industry, civil society (e.g. environmental NGOs, consumer associations) and the research community. Different selections and groupings will be made to serve varied project purposes. First, a broad list of stakeholders and experts will be identified as target audience for project communication and dissemination of activities and results. A selection of stakeholders made from the initial list will be invited to take part in the participatory workshops

developed in WP2 (Task 2.2) and WP4 (Task 4.1). Finally, a reduced group of selected experts will be included in specific consultation activities in Task 1.1 (current situation, needs and gaps), Task 2.1 (scenario pre-selection) and Task 3.2 (model development).

Task 5.2: Dissemination and communication. This task involves the production and release of different outreach scientific materials, including:

1. the project identity and website;
2. dissemination materials: project leaflet, two press-releases (one after the first two years presenting the progress made in the first two years of the project and another one at the end of the project showing the final results of the project) through the Scientific Culture Unit of UPM;
3. production of audiovisual materials (two videos);
4. scientific open access publications on high impact journals (two publications set as project deliverables in WP2) (D2.2) and WP3(D3.3) and additional publications expected in the framework of PhD Thesis;
5. participation of the project members at the main scientific congresses;

Task 5.3: Development of scientific networks. This task is devoted to the development of national and international scientific networks to open new lines of collaboration and set the foundation for future proposals/projects that allow for a continuation of the research line developed in RECLAMO.

The task will particularly focus in the following activities:

1. RECLAMO Scientific event: A scientific international event will be organised in Madrid in collaboration with the Botín Foundation Water Observatory. This event will include the invitation of international experts in the field of reclaimed water reuse in agriculture. Potentially, experts invited will include researchers from the EU H2020 Project MADFORWATER, the project SUWANU and experts from European scientific and technical platforms such Water Europe (formerly WssTP) - European Technology Platform (ETP) for water or the European Innovation Partnership on Water (EIP-Water). This event will also contribute to the project internationalisation.
2. Participation at brokerage events: water events that promote the science-policy-society dialogue, such as those organised by Water Europe, EIP-Water or Water Reuse Europe (e.g. Water Reuse Europe Knowledge Exchange Event 2019), where the results of the project will be presented and new collaboration and funding opportunities will be explored, in particular, those related to Horizon Europe.
3. Research stays: the project will pursue international exchanges with other research institutions with the aim of establishing new collaborations, developing joint scientific publications and new research proposals. Potential scientific institutions include partners from the EU project MADFORWATER, the Cranfield Water Science Institute (Cranfield, United Kingdom) or the Stockholm Environment Institute Water Groups (Davis, California).

Deliverables

D5.1. Project website (M6)

D5.2. Project leaflet (M7)

D5.3. Press release on project advances in first 2 years (D5.3.1, in M24) and final results and conclusions (D5.3.2, in M48)

D5.4: Summary report on the scientific conference development (participants, summary of sessions and materials presented) (M28)

D5.5: Two abstracts in conferences (M37)

Milestones

MS5.1: Stakeholders mapped and contacted (M6)

MS5.2: Project website operative (M6)

MS5.3: Project leaflet electronically and physically distributed to selected stakeholders (M7)

MS5.4: Press releases published (MS5.4.1 in M24, and MS5.4.2 in M48)

MS5.5: Scientific event (M27)

MS5.6: Presentation of project results in an EU water brokerage event. (M48)

Materials

The project will profit from the infrastructure and material resources provided by Universidad Politécnica de Madrid (UPM). Particularly, the project will be developed at the School of Agronomic, Food and Biosystems Engineering, counting on facilities and resources (laboratories, computing systems, software licences etc.) provided by four different departments: the Department of Agricultural Economics, Statistics and Business Management, the Department of Agroforestry Engineering – Hydraulic Engineering, the Department of Agricultural Production and the Department of Chemistry and Food Engineering.

Most of the Project activities will be developed within the framework of CEIGRAM (Centro de Estudios e Investigación para la Gestión de Riesgos Agrarios y Medioambientales), a UPM Research Centre to which most of the research team members belong. CEIGRAM has a unique institutional set-up as a joint centre formed by UPM, ENESA (Entidad Estatal de Seguros Agrarios, an Autonomous Agency, under the Ministry of Agriculture, Fisheries and Food) and Agroseguro (Spanish Association of Insurance Entities for Combined Agricultural Insurance). CEIGRAM is a leading R&D multidisciplinary centre covering a broad set of topics under a common overarching theme: climate change,

sustainable agriculture, natural resource management and risk management. It has: more than 50 scientists, more than 30 projects from competitive public calls and more than 15 PhD students. The Centre has access to 500 m^2 facilities, collaborative farms, scientific equipment, available labs, own servers, videoconference devices and multiple software licences (e.g. ARCGIS, MATLAB, @risk, STATA, XLSTAT...).

Significant risks and contingency plan

The main risks that threaten the attainment of SOs and countermeasures are:

- Risk#1: Unexpected unavailability of team members. Related to all SOs. The project has a multi-disciplinary dimension and counts onexperienced and skilled staff covering all areas of the research. Close collaboration between the project's research team and other researchers in the host institution (CEIGRAM, a multidisciplinary research centre of the UPM) will enable substitution in case of unexpected unavailability.
- Risk #2: Delay achieving milestones, delaying project objectives. Related to all SOs. The Principal Investigator will monitor progress made on the programmed tasks to detect any delay at the early stages. In case a delay is detected, a meeting with research team members will be held, to understand the reasons for the delay and to identify corrective measures in order to ensure a timely achievement of the results under consideration.
- Risk #3: Limited data access and data availability for the analysis of the current situation of TWW reuse or for the modelling exercise. Related to SO1 and SO3. Continuous dialogue with local stakeholders and other research groups to aid in accessing the required information. In addition, consideration and discussion of proxy variables to mitigate incomplete or non-available data. Previous studies of the multidisciplinary research team in the case study areas could be used as reference data.
- Risk #4: Reluctance of stakeholders (and experts) to participate in the project. Related to SO2 and SO4. Mitigated by the high importance of TWW reuse and urgent need for action. Initial contacts with key stakeholder groups have already taken place and 12 letters of support have been collected, to ensure their engagement in the project in case it is finally funded. Awareness-raising activities and previous experience by the research team will be used to explain what is expected from the stakeholders. The unresponsive stakeholders will be replaced by others. Good links with stakeholders are already in place and will be further exploited.
- Risk #5: Project results not effectively communicated. Related to SO5. Researchers have in-house communications professionals with good knowledge of social media and other communication channels. They will discuss with these professionals the best way to reach the targeted stakeholders and will adapt the

dissemination strategy accordingly. Furthermore, researchers are involved in other relevant projects and networks, which will act as “leverage multipliers”.

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Hosting institution

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Conflicts of interest

The authors declare that the project was carried out without any economic or financial benefit that could be interpreted as a possible conflict of interest.

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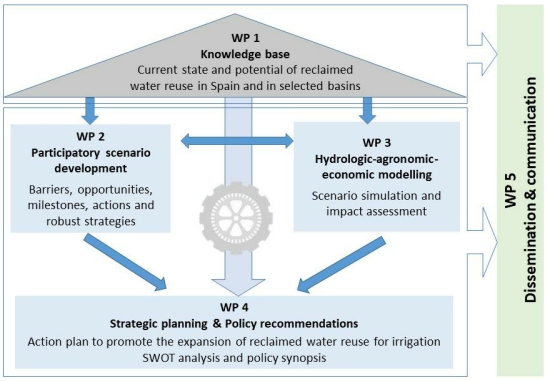

Figure 1.

PERT Diagram. Project structure and links between WPs.

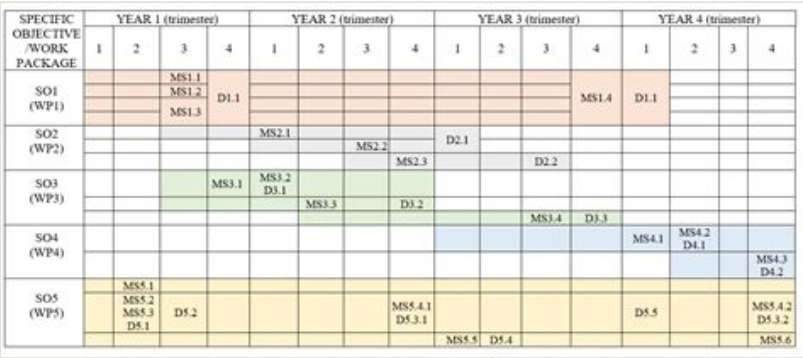

Figure 2.

GANNT Diagram.

Table 1.
Key stakeholders.

STAKEHOLDER GROUP	ORGANISATION
Policy-makers	Sub-Directorate-General for Sustainable Water Use and Planning- Ministry for the Ecological Transition and the Demographic Challenge (MITECO)
Water industry	Regional Public Entity for Wastewater Sanitation and Treatment in Murcia (ESAMUR) Private company specialised in innovation and R&D consulting and commercialisation of innovative product in the fields of water, energy and environmental protection (BIOAZUL)
Farmers	Irrigation community Campo de Cartagena (Segura River Basin) Irrigation community Los Auriles (Upper Guadiana River Basin) Farmers' Unions (Unión de Uniones)
Civil organisations and Environmental NGOs	WWF (World Wildlife Fund) Spain New Water Culture Foundation (FNCA) Botin Foundation– Water Observatory Spanish Association for Sustainable Water Reuse (ASERSA)
Scientists and Research Initiatives	Spanish Centre for Energy, Environment and Technology Research (CIEMAT) Technical University of Cartagena (UPCT)