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The use of reclaimed water
by the agricultural sector:
barriers and factors of
success in the case of
Andalusia (Spain).





The use of reclaimed water by the agricultural sector: barriers and factors of success in the case of Andalusia (Spain)

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TITLE

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KEY WORDS

Reclaimed water, SWOT analyses, water reuse, sustainable agriculture

ABSTRACT

English

Reclaimed water has a strong potential for complementing conventional water resources and it is of especial relevancy in agriculture as this is one of the main water consumers. The use of reclaimed water has several benefits for farmers: lower cost compared to other solutions (e.g. desalination), reliability of supply regardless of season, climatic conditions and associated water restrictions, and nutrients contribution of the treated wastewater that can supplement or replace conventional chemical fertilizers. Therefore, intended to bridge the current innovation gaps and achieve an effective implementation of reuse solutions in agriculture are necessary.

This is the objective of [SUWANU-Europe](#) “Network for effective knowledge transfer on safe and economic wastewater reuse in agriculture in Europe” an European H2020 project.

This study shows the results of the SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis in the case of Andalusia (Southern region in Spain), and one of the eight regions studied with SUWANU-Europe thematic network. The SWOT analysis contributes to the identification of limitations and success factors in the use of reclaimed water by the agricultural sector in different European regions.

Final goal is to define a Regional Strategic Plan for a fast implementation of water reuse concepts for irrigation purposes at regional level. The SWOT analysis carried out in this study has identified barriers and challenges that still exist in the implementation of irrigation systems with reclaimed water. Among the main threats identified, stakeholders’ perceptions and the higher cost of reclaimed water for irrigators (compared to alternative sources) play a relevant role. Additionally, the excessive bureaucracy and long administrative processes are significant weaknesses to be considered. On the other hand, technology availability and the increasing scarcity of conventional sources is seen as strength and opportunity factors for the expansion of reclaimed water use for irrigation purposes.

Spanish

El agua regenerada tiene un gran potencial para complementar los recursos hídricos convencionales y es de especial relevancia en la agricultura ya que es uno de los principales consumidores de agua. El uso de agua regenerada lleva asociados varios beneficios para los agricultores: menor costo en comparación con otras soluciones (por ejemplo, desalinización),

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seguridad en el suministro a lo largo de todo el año, las condiciones climáticas y las restricciones de agua, y el aporte de nutrientes de las aguas residuales tratadas que pueden complementar o reemplazar los fertilizantes convencionales. Por lo tanto, cada vez son más necesarias las acciones destinadas a cerrar las brechas de innovación actuales y lograr una implementación efectiva de las soluciones de reutilización en la agricultura.

Este es el objetivo principal de [SUWANU-Europe](#) "Red para la transferencia efectiva de conocimientos sobre la reutilización segura y económica de aguas residuales en la agricultura en Europa", un proyecto europeo H2020.

Este estudio muestra los resultados del análisis DAFO (Debilidades-Amenazas-Fortalezas-Oportunidades) en el caso de Andalucía (región situada al sur de España), una de las ocho regiones estudiadas con la red temática SUWANU-Europe. El análisis contribuye a la identificación de limitaciones y factores de éxito del uso de agua regenerada por el sector agrícola en diferentes regiones europeas.

El objetivo final es definir un plan estratégico regional para una rápida implementación de proyectos de reutilización del agua para riego. El análisis DAFO realizado en este estudio ha identificado barreras y desafíos que aún existen en la implementación de sistemas de riego con agua regenerada. Entre las principales amenazas identificadas, las percepciones de los usuarios y el mayor costo del agua regenerada para los regantes (en comparación con otras fuentes alternativas) juegan un papel relevante. Además, la excesiva burocracia y los largos procesos administrativos son debilidades importantes a considerar. Por otro lado, la disponibilidad de tecnología y la creciente escasez de fuentes convencionales se consideran fortalezas y oportunidades para la expansión del uso de agua regenerada para riego.

INTRODUCTION

Water scarcity is a global problem which is not only limited to traditional dry areas. The number of areas and people affected by drought events increased by almost 20% between 1976 and 2006. Indeed, 11% of the European population and 17% of European territory suffers from water scarcity, with an associated economic cost estimated at around € 100,000M, and 46% of the European population lives in places which are water-stressed¹. Additionally, according to the European Commission (2012)², during the last forty years, drought episodes in the EU have increased dramatically in frequency and intensity³.

The problem is especially acute in Southern Europe, suffering from climate change impacts such as an increased in temperatures, reduced precipitation and changed the rainfall regime [18]. Furthermore, there is a growing water demand mainly for the agriculture and tourism sectors,

¹ Communication from the Commission to the European Parliament and the Council - Addressing the challenge of water scarcity and droughts in the European Union {SEC(2007) 993} / {SEC(2007) 996.

² Report on the review of the European water scarcity and droughts policy. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM/2012/ 672 final. European Commission, Brussels.

³ Report on the review of the European water scarcity and droughts policy. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM/2012/ 672 final. European Commission, Brussels.

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main pillars of the regional economy, and have to deal with relatively scarce water resources and more and more of less quality.

Water scarcity is the result of a 'long term' imbalance between supply and demand where available conventional sources are not enough to satisfy the increasing demand for economic and societal activities in a context of population growth and climate change. The use of reclaimed water is understood as a reliable and safe alternative to conventional water resources and contributes to balance water supply and demand. Therefore, it should be considered as a powerful climate change adaptation measure and should be included in the river basing plans as another source of water to cover current demands.

Supply-side mechanisms have been implemented by governments to avoid drought effects and associated economic losses [2]. In some cases, like in the Segura river basin, employing re-use water for agricultural or urban irrigation allowed the region to reduce the pressure on freshwater resources and achieve a more sustainable use of water [12]. Specifically, the study of Morote *et al.* (2019) concludes that the mixed-use of water resources (e.g. by using reclaimed water) could improve water availability in certain regions of the world suffering from critical water scarcity.

Andalusia region, located in the South of Spain, has Mediterranean climate, characterised by dry and hot summers, warm winters and irregular rainfall. The water availability is also irregular, alternating droughts and rainy periods. Andalusia suffers from severe water scarcity that leads to increasing conflicts among different water users [5]. The region is technologically prepared to offer tertiary treatment that enables the use of reclaimed water for irrigation (urban and/or agricultural) purposes. In fact, 33% of the 2000 wastewater treatment plants (WWTP) operating in Spain are located in Andalusia. Spain already reuses more than 492 cubic hectometres of urban wastewater per year (10.4 % of total treated urban wastewater)⁴. Moreover, the use of reclaimed water can benefit the agrobusiness sector which is the third most important sector in the Andalusian economy, behind services and construction.

This research, performed in the frame of the "Network for effective knowledge transfer on safe and economic wastewater reuse in agriculture in Europe" project (SUWANU-Europe), aims to identify and assess main barriers and success factors for the implementation of water reuse projects in Andalusia for agriculture purposes. In order to achieve this objective, a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis has been carried out taking as a basis the SWOT analysis developed in the previous SuWaNu project⁵. Within SuWaNu Europe, the seven dimensions identified in previous SuWanu project – Economic, Technical, Health, Markets, R&D Transfer, Agriculture and Legislation - have been adapted and classified into three main domains: **market-related, product-related and social & governance.**

The SWOT analysis can support further development of a strategic management policy [14]. Specifically, the analysis studies perceptions of experts and stakeholders of the water and agriculture value chain, as well as those of other relevant actors from public administrations and consumers associations, regarding the strengths, weaknesses, opportunities and threats related to the use of reclaimed water for irrigation. The SWOT analysis carried out addresses a wide

⁴ SuWaNu Europe, Deliverable 2.1

⁵ <https://cordis.europa.eu/project/id/319998/es>

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range of aspects related to reclaimed water reuse for irrigation purposes, including market-related, product-related, social and governance aspects.

The SWOT analyses shows main barriers and challenges for the implementation of water reuse projects in Andalusia. Internal factors, through the analyses of strengths and weaknesses, as well as external factors, through the analyses of opportunities and threats, have been identified that are key to focus on future planning and research activities to facilitate the acceptance of reclaimed water as an alternative water source for irrigation purposes in Andalusia.

This analysis has led to the identification of some economic, social and environmental benefits, that may facilitate the increase on the use of reclaimed water in the region. In fact, the cost of reclaimed water supported by local agents is close to 0.4 €/m³, which is significantly lower than the cost of desalinated water (0.6-0.8 €/m³) [4], thus helping the economic viability of small farms in coastal areas of Andalusia. Further, water reclamation in coastal areas seems to have better acceptance by farmers as they have the perception of the resource being lost as this is discharge to the sea. Therefore, water reclamation at the coast provides a net water contribution to southern water basins by avoiding discharges to the sea, thus improving water availability during drought periods and any negative environmental impact associated to its discharge.

Therefore, the use reclaimed water offers an alternative non-conventional source to manage water in a more sustainable way, capable of improving supply reliability, adapting and mitigating climate change impacts on the irrigation sector. Moreover, reclaimed water use in primary production will contribute to food system sustainability, moving to a circular economy model.

Case study description

This study is based on previous work done within the project SuWanu “Sustainable water treatment and nutrient reuse options”, funded by the 7th Framework programme of the European Commission that run from 2013 to 2015. In SuWanu, different attributes related to water and nutrient reuse were identified and evaluated in the EU context [11]. The current project SUWANU-Europe⁶ aims to further develop and assess these attributes in order to identify barriers and factors of success in the implementation of reclaimed water use for irrigation purposes, with special focus eight EU regions, including Andalusia (southern Spain), with significant potential benefits.

The use of reclaimed water is a well-recognised climate change adaptation measure and a powerful approach to move to circular economy and resource efficiency in the water sector, both by reusing water and recycling nutrients embedded in the effluents, as already stated in the Water Framework Directive 2000/60/EC⁷ and further declared in the EU Circular Economy Action Plan by the EU⁸ launched in 2015. That Plan includes the implementation of measures for

⁶ <https://cordis.europa.eu/project/id/818088/es>

⁷ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32000L0060>

⁸ <https://ec.europa.eu/environment/circular-economy/>

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wastewater reuse as an essential part of the global strategy⁹. Recently, the EU has published the REGULATION (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse¹⁰.

Its aim is to support the use of reclaimed water in agriculture irrigation in order to improve the status of the environment by alleviating pressure on water bodies (surface freshwater and groundwater) and relieving pressure of discharge from UWWTP to sensitive areas. Furthermore, water reclamation requires lowest investment costs and energy, and generates less greenhouse gas emissions compare to other alternative sources such as desalination.

The Regulation 2020/741 aims to increase the confidence in the use of this type of water and minimise potential risks through the establishment of high-quality requirements in the whole EU. Areas with water scarcity like Israel, California or Australia have already implemented projects to reuse wastewater for different uses, such as golf course irrigation, industrial uses or even tap water uses [10]. In the EU, currently about 1 billion cubic metres of treated urban wastewater is reused annually, which accounts for approximately 2.4% of the treated urban wastewater effluents and less than 0.5% of annual EU freshwater withdrawals¹¹. The use of reclaimed water is more common in the Mediterranean countries. The case of Cyprus is the keystone as 90% of their wastewater is already reuse, but also Greece, Italy and some regions in Spain are implementing the use of reclaimed water as an alternative water resource ([2], [12], [13], [17]).

The SWOT analysis results show that public acceptance is essential to success in the implementation of reclaimed water for different uses such as irrigation, environmental restoration or industrial uses. Moreover, societal agreement among all involved groups and stakeholders constitutes a prerequisite for success, and not allaying stakeholders' doubts about health risks, public opposition, political disinterest, and information manipulation constitute the main causes of failure of reclaimed water projects.

The region of Andalusia is the most populated region in Spain and the second in terms of extension with an area of 87,268 km². The total annual rainfall varies according to the climate area of the region. The main water sources in Andalusia are surface water (76.6%) and groundwater (28.2%)¹². Other alternative sources, such as reclaimed water and mainly desalinated water produced in the four desalination plants of the region, still contribute with low figures (1.2% in 2016). The total population of Andalusia is 8.4 million inhabitants¹³, and almost 13 % of the total population of Andalusia still remains without an appropriate wastewater treatment service. The total volume of wastewater treated in Andalusian amounts to 698 hm³/year, thus representing a significant potential as an alternative water source to be reused¹¹.

⁹ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Closing the loop - An EU action plan for the Circular Economy. COM/2015/0614 final. European Commission, Brussels.

¹⁰ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R0741>

¹¹ <https://ec.europa.eu/environment/water/reuse.htm>

¹² INE (2016). Water statistics. Instituto Nacional de Estadística [National Institute of Statistics], Madrid, Spain. Accessed at <https://www.ine.es>.

¹³ <https://www.juntadeandalucia.es/institutodeestadisticaycartografia/padron/index.htm>

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Water reuse in Spain is ruled by the Royal Decree 1620/2007 “Wastewater reuse standards”. This Decree was based on similar existing regulations in similar regions, for example in California [2]. Despite regional differences, Royal Decree 1620/2007 has represented an important advance to standardize wastewater reuse practices [8]. The Royal Decree is complemented in some regions by specific guidelines as for example Andalusia, Balearic Island and Catalonia¹⁴. In Spain, the level of water reuse was estimated at over 500 million m³/year (2014/2015)¹⁵, situating Spain as the largest user of reclaimed water in the EU. The majority of the reclaimed water is used in agriculture irrigation. The EU Regulation on water reuse is quite similar to the Spanish Royal Decree 1620/2007: similar parameters are defined and applied to different categories of water defined according to the final use, but it does not include provisions for validation monitoring, water reuse risk management plans, nor detailed information to the public¹⁶

As shown in Table 1, in 2016, there are important differences among Spanish regions on the percentage of water being reused. Mediterranean regions like Murcia, Comunidad Valenciana and the Balearic Islands reused 71.8%, 47.5% and 33.0% of the total treated urban wastewater, respectively. These three regions represent 90% of total water reused in Spain (INE, 2016). Andalusia, although located in the southern Mediterranean area and with serious water scarcity problems, only reuses 5.90% of the treated urban wastewater.

Table 1. Percentage of wastewater according to the point of discharge

	Sea	River	Reuse	Groundwater
Spain	33.5	55.8	10.4	0.2
Andalusia	58.0	36.1	5.9	0.0
Aragón	0.0	99.2	0.8	0.0
Asturias	21.7	74.5	3.8	0.0
Balearic Islands	59.6	7.3	33.0	0.0
Canarias	77.9	2.1	19.8	0.2
Cantabria	79.5	18.8	1.7	0.0
Castilla y León	0.0	99.1	0.9	0.0
Castilla-La Mancha	0.0	96.2	3.8	0.0
Cataluña	66.3	28.7	4.9	0.1
Comunidad Valenciana	16.5	33.6	47.5	2.4
Extremadura	0.0	100.0	0.0	0.0
Galicia	30.5	60.7	8.8	0.0
Madrid	0.0	97.7	2.3	0.0
Murcia	11.5	16.7	71.8	0.0
Navarra	0.0	100.0	0.0	0.0
País Vasco	67.7	31.4	0.9	0.0
La Rioja	0.0	100.0	0.0	0.0
Ceuta y Melilla	100.0	0.0	0.0	0.0

¹⁴ BIO Deloitte, ICF GHK and Cranfield University, 2015, Optimising water reuse in the EU, Final report – Part I.

¹⁵ Eurostat, 2018, Water use balance statistics and BIO Deloitte, ICF GHK and Cranfield University, 2015, Optimising water reuse in the EU, Final report –Part I.

¹⁶ Water Reuse – Legislative Framework in EU Regions. © European Union, 2018.

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Fuente: Instituto Nacional de Estadística España, 2016

The percentage of treated water reused represents 5.90% in 2016, while in 2014 it was 7.83% and in 2013, it was 8.31% (INE, 2016). Through an in-depth analysis about the uses of reclaimed water, we found that in 2016, 69.20% of treated water was used for gardens and golf courses, while only 2.50% of the reclaimed water was used for agricultural irrigation (INE, 2016).

METHODOLOGY

Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis is one of the most effective approaches used for the development of strategic management policy. The components of the SWOT analysis are internal and external as described below:

- Strengths: **(internal)** characteristics of the project that give it an advantage over others.
- Weaknesses: **(internal)** characteristics of the project that are a disadvantage relative to others.
- Opportunities: **(external)** elements in the environment that the project could exploit to its advantage.
- Threats: **(external)** elements in the environment that could cause trouble for the project.

Although the use of conventional SWOT analysis is usually based on qualitative analysis (i.e. identification of the different attributes: elements and characteristics), various methodologies include a quantitative assessment of the relevance of the different attributes. For instance, Analytical Hierarchical Method (AHP) has been recently used for the reclaimed water allocation for agriculture use [3]. Some applications have combined SWOT with AHP so that individual SWOT factors can be weighted and rated quantitatively ([15], [19], [1]).

Existing literature concludes therefore, that SWOT is a methodological tool that allows the identification of factors influencing the development of a management initiative [14]. The SWOT analysis tool applied in this study allows the identification of strategic factors- including barriers, challenges and opportunities - that should receive attention for the development of regional strategies for the use of reclaimed water [7].

The study takes the attributes identified by Michailidis *et al.* (2015) as a baseline to focus on all kinds of aspects influencing/determining strengths, weaknesses, opportunities and threats for reclaimed water reuse, including: 1) **Market related**: economic, availability and market aspects; 2) **Product-related** (reclaimed wastewater): technical aspects, technological transfer aspects and health; and 3) **Social and governance**: social aspects, regulators, management and environmental aspects. The use of the three domains within this study, simplifies the presentation and comparison of the Regional Strategic plans developed within SuWaNu-Europe project.

With the objective of updating these aspects, a four-step process has been followed:

1. **Analysis of aspects identified in previous project SUWANU**: Existing aspects were analysed by ten Spanish experts, who reconsidered their suitability and identified new

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factors/aspects to take into account. This group of experts comprised distinguished scholars, policy-makers and business practitioners in the Spanish water sector. They also evaluated if the roles assigned to the different aspects were right, e.g. whether an aspect that was evaluated as an opportunity actually represented an opportunity in the current context or not.

2. **Analysis of expert feedback:** The experts feedback were discussed individually by the Spanish partners of the SUWANU-Europe (2019) consortium in a working session, with the aim to contrast all received information and decide whether the different aspects included in each group of the SWOT were adequate to ensure the implementation of water reuse in Andalusia. Considering the comments received from the 10 independent experts and those of the members of the project consortium, the list of aspects to be evaluated in each group was selected.
3. **Development of a questionnaire:** this questionnaire aimed to evaluating the relevance of identified aspects in each group. It was tested by two external experts and the consortium partners in order to produce the final version. The questionnaire uses a Likert scale from 1 (not relevant) to 5 (very relevant) to assess the relevance of the SWOT factors/aspects identified. The questionnaire permits respondents to rank the different aspects within each group according to the average relevance given by the consulted experts.
4. **Questionnaire distribution among relevant stakeholders:** the questionnaire was sent to a group of national experts and relevant stakeholders, both from public and private entities, representing different interests and views regarding water reuse in Spain. Furthermore, relevant actors and institutions (e.g. Spanish Ministry of Agriculture, Spanish Ministry for Ecological Transition, Consumers organizations), which have an active role in decision making, were also invited to participate. Potential experts and stakeholders were identified from the state-of-the-art review made by all participants in the SUWANU-Europe project (SUWANU-Europe Deliverable 1.1, available on the project's website ¹⁷).

RESULTS

The results presented in this section correspond to the twenty-two responses received from the Spanish national experts and relevant stakeholders that fulfilled the questionnaire. They belong to different stakeholder groups: researchers (7), members of NGOs (5), members of utilities (4), users (2), public administration (2) and agri-food firms (2). To assess the relevance of every aspect of the questionnaire, responders were asked to rank their replies in an scale from 1 (not relevant) to 5 (very relevant). The results of the SWOT analysis for Andalusia Region are presented in the following sections:

STRENGTH

A total of eleven strengths were identified in the questionnaire as shown in figure 1.

¹⁷ <https://suwanu-europe.eu/water-recycle-project-documents/>

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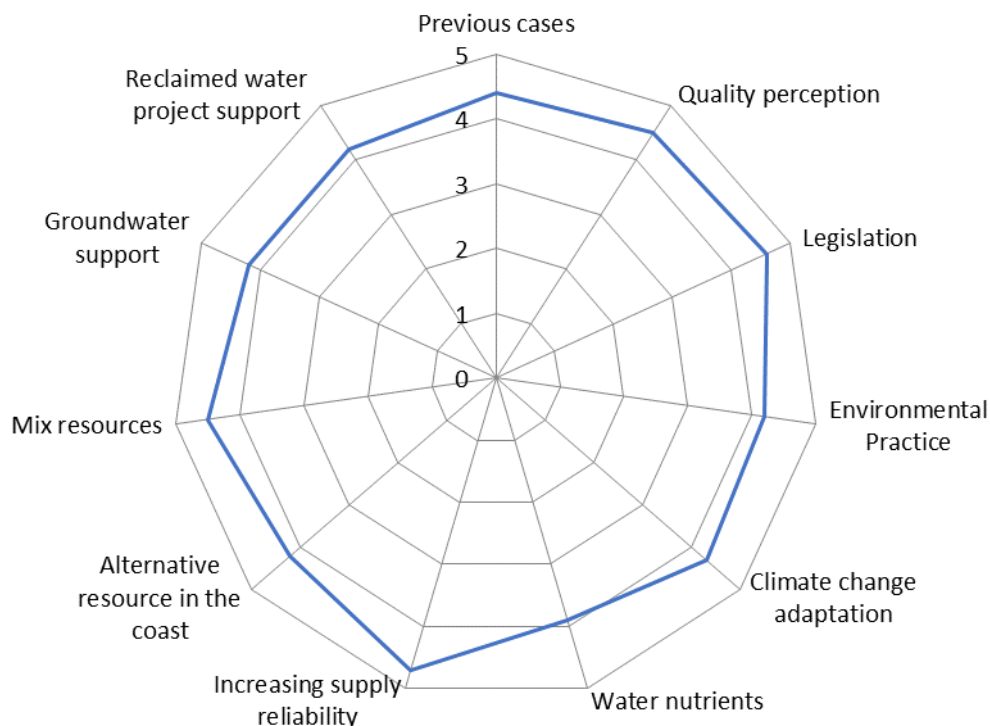


Figura 1. Strengths relevance (SuWaNu-Europe D2.1³)

Most of the strengths identified were scored between “5-Very relevant” and “4-Relevant” with the exception of “Water nutrients receiving” with an average score of 3.9. The average evaluation of most strengths has received an average score of 4.3. This result shows the high relevance assigned by the consulted experts to these strength aspects to promote the use of reclaimed water for irrigation purposes.

The high score was for Strength: Increasing supply reliability with a 4.7, as it is understood as “water sovereignty”, meaning water availability guaranteed even in drought periods. Strength: Legislation with a 4.6, was the second better scored and this is linked to the legal framework at national and European level, that ensure quality and safety of the reclaimed water being used for irrigation.

The Strengths: Quality perception and the use of reclaimed water with mixed resources got both an average score of 4.5. The experts reported to have scientifically documented successful case studies on the use of reclaimed water for irrigation that ensure the quality and safety of food crops. The implementation of project of mixed resources, for indirect reclaimed water use, seems to be a quite well accepted approach. It is being used in Andalusia for aquifer recharge for example and seems to be less risky for the farmers at the time of using reclaimed water.

The Strength: “Water nutrients receiving” received the lowest average score. of 3.9. The natural supply of nutrients (nitrogen and phosphorus) through the use of reclaimed water, was not considered as a strong aspect. Experts and, especially farmers, should have access to evidence of the saving that the use of reclaimed water on chemical fertilizers, and how this contribute to fight against climate change and reach the Sustainability of the food systems.

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WEAKNESSES

A total of nine weaknesses were identified in the questionnaire as shown in figure 2.

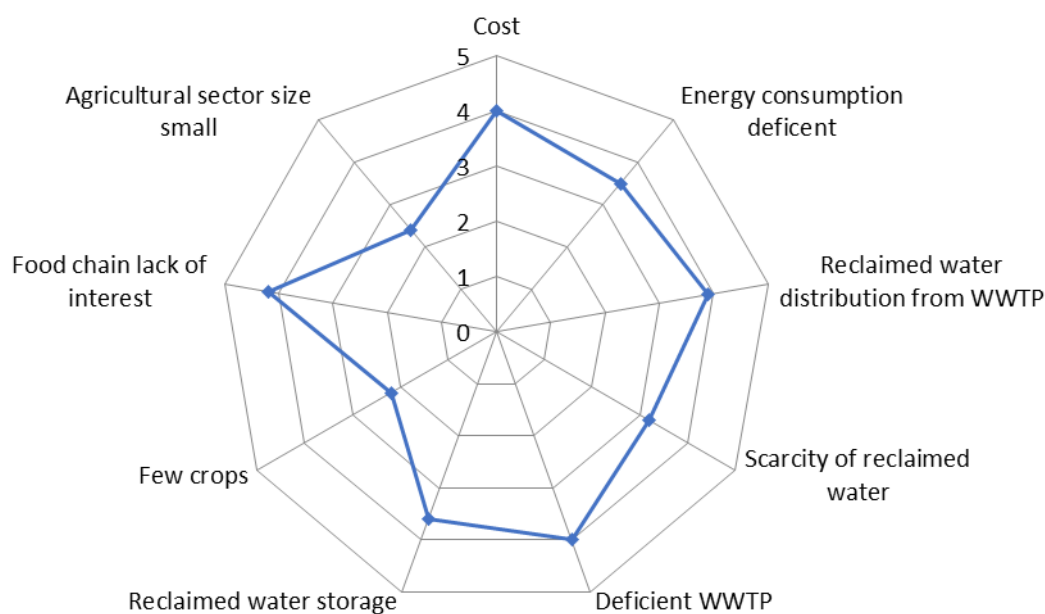


Figura 2. Weaknesses relevance (SuWaNu-Europe D2.1³)

The experts did not identify as many aspects for this factor as they did for the others.

The most important weakness, scored with 4.2, within this factor is the **lack of interest within the food distribution actors** about the quality standards of reclaimed water and the system of quality assurance (i.e. risk assessment and quality monitoring plan) needed to secure a high-quality water source. This is associated to the lack or very limited knowledge about the implications and public health safety of using reclaimed water for irrigation by the wholesalers and retailers of agricultural food crops.

The second most relevant weaknesses, both scored with 4.0, are associated to the **costs of reclaimed water and the deficient situation of wastewater treatment plants**. Cost of reclaimed water is considered very expensive by an important part of the agricultural sector, even though it is less expensive than desalinated water (0.4 vs 0.6 €/m³). Therefore, it is identified as a very significant barrier for water reuse projects implementation.

In addition, agriculture sector is concerned about the quality of the wastewater treated effluents (inflows to the water reclamation facility) as it may not comply with the applicable regulatory limits as stated in the Urban Wastewater Treatment Directive (Directive 91/271).

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Finally, several weaknesses have been considered as less relevant (Figure 2), such as the small size of many irrigation districts, scored with 2.4, and the limited number of crops with 2.4, in term of amount, irrigated with reclaimed water in certain irrigation areas which are small and made up of a limited number of users.

This analysis has shown that main challenges to be addressed by a future regional strategy would be: the promotion of information among food-chain agents, the guarantee of quality standards of reclaimed water, and cost affordability by irrigators.

OPPORTUNITIES

A total of nineteen opportunities were identified in the questionnaire as shown in figure 3.

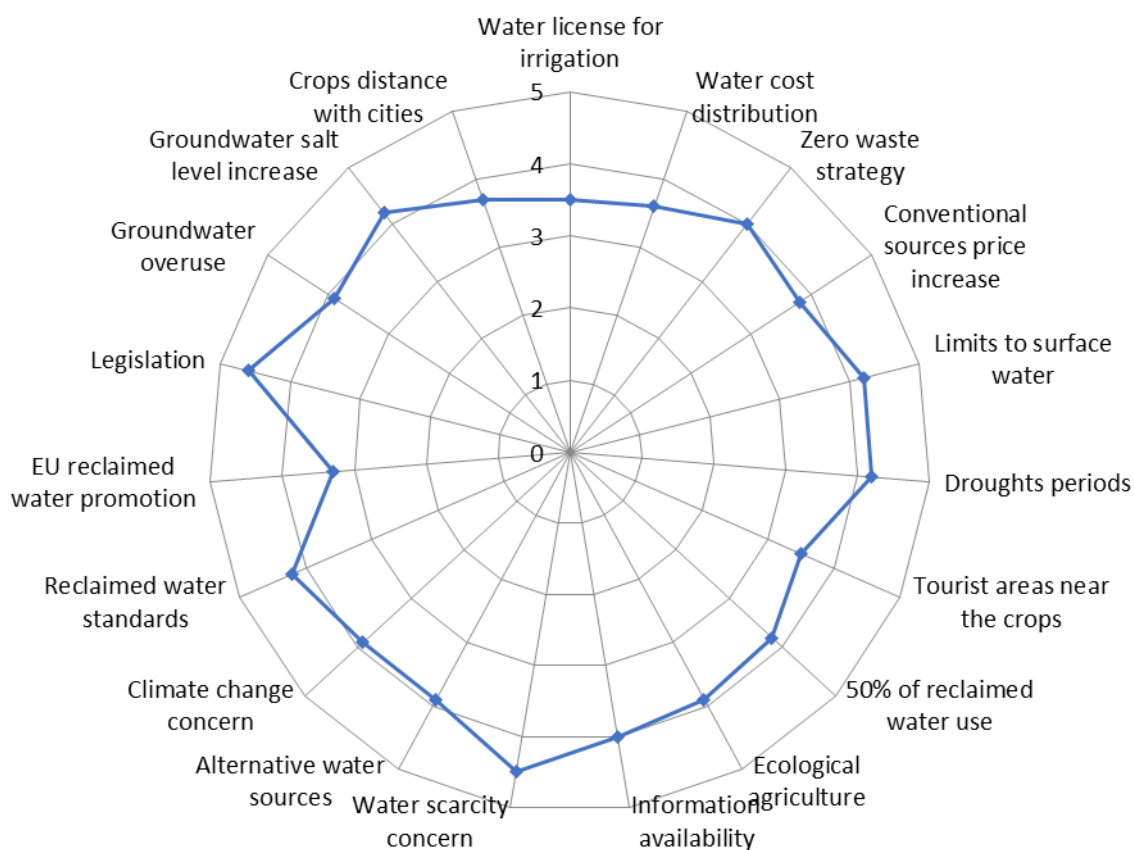


Figura 3. Opportunities relevance (SuWaNu-Europe D2.1³)

This group is the one with more items and appears as the second most relevant aggregated in the average evaluation with 3.9, after the average of strengths.

Legislation has been identified as the main opportunity, scored with 4.6. It seems that the national Royal Decree 1620/2007 offers assurance to farmers and consumers on the potential public health impacts associated to the consumption of food crops irrigated with reclaimed water. By the time the SWOT analyses was performed, the EU regulation was being developed

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and there was only a proposal for this regulation available¹⁸. This situation might explain the contradictory perception of respondents, who consider the existing policy framework as an opportunity though the lack of compliance with the regulatory limits also constitutes a relevant weakness. According to the experts' replies, it can be said that with the current European regulation already published, offering clear rules for irrigating with reclaimed water and bringing security to stakeholders, this opportunity may have got even higher score. Therefore, the development of European and national regulations to guarantee quality standards represent a powerful means to promote confidence and bring security on the use of reclaimed water among irrigators and general public.

The second most relevant opportunity identified is linked to the **concern regarding water scarcity** as there is growing social concern about the effects of future water droughts and scarcity episodes, associated with the weather irregularity resulting from climate change. In addition, the agriculture production faces challenges regarding the agricultural water management to have available water to feed a world population which is expected to be around 10, 000 million in 2050.

Other aspects, such as the **limits to use surface water** for irrigation, as well as the **occurrence of more frequent and long drought periods**, were identified as especially relevant opportunity sources. Experts seem to agree on the opportunity that the use of reclaimed water represents for a region such as Andalusia in terms of higher water supply reliability in a context of climate change with increasing water scarcity.

THREATS

A total of nine threats were identified in the questionnaire as shown in figure 4.

¹⁸ Proposal for a Regulation of the European Parliament and of the Council on minimum requirements for water reuse. COM/2018/337 final - 2018/0169 (COD). European Commission, Brussels.

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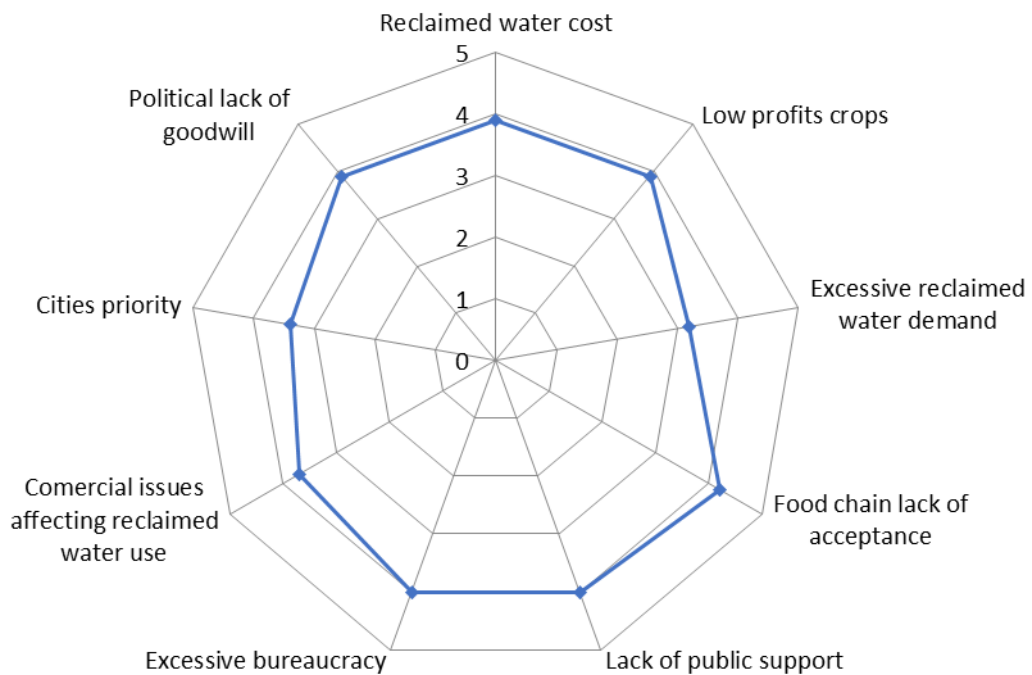


Figura 4. Threats relevance (SuWaNu-Europe D2.1³)

Within the identified threats, and as in the case of weaknesses, the most important threat is related to wholesalers and retailers lack of acceptance of agricultural products irrigated with reclaimed water, scored with 4.2.

“Irrigation with reclaimed water lacks public acceptance in Andalusia” and “Excessive bureaucracy needed for irrigating with reclaimed water”, with 4.00, were identified as very relevant threats as well for the promotion of the use of reclaimed water for irrigation in Andalusia. The lack of acceptance of products irrigated with reclaimed water by the food chain agents and the general public are related to one of the main weaknesses identified previously, the lack of public acceptance. These findings are similar to those found by Mainali *et al.* (2011a) in previous reclaimed water implementation projects, where the lack of public acceptance and participation in the reclaimed water implementation process were considered the main cause of failure. The excessive bureaucracy refers to the long and complicated administrative process needed to obtain the water reuse permission. This result seems paradoxical, since the existing legislation is also understood as a strength (referred to the national Royal Decree 1620/2007) by providing confidence to farmers and general public on public health impacts

Threats and weaknesses received the lowest average score, 3.8, within the different categories of aspects evaluated by the experts. This low score may show that the responders understand that the implementation of water reused project in Andalusia for irrigation of crops, has more positive than negative aspects.

DISCUSSION

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The main objective of the study performed is to identify the barriers and factors of success that determine the use of reclaimed water as an alternative water source for agriculture irrigation.

The SWOT analysis is one of the activities to be performed in the frame of a more ambitious planning process and constitutes a step further in the regional diagnosis of the Andalusian water sector and reuse potential. The results of the SWOT analysis are to be taken into account for the Regional Action Plan for Andalusia definition of objectives and prioritizing actions.

The participatory approach for the SWOT analysis development, with the participation of experts and stakeholders of the value chain, has been essential to guarantee the co-creation of strategies and consequently, to increase the success of the implementation of reclaimed water projects and the further acceptance by the sector and the public as an alternative source.

CONCLUSIONS

The SWOT analysis performed within SuWaNu-Europe shows the perception by experts and value chain stakeholders and identifies main barriers and factors of success with regards to the use of reclaimed water irrigation in the region of Andalusia.

Based on experts and stakeholders' feedback, there are three main areas that should receive special attention to promote the use of reclaimed water in the design of the Regional Action Plan and priority actions:

1. **Water availability linked to water scarcity and supply reliability.**

Drought periods are more and more frequent and lead to water shortages and a decrease on water quality, that may be a limiting factor for production and cause conflicts among water users, especially in tourist areas in Andalusia.

There is growing social concern about water scarcity associated to weather irregularity resulting from climate change that may compromise the food supply in the coming years. The social concern regarding water scarcity is the second better ranked **opportunity**, as consumers are aware of the need to turn food systems more sustainable and the use of reclaimed water contributes to this sustainability and efficient management of the resource.

The increased in the supply reliability though the use of reclaimed water has been identified as the main **strength** as water availability would be guaranteed even in drought periods.

2. **Consumers and food chain stakeholder's perception**

Food chain actors lack of interest and acceptance of agricultural products irrigated with reclaimed water has been identified as one of the most important threats and weaknesses.

Food stakeholders do lack or have very limited knowledge about the implications and public health safety of using reclaimed water for irrigation, and the quality standards of reclaimed water and the system of quality assurance (i.e. risk assessment and quality monitoring plan) needed to secure a high-quality water source. International retailers buying products in Andalusia for international markets, are little by little paying more attention to reclaimed

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water quality standards as they are obliged to comply with standards for Good Agricultural Practices, including water, as those of GLOBALG.A.P.

3. Legal framework and administrative procedures

Legal framework is perceived as a strength (existing national Royal Decree 1620/2007 and regional guidelines), as well as an opportunity (future legislation, the current European Regulation 741/2020, that was a proposal by the time the SWOT was performed), as strict quality requirements to ensure water safety are mandatory and could increase trust in this alternative water source among irrigators and general public.

The excessive bureaucracy and long administrative processes to obtain water reuse permissions, has been identified as a threat to be addressed. Reclaimed water licenses in Andalusia are mostly focused in irrigating gardens and golf courses. As previously explained, only 2.5% of total reclaimed water is used for agricultural irrigation in Andalusia. In 2017 the Andalusian government set the goal of 20 hm³ of reclaimed water to be allocated to the agricultural irrigation sector though this goal has not be fulfilled by the end of 2019. Lack of political will in the facilitation of new reclaimed water entitlements and long administrative processes could explain this delay.

Furthermore, it is important to mention that the high cost of reclaimed water for irrigators, compared to the current low cost of surface and groundwater resources, seen to be a relevant weakness. The lower price of reclaimed water compared to desalinated water, may constitute an opportunity to decrease water cost for irrigators in the most arid areas, such as Almeria where greenhouses farmers are currently buying desalinated water at high prices.

The SWOT analysis should be understood as a first stage in the analysis of barriers for reclaimed water use and indicates the main issues where future research should be focused on.

Previous studies show the increasing necessity to consider the use of non-conventional water sources, as reclaimed water, as a reliable alternative to conventional water resources, and its contribution to facilitate climate change adaptation and mitigation in a context of increasing water scarcity and drought frequency, as in the South of Spain. In addition, successful initiatives as the cases of Israel and Cyprus, with very high reuse rate of the treated wastewater, provide the evidence of the positive impacts on higher water supply reliability by the integration of reclaimed water into general resources management strategies. But still, weaknesses and threats identified should be addressed to increase the level of reclaimed water use in Andalusia.

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