UNIVERSIDAD DE GRANADA

DOCTORAL THESIS

Spain and Sustainable Development Goal 6: The main challenges of water policy for residential use

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"***Nunca digas 'De esta agua no beberé'***"

Refranero español

"Y te das cuenta que hasta el tiempo es un tirano,
porque se escapa corriendo igual que el agua entre las manos"

Sharif, 2015

A ti abuela, que impregnas cada 22 de marzo con el rastro salado de tu partida.

A ti Andrea, por ser la hermana que cualquiera desearía.

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Abstract

Despite the expectation that Sustainable Development Goal 6 (SDG 6) would not pose significant challenges for developed countries, substantial issues in residential water management persist in Spain, potentially hindering the goal's full realization. This research examines the legal, economic, and social barriers that affect equitable and sustainable access to water, with a focus on affordability, the feasibility of using non-conventional water sources like recycled water, and the role of water utilities in promoting sustainable practices.

The main objective of the study is to identify how Spain can improve its water policies to ensure fair access for all citizens, including economically vulnerable populations. Additionally, it explores public attitudes toward non-traditional water sources and analyzes which types of water utilities are more committed to driving conservation efforts, as well as the methods they use to encourage sustainable water usage.

Using a combination of qualitative legal analysis and quantitative data from Spanish municipalities, the research gathers insights through public surveys and applies statistical models to evaluate the relationships between water tariffs, public acceptance of recycled water, and how different types of water utility ownership influence conservation behaviors.

The findings show that while physical access to water is nearly universal, economic barriers remain a critical issue, with many low-income households at risk of water poverty. Public resistance to the use of recycled water would pose a challenge if authorities were to implement it for domestic purposes. Moreover, the study reveals that while there is room for improvement, publicly owned utilities are more proactive in promoting water conservation compared to private companies.

The research calls for the creation of an independent regulatory agency to address regional disparities in water affordability and management. It also emphasizes the need for targeted public education campaigns to increase acceptance of recycled water, along with stronger regulatory frameworks to ensure that all water utilities actively promote water-saving practices.

Keywords: *Spain · Sustainable Development Goal 6 (SDG 6) · Residential water management · Affordability · Water utilities*

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PROLOGUE

This doctoral thesis is dedicated to exploring, analyzing, and proposing solutions to the inherent challenges of residential water policy in Spain, particularly in the context of the country's commitment to Sustainable Development Goal 6 (SDG 6). Supported by funding from the Spanish Ministry of Universities through the University Teaching Staff Training (FPU) grants and research projects ECO2017-86822-R, SEJ-018-UGR18, PID2022-136235NB-I00, NB-I00, P18-RT-576, and UCE2019-01, this collection of articles represents a social sciences-based effort to unravel the complexities surrounding domestic water management.

From its inception, this doctoral thesis was conceived as an interdisciplinary project. It aimed to provide a holistic perspective on the subject by fostering collaboration and creating synergies with experts from various social science disciplines. This approach not only enriched the research but also offered a broader and deeper understanding of the challenges related to residential water policy in Spain.

The decision to assemble a supervisory team that not only guided but also actively encouraged the researcher was crucial. The inclusion of both an economist and a political scientist as supervisors contributed diverse perspectives and stimulated a deeper exploration of the many facets of the issue at hand. This interdisciplinary collaboration is not only reflected in the structure of the thesis but has also shaped the researcher's academic and professional journey.

The content of this thesis, aligned with its multidisciplinary approach, reflects the researcher's diverse academic background. With a degree in Political Science and Administration, a master's in International Public and European Law, and an early interest in political economy, the author approaches water policy through an interconnected lens that encompasses legal, political, economic, sociological, and environmental dimensions.

For the researcher, the goal of this thesis is not merely academic. The research is part of a broader process in which knowledge can serves as the foundation for real-world problem-solving. It is therefore crucial to emphasize the relationship between this thesis and practical applications, which might otherwise go unnoticed in the prologue.

It is impossible to encapsulate everything learned during the doctoral training period in one thesis, particularly in an article-based format. This doctoral thesis presents a synthesis of several research efforts and their main conclusions. However, the researcher feels grateful and fortunate to have been able to give back to society through various applied research projects, which allowed for the testing and application of the findings presented here in the Spanish context.

This prologue, therefore, not only marks the formal beginning of the thesis but also serves as a testimony to the author's commitment to interdisciplinarity and a comprehensive understanding of the topic at hand. As the following chapters unfold, readers will find a detailed analysis of the complexity of residential water management, offering reflections on the connections between various social science fields and highlighting the importance of collaborative approaches in finding sustainable solutions to today's challenges.

In a global context where sustainability and the protection of fundamental rights are becoming increasingly important, water policy emerges as a critical area for intervention. This research focuses on three main areas, providing a comprehensive—though necessarily incomplete—view of the human dimension and potential government and business strategies for optimizing water resources.

The first line of research delves into the recognition of water as a fundamental human right. The analysis of Spain's situation reveals both challenges and opportunities, proposing strategies to ensure equitable access to this vital resource, thereby safeguarding the dignity and well-being of the population. This research allowed the author to collaborate on two public-private projects aimed at reviewing and updating Spain's Water Supply and Sanitation Services Tariff Guide. It also provided the researcher with valuable insight into tariff structures and subsidies, which later proved essential in her role as an external consultant for the Inter-American Development Bank, analyzing water and sanitation tariffs in several Latin American countries.

The second research focus explores non-traditional ways of securing drinking water for households. In particular, it examines the reuse and recycling of water, assessing both the potential of these unconventional sources to meet rising household water demands sustainably and the political viability of using them for human consumption. As a result of this line of inquiry, the researcher was invited to participate in various forums to disseminate scientific knowledge.

The third line of research centers on sustainable water use, exploring the interaction between public policy, public awareness, and daily practices. Through a critical analysis of current strategies and the proposal of new perspectives, the research aims to chart a path toward water management that is not only efficient but also respectful of the planet's limits. As part of this effort, the researcher and her team designed and carried out a youth-targeted campaign in the province of Granada to promote environmentally friendly shower habits, funded by the Provincial Council of Granada. Additionally, she was invited to appear on an international podcast focused on bridging the gap between academia and policymakers.

Ultimately, this thesis seeks not only to deepen academic knowledge but also to offer concrete, actionable contributions for the formulation of public policies that will help Spain meet the SDG 6 targets. Furthermore, I hope this doctoral thesis demonstrates the value of political science in areas beyond the traditional study of political actors, electoral behavior, and political processes. I firmly believe that traditionally distant fields can benefit from our involvement, just as we can learn from and expand the boundaries of our discipline. For this reason, I express my gratitude to the Ministry of Universities of the Government of Spain for its support, with the hope that this research contributes to more just, equitable, and sustainable water management.

Chapter 1. Introduction

Water is a fundamental resource that sustains life, supports ecosystems, and drives economies. Yet, the issues surrounding water policy have emerged as some of the most pressing challenges of our time (SIWI, 2020). Since 2012, water crises have consistently ranked among the top global threats, according to the Global Risk Report[1]. By 2023, water crises were identified as the fourth most significant threat in terms of impact and the ninth in likelihood, overshadowed only by extreme weather events, climate change failures, and natural disasters. This ranking underscores the gravity of the situation, but a deeper analysis reveals an even more alarming reality: nine out of ten of the most severe natural disasters that have occurred since 1990 are intricately linked to water (SIWI, 2019; World Meteorological Organization, 2021). This interconnectedness highlights the critical importance of addressing water-related issues comprehensively and urgently.

Given these global challenges, this research focuses on Spain, where the interplay between sustainable water management, public policy, and social equity is particularly complex. The central research interest lies in understanding how current policies and practices can evolve to ensure equitable, affordable, and sustainable access to water, considering the social, political, legal and economic dynamics influencing this vital resource.

While agricultural use remains the largest global consumer of water, the demand for urban water use is projected to grow at a significantly faster rate, underscoring the urgent need for enhanced demand management in the face of increasing water scarcity (He et al., 2021). This shift emphasizes the critical need to prioritize research on domestic water supply, especially given that drinking water is legally prioritized over other uses in most countries due to its vital role in sustaining life (Hildering, 2020). [2] Beyond its economic and ecological importance, water's status as a fundamental human right—essential for

[1] The Global Risk Report is an initiative of the World Economic Forum, which solicits input from approximately 1,000 decision-makers across various sectors, including the public sector, business, academia, and civil society worldwide, to evaluate the risks confronting the world over the coming decade.
[2] Zheng and Spijkers (2021) provide an analysis of the priorities of water uses in international water law, highlighting that water uses that directly satisfy vital human needs take precedence over other water uses. However, they emphasize the importance of distinguishing domestic uses from vital human needs, as the latter can vary depending on the context, while domestic uses may encompass recreational activities.

preserving both life and human dignity—further elevates its significance in public policy and sustainable development (United Nations, 2010a).

As will be highlighted in later chapters of this thesis, Spain serves as an excellent case study for investigating water management for domestic purposes. The reasons are varied: its Mediterranean climate exacerbates regional disparities in water availability (Baigorri et al., 2022), with irregular rainfall patterns (Noguera et al., 2020) and high demand from agriculture and tourism (Pérez et al., 2020). Spain is also one of the countries facing significant water stress, a situation expected to worsen in the coming years (Mendez-Jiménez, 2012; We are water, 2022). Additionally, the country's highly decentralized water supply system creates a variety of tariff schemes, including subsidies and special tariffs for economic reasons. Finally, the presence of both public and private ownership models in the water supply sector provides a unique opportunity to explore differences in management practices and outcomes between these types of utilities. Therefore, Spain's Mediterranean climate, combined with its highly decentralized water supply system and mixed ownership models in the water sector, provides a unique landscape for examining the efficacy of water management strategies in a developed yet water-stressed nation.

The pressing need for innovative approaches to water management underscores the urgency of transformative changes in how we manage and use water resources. Ensuring a sustainable water supply is not just a priority; it is a necessity for survival. Recognizing this urgency, international organizations and programs, such as the United Nations Sustainable Development Goals (SDGs), have placed water at the forefront of their agendas (United Nations, 2015; United Nations, 2010b). The concept of sustainable development, first articulated in the Brundtland Report of 1987, underpins these goals by emphasizing that sustainable development requires not only meeting the basic needs of all, including essential water supply and sanitation, but also extending the opportunity to satisfy aspirations for a better life (WCED, 1987)[3]. This holistic approach laid the foundation for a global strategy to address socio-economic and environmental challenges, evolving into the comprehensive framework of the SDGs.

Among the SDGs, Goal 6 stands out for its focus on ensuring the availability and sustainable management of water and sanitation for all. This goal is not merely about

[3] The report defines development as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

providing water but ensuring that it is safe, clean, and accessible to everyone. The importance of water is multifaceted—it is crucial for health, drives economic growth, and serves as a keystone for environmental sustainability. Recognizing this, SDG 6 is structured around several targets that address specific focal points, including universal access to water and sanitation (6.1 & 6.2), water quality and sustainable management (6.3, 6.4, 6.5 & 6.6), and international cooperation and capacity building (6.a & 6.b).

1.1 Research background and rationale

The United Nations General Assembly's recognition in July 2010 of access to basic water and sanitation as a human entitlement underscores water's classification as a public good, foundational to life, the economy, and the promotion of the common welfare. This significance is further emphasized in the first group of SDG 6 targets (6.1 & 6.2), which focus on achieving universal and equitable access to safe drinking water and adequate sanitation and hygiene services. These targets represent one of the significant challenges outlined by the UN in this area to be addressed by 2030. Given these considerations, this thesis will specifically explore the challenges and opportunities related to achieving SDG 6 targets on domestic water use in Spain, examining how effective water management practices can ensure equitable and sustainable access to this vital resource.

However, despite progress under the SDGs, significant challenges remain. By 2022, 703 million people still lacked access to basic drinking water services, and the situation is projected to worsen, with around 700 million people expected to be displaced by water scarcity by 2030 (JMP, 2023). Additionally, 19 percent of the world's renewable water resources are being withdrawn, accounting for environmental flow requirements (JMP, 2023). Monitoring and implementing SDG 6, coordinated by the UN-Water-led Integrated Monitoring Initiative, is crucial for tracking progress and initiating necessary interventions (Huber, 2021). However, data gaps and inadequate monitoring capacity pose serious risks, potentially leaving the most vulnerable populations behind and stalling global progress (IAEG 2014).

These challenges are not limited to developing countries. In developed nations like Spain, where advanced water infrastructure and governance exist, significant issues still hinder the achievement of SDG 6 targets (O'Neill et al., 2018; González-Gómez et al., 2020). Scholars have noted that these challenges are often inadequately captured by globally defined indicators, suggesting the need for more localized strategies (Germann and

Langergraber, 2022). This observation is particularly relevant for Spain, where regional disparities in water availability and increasing urbanization present unique challenges in balancing water resource use with sustainable development goals. For instance, regarding Target 6.1, global indicators tend to focus on coverage, which is less of a challenge in developed countries where near-universal coverage of safely treated water exists. However, there is no official monitoring of affordability, which could be a more pressing issue in developed nations than physical access.

Moreover, for many countries in the Global North, the primary challenge to sustainable development lies in finding strategies to reduce resource use without transgressing planetary boundaries while maintaining or improving social thresholds (O'Neill et al., 2018). Regarding the potential to increase water supply through alternative water resources such as desalinated or reused water (SDG 6.3), current SDG indicators focus on the percentage of water treated or reused but do not consider whether it is socially acceptable to expand its use to meet additional demands. Water reuse is been extensively studied in relation to agriculture uses (Iglesias-Esteban, 2016), but there is a gap regarding domestic uses. Similarly, while the influence of residential water use efficiency measures on household water demand (SDG 6.4) has been extensively studied (Lee et al., 2011; Tortajada et al., 2019; Viera et al., 2017), less is known about the actions of key stakeholders, such as water utilities, in promoting sustainable water behaviors (Romano et al., 2014).

In this context, academic research must go beyond simply assessing SDG 6, its associated targets, indicators, and challenges. Universities and research institutes are uniquely positioned to serve as catalysts for sustainable development, particularly by facilitating effective dialogue among science, society, and policy (El-Jardali et al., 2018; Gratzer et al., 2019). By maintaining strong connections with regional and external stakeholders, these institutions can offer the necessary expertise to translate research into practical, policy-relevant applications (Gratzer et al., 2019).

To meet these expectations, academia is increasingly called upon to transition from passive observation to active participation in the development of policies and strategies that support the achievement of the SDGs (Arbo & Benneworth, 2007; Cuesta-Claros et al., 2022). By producing context-specific, evidence-based recommendations, academic institutions can play a pivotal role in the policymaking process (McGuire and Perna,

2023). In Spain, where the challenges of achieving SDG 6 in domestic water use are particularly pronounced, there is a pressing need for research that not only critiques existing policies but also proposes actionable solutions. This underscores the importance of a policy-oriented research focus in addressing Spain's unique challenges in sustainable water management and domestic water use, which are crucial for meeting the broader goals of SDG 6.

Furthermore, the three key areas explored in this thesis—universal water access with a focus on affordability, potable water reuse with an emphasis on public acceptance, and the sustainable use of water, particularly the efforts by companies to promote it—have traditionally been the domain of engineering, environmental sciences, ecology economics.[4] However, despite the complexity and multifaceted nature of these issues, they have not been extensively studied from an interdisciplinary perspective. Nor have they been thoroughly examined within the field of political science, despite its critical role in analyzing and designing public policy. This gap highlights the need for further exploration of these topics through an interdisciplinary approach, including the lens of political science, given its crucial role in the development and implementation of public policy and governance (Döring et al., 2023; Zwarteveen et al., 2017; Edmonds, 2023).

In response, this thesis adopts a holistic and interdisciplinary approach to water management, while placing a novel emphasis on the on the political science perspective. By applying an interdisciplinary approach, this research not only examines the legal and institutional frameworks governing water use in Spain but also critically assesses the influence of various stakeholders—from government bodies to private utilities—in crafting equitable and sustainable water policies. The political science lens is particularly valuable for understanding the governance structures, policy decisions, and power dynamics that shape water distribution and access. This comprehensive approach is essential for developing solutions that address both the immediate and long-term

[4] A search in the Scopus and Web of Science databases indicates a growing scholarly interest in the topics addressed by this thesis. The results show that the predominant research areas related to these subjects are engineering, environmental science, ecology, business economics, and water resources. Notably, public administration emerged as a top ten category only in the context of research on water affordability.
The search was conducted using specific keywords and phrases directly related to the topics under investigation. It focused on the 'Title-Abstract-Keywords' fields to ensure the capture of relevant literature. The search terms were structured as follows:
Topic 1: 'Water affordability' AND 'Human rights to water' AND 'Water poverty.'
Topic 2: 'Water reuse' AND 'Potable reuse' AND 'Domestic reuse' AND 'Public acceptance.'
Topic 3: 'Water sustainability' AND 'Water management' AND 'Water scarcity' AND 'Domestic use.'

challenges of water management, with a particular focus on social equity and resource sustainability.

1.2. Research objectives and method

Is Spain prepared to meet the SDG 6 targets related to residential water use, and how can it improve its performance in response to current and future challenges? This central research question forms the foundation of the present doctoral thesis, which aims to analyze the primary challenges of Spain's water policy for urban areas.

In response to global concerns about water access and scarcity, this thesis seeks to contribute to the Sustainable Development Goals (SDGs) by providing context-specific, policy-relevant evidence to actively support decision-making. The research explores the complex interplay of water policy issues within the framework of SDG 6, with a particular emphasis on domestic water use in Spain.

Focusing on the specific targets of SDG 6, three critical areas emerge where governments and stakeholders must concentrate their efforts. Accordingly, this research assesses Spain's current status concerning these targets, identifying both strengths and areas for improvement to inform the design and evaluation of effective public policies. Specifically, the research addresses three key targets: ensuring universal and equitable access to safe and affordable drinking water for all [Target 6.1] improving water quality by reducing pollution, minimizing the release of hazardous chemicals, and promoting the safe reuse of treated wastewater to combat water scarcity [Target 6.3], and substantially increasing water-use efficiency across all sectors, particularly in rapidly growing urban areas [Target 6.4].

Therefore, the general objective is further specified into the following specific objectives:

- Analyze and assess whether the legal and institutional framework in Spain guarantees the human right to water for households at risk of poverty and social exclusion. *(Target 6.1)*
- Determine whether low-income families face a threat of exclusion from potable water supply due to economic reasons. *(Target 6.1)*
- Examine the policy of water reuse and regeneration in Spain. *(Target 6.3)*

- Analyze citizens' perceptions of using non-conventional water sources for residential purposes and study the factors that influence their acceptance. *(Target 6.3)*
- Identify the specific uses for which citizens would be willing to utilize non-conventional water sources. *(Target 6.3)*
- Examine whether water supply companies promote pro-environmental behaviors and habits. *(Target 6.4)*
- Investigate the effect of ownership of water utilities on the promotion of sustainable water use in households. *(Target 6.4)*

By way of synthesis, Table 1.1 delineates the relationship between the research questions and the specific targets under analysis that have structured the investigation.

This table demonstrates how the research aligns with global sustainability goals while addressing the specific context of water management in Spain. Each chapter of the thesis is structured around these questions, ensuring a coherent and targeted approach to investigating the critical issues of water affordability, reuse, and governance.

Table 1.1.Relationship between targets, challenges, and research questions

			Target	Challange	Research question	Chapter of the thesis
ODS 6	Part I	**ODS 6.1**	By 2030, achieve universal and equitable access to safe and affordable drinking water for all.	Design equitable tariff policies with a human rights approach.	Does the Spanish legal and institutional framework ensure the human right to water in households at risk of poverty and social exclusion?	Chapter 2&3
					Is there an affordability issue in water access in Spain as defined by the United Nations?	Chapter 3
	Part II	**ODS 6.3**	By 2030, improve water quality by reducing pollution, eliminating dumping, minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing safe recycling and reuse globally.	Reduce water stress levels through the implementation of alternative sources and efficient water use.	How has the existing policy in Spain related to water reuse and regeneration evolved?	Chapter 4
					What is the perception of Spanish citizens regarding the use of non-conventional water sources for residential purposes?	Chapter 5
					What factors influence the acceptance of recycled water for residential uses?	Chapter 5
					Does the willingness to use non-conventional water vary depending on its specific use?	Chapter 5&6
	Part III	**ODS 6.4**	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity.	Reduce water stress levels through the implementation of alternative sources and efficient water use.	What actions are water supply companies taking to promote pro-environmental behaviors and habits among users?	Chapter 7
					Are there differences in the strategy to implement sustainable water use practices depending on the ownership of the utility?	Chapter 8

While physical access to water is nearly universal in developed countries, the focus regarding SDG 6.1 in this context shifts to the economic accessibility of water services—an issue increasingly recognized as crucial for ensuring truly equitable access (González-Gómez et al., 2020). As affordability has become a central challenge for low-income households, often leading to water poverty, this research aims to shed light on this often overlooked but significant issue. The thesis will analyze whether low-income families in Spain face a genuine threat of exclusion from essential water services due to economic barriers.

Regarding Target 6.3, which aims to improve water quality and promote water reuse, there is growing concern about how water scarcity can increase costs and impact water availability, particularly in terms of quality. In recent years, Spain has faced situations where some villages lacked sufficient conventional water resources to meet their needs (El confidencial, 2023). This has sparked debates about the potential of non-conventional resources, such as desalination and water reuse, to supply households effectively (El periódico, 2024; López-Ruiz, 2024). This thesis will provide a comprehensive analysis of water reuse practices in Spain and evaluate their social feasibility for domestic purposes.

Although Target 6.4, which focuses on increasing water-use efficiency, has been widely researched, particularly in response to growing water demand in urban areas, there is still a significant gap in understanding how key stakeholders, such as water utilities, actively promote sustainable water behaviors among users. This research will explore whether these stakeholders are not only supplying and managing water resources but also influencing consumer behavior through the promotion of water-saving technologies and conservation practices. This is crucial for enhancing water-use efficiency in domestic settings, especially in contexts like Spain, where both urbanization and tourism exert significant pressure on water resources. Additionally, this part of the thesis will engage with broader debates on the responsibilities of stakeholders in achieving sustainable resource use and the role of corporate social responsibility in the water sector (Fallah Shayan et al., 2022)

By concentrating on the targets most intricately related to domestic uses—namely 6.1, 6.3, and 6.4—this research aims to critically analyze the challenges and opportunities Spain faces in achieving these targets beyond official indicators, while providing actionable recommendations for policy improvements and sustainable practices.

To achieve its objectives, this thesis employs a diverse and multifaceted methodological approach that integrates both qualitative and quantitative research techniques, each tailored to address the specific research questions posed in each chapter.

The qualitative component focuses on legal and institutional analyses of water management frameworks in Spain. This involves a critical review of national, regional, and local regulations, with particular attention to how these frameworks impact the protection of the human right to water, especially for vulnerable populations. This analysis forms the foundation for understanding the broader regulatory environment within which water policies are developed and implemented.

Complementing this, the empirical component of the thesis involves extensive data collection across a wide range of Spanish municipalities. The quantitative data encompasses variables such as water tariffs, consumption levels, household incomes, and other socio-economic factors. Various statistical techniques, including logistic regression, analysis of variance (ANOVA), and ordinary least squares (OLS) regression, are employed to rigorously examine the relationships between these variables and the dependent outcomes of each study.

Depending on the chapter, the thesis utilizes either primary or secondary data, ensuring that the most appropriate data sources are used to address the specific research questions. This comprehensive methodological approach ensures a thorough and nuanced exploration of water management issues in Spain, contributing valuable insights to the broader discourse on sustainable water governance.

To provide a clear overview of the specific methodologies and techniques applied throughout the thesis, Table 1.2 outlines the methods and data used in each chapter, corresponding to the particular objectives addressed.

Table 1.2.Summary of methodology, data and techniques by chapter

Chapter	Objective	Data sources	Methodology	Techniques
Chapter 2: Human rights in Spain: Protection of the right to water in families with affordability problems	Analyze the protection of the right to water in Spain for families facing affordability issues, and propose necessary legal reforms to ensure this right.	International and national legislation on human rights to water; Data from INE on poverty and social exclusion in Spain; Reports from organizations on water disconnections.	Review of national and regional legislation; Comparison across different autonomous communities; Evaluation of municipal social measures related to water supply.	Critical normative analysis of the legal guarantee of the right to water in situations of poverty, evaluating existing regulations at national, regional, and local levels.
Chapter 3: Is the human right to water sufficiently protected in Spain? Affordability and governance concerns	Determine whether low-income families in Spain face a real risk of being cut off from water services due to affordability and governance issues.	Data from 16 Spanish cities representing 35% of the total population; Municipal and regional regulations on water cutoffs; Income statistics and water tariffs; Reports on social assistance and aid programs.	Estimation of financial effort required to pay for water across different income levels; Evaluation of assistance programs and water tariff discounts; Comparative analysis of water service ownership and management (public vs. private).	Empirical analysis of water costs relative to household income; Review of the legal framework allowing or preventing water cutoffs for non-payment.
Chapter 4: Regenerate and reuse water in Spain: Facts and politics	Examine the evolution of water regeneration and reuse practices in Spain, focusing on the political, legal, and socioeconomic factors influencing their development.	National and European legislation on water regeneration and reuse; Reports from the Spanish Water Agency and the EU; Data from national and international organizations on water usage.	Review of relevant legislation and public policies; Analysis of historical data on the evolution of reclaimed water use in various sectors; Comparison across different autonomous communities and their reuse practices.	Descriptive and critical analysis of policies and practices related to water regeneration and reuse in Spain.

Chapter 5: Acceptance of direct potable water reuse for domestic purposes: evidence from southern Spain	Investigate public acceptance of the use of recycled water for domestic purposes in southern Spain and the factors that determine this acceptance.	Data from 791 questionnaires administered in Andalusia, Spain, to individuals aged 18-30.	Surveys on the willingness to use water from different sources (current, desalinated, rainwater, recycled); Regression analysis to identify factors influencing acceptance of recycled water use.	Empirical analysis using ordinary least squares (OLS) regression to identify factors influencing the acceptance of recycled water use.
Chapter 6: Determinants of the acceptance of domestic use of recycled water by use type	Analyze the determinants of acceptance for the use of recycled water at home, depending on the type of use.	Data from a questionnaire administered to 844 university students in Andalusia, Spain.	Classification of recycled water uses into five levels based on proximity to personal contact and function; Missing data imputation using the k-Nearest Neighbour Imputation (kNNI) method.	Regression analysis using ordinary least squares (OLS) to identify factors influencing acceptance of recycled water use by type.
Chapter 7: Promoting water conservation habits in shower use: review of water utility websites in OECD cities	Review how water utilities in OECD cities promote water conservation habits in shower use and analyze the effectiveness of these campaigns.	Information from the websites of 38 water companies in capitals of OECD countries.	Website content review for recommendations on shower frequency, duration, turning off water while lathering, and collecting cold water for other uses; Estimation of water use and potential savings based on different shower practices.	Descriptive and comparative analysis of the content available on websites regarding water conservation tips related to shower use.
Chapter 8: Does the ownership of Water Utilities Influence Water-Saving advice provided to service users? An analysis of the Spanish Water Sector	Analyze whether the ownership of water utilities influences the provision and content of water-saving advice on their websites in the Spanish water sector.	Data collected from the websites of 341 service areas in Spain, covering 67.27% of the country's population; INE data on the population served; Water Exploitation Index from the European Environment Agency (EEA).	Website content review of water utilities; Comparison between areas managed by public, private, and public-private partnership companies.	Logistic regression analysis for the presence of water-saving tips; ANOVA and ordinary least squares (OLS) regression for analyzing the content of the tips.

1.3 Structure of the thesis

Following the introduction, the main body of the thesis is structured into seven chapters, organized into three main parts, each dedicated to one of the specific targets under analysis from SDG 6. Each chapter corresponds to a specific research objective and consists of a paper that has already been published. These published papers are carefully aligned with the thesis's objectives, offering a focused and detailed examination of each SDG target (see Table 1.1 for a detailed mapping of chapters, research questions, and SDG targets). Additionally, each part of the thesis begins with a general introduction that sets the context, outlines the specific challenges associated with the target under study, and briefly relates to the overall methodology, which will be further and specifically developed in each chapter.

Part I focuses on Target 6.1, which aims to ensure universal and equitable access to safe and affordable drinking water for all. This part includes Chapters 2 and 3. Chapter 2 explores whether the Spanish legal and institutional framework ensures the human right to water, particularly for households at risk of poverty and social exclusion. Chapter 3 delves into the economic accessibility of water services, analyzing whether low-income families face significant threats of exclusion from essential water services due to economic barriers.

Part II is dedicated to Target 6.3, which seeks to improve water quality by reducing pollution, minimizing the release of hazardous chemicals, and promoting the safe reuse of treated wastewater. This part encompasses Chapters 4, 5, and 6. Chapter 4 analyzes the evolution of water reuse policies in Spain, Chapter 5 examines public perception towards non-conventional water sources for residential use, and Chapter 6 investigates the factors influencing the acceptance of recycled water and the contexts in which it is considered viable.

Part III addresses Target 6.4, which aims to substantially increase water-use efficiency across all sectors, with an emphasis on urban areas where demand is growing rapidly. This part comprises Chapters 7 and 8. Chapter 7 evaluates the strategies implemented by water utilities to promote sustainable water use behaviors among consumers, while Chapter 8 examines the influence of water utility ownership on the promotion of water conservation practices.

The final chapter, **Chapter 9**, is dedicated to a comprehensive discussion of the findings across all parts and the formulation of conclusions and recommendations for policy improvements and sustainable practices. In addressing these challenges, this thesis not only contributes to the academic discourse on sustainable water management but also offers policy-relevant insights that are crucial for meeting the Sustainable Development Goals in Spain and beyond.

PART I.

Water as a Human Right: addressing affordability in Spain's water policy

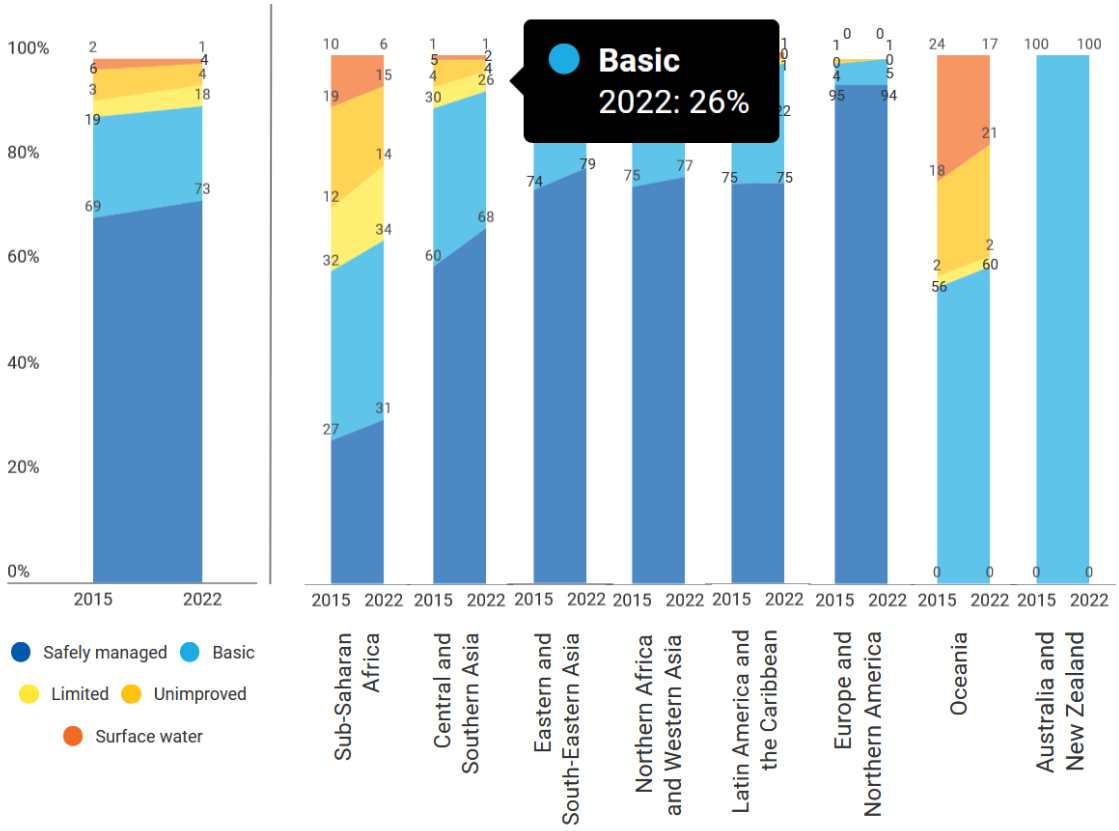
SDG 6.1. Achieve universal and equitable access to safe and affordable drinking water for all

INTRODUCTION

Water access is globally recognized as a fundamental human right and a cornerstone for achieving sustainable development (Filmer-Wilson, 2005). The United Nations Sustainable Development Goal 6 (SDG 6) underscores the importance of this issue, aiming to ensure the availability and sustainable management of water and sanitation for all. Within this framework, SDG 6.1 specifically targets achieving universal and equitable access to safe and affordable drinking water by 2030, recognizing that water access is not only a basic human need but also a driver of broader development outcomes (United Nations, 2015). Equitable access to water is critical, as disparities in access often reflect and exacerbate broader social inequalities (Brown et al., 2023; Jiwani and Antiporta, 2020). Marginalized groups, including rural populations, are disproportionately affected by the lack of access to clean water, with women and girls particularly burdened by water collection duties, limiting their opportunities for education and economic participation (WHO & UNICEF, 2023). Therefore, achieving SDG 6.1 is integral to advancing gender equality and social justice, as it seeks to address these disparities and ensure that all people, regardless of socio-economic status, have access to this vital resource.

Despite progress under Agenda 2030, access to clean water remains a critical issue worldwide, with over 2.2 billion people still lacking access to safely managed drinking water services, leading to severe implications for health, economic stability, and overall well-being (WHO & UNICEF, 2023). These challenges are particularly pronounced in developing countries, where lower access rates and inadequate infrastructure pose significant barriers (see Figure I.1) (Biswas and Tortajada, 2018). Consequently, most research on water access has naturally concentrated on these regions, where the challenges are most acute (see p.e. Smiley, 2017; Adams et al., 2018), and where the primary concern is ensuring that all populations can physically access safe drinking water.

Figure I.1. Progress on household drinking water 2015-2022 by region.



Source: WHO/UNICEF JMP 2023 Progress on household drinking water, sanitation an hygiene 2000-2022: special focus on gender

However, this study takes a different perspective by focusing on a developed country—Spain. While water access issues are commonly associated with developing nations, they also exist in developed countries, albeit in a different form (González-Gómez et al., 2020). In these settings, the challenge is not so much about physical access to water, which is nearly universal according to WHO-UNICEF statistics (2023), but rather about the affordability of water services.

In developed countries like Spain, low-income families often struggle to afford their water bills, leading to conditions of water poverty (González-Gómez et al., 2020). This economic barrier, rather than physical access, is increasingly recognized as a significant issue, with recent studies highlighting the growing problem of water poverty where affordability is the central challenge. However, the scarcity of data and statistics on water poverty in developed countries renders it an "invisible" issue (Jones and Moulton, 2016), making it exceedingly challenging to address (Josset et al., 2019).

When the papers in this thesis were written, research on water poverty in developed nations was still relatively scarce. The existing studies, including those from Spain (Yoon et al., 2019), the United States (Mack and Wrase, 2017; Teodoro, 2019), Belgium (Vanhille et al., 2018), England and Wales (Bradshaw and Huby, 2013; Zetland, 2016), and Portugal (Martins et al., 2016, 2019), highlight the struggles faced by low-income households in paying for essential water services. This financial strain jeopardizes their full and effective enjoyment of the human right to water. Additionally, these studies have explored various methodologies for measuring water affordability in developed countries, revealing significant differences in how affordability is defined and addressed (García-Valiñas et al., 2010; Martinez-Espiñeira and Pérez-Urdiales, 2024).

Despite these contributions, significant gaps remain in the literature, particularly concerning the specific legal protections and social support mechanisms needed to safeguard the human right to water in developed countries (Meehan et al., 2020). Much of the existing research tends to focus on economic aspects of water affordability, often overlooking the legal and institutional frameworks that underpin access to water (Leflaive and Hjort, 2020). There is a lack of comprehensive studies integrating both legal and socio-economic analyses to provide a holistic understanding of the issue. Consequently, this chapter seeks to fill this gap by providing an integrated analysis that considers both the legal protections and the socio-economic factors influencing water access in Spain. By addressing these gaps, the chapter contributes to a more nuanced understanding of the challenges and opportunities in achieving SDG 6.1 in developed countries, emphasizing the need for comprehensive legal reforms and targeted policy interventions to ensure equitable water access for all, regardless of socio-economic status.

Spain serves as a compelling case study for examining the human right to water in a developed country, due to its unique combination of geographical, socio-economic, and governance factors. The country's diverse climate, ranging from arid regions in the south to more temperate areas in the north, creates significant variability in water availability, making it a microcosm of broader global challenges related to water scarcity and distribution that affect awareness on water issues.[5] Regional disparities in water access

[5] Additionally, Spain also presents an interesting case for studying water affordability due to the diversity in water utility management across the country. Depending on the municipality's decision, water services may be managed by private entities, public authorities, or through public-private partnerships (PPP). This variety in management models provides a unique opportunity to analyze how different governance structures impact water affordability and access. Although this variable has not been addressed in the thesis

and affordability are exacerbated by Spain's decentralized governance structure, which gives significant autonomy to regional governments in managing water resources. This decentralization leads to inconsistencies in water pricing and the provision of social support mechanisms across regions, that can influence how population deal with water poverty (PWC, 2018). Moreover, the chosen case of study is specifically relevant because the 2007 economic crisis significantly increased poverty rates in Spain, resulting in many households struggling to pay for basic services, with some even facing water supply cutoffs (Guardiola and Guillen-Royo, 2015; Yoon et al., 2021). Despite relatively low water prices compared to other developed countries, ongoing political debates question whether access to water is adequately protected, especially for vulnerable populations (Defensor del pueblo andaluz, 2015; Lara-García and del Moral Ituarte, 2020). This research explores these issues by analyzing water affordability across Spain's largest population centers, focusing on cities with the highest concentrations of residents. It also assesses whether current legal and institutional frameworks are adequate to protect low-income families from losing access to essential water services.

The central research question guiding this chapter is: **How effective are Spain's legal and institutional frameworks in ensuring the human right to water, particularly in the context of SDG 6.1?** To address this question, the chapter covers four specific objectives research:

1. Analyze the current state of water access and affordability in Spain.
2. Assess the effectiveness of existing legal protections and institutional arrangements.
3. Explore the socio-economic impacts of water poverty on vulnerable populations.
4. Provide recommendations for policy reforms to ensure equitable access to water.

These four objectives are developed around the two key papers that comprise this chapter and collectively address the challenges related to SDG 6.1 in Spain. The first paper critically examines the legal and institutional frameworks governing water access, assessing their effectiveness in protecting the human right to water. This foundational analysis is crucial for understanding the structural and regulatory issues that influence equitable access to water. The second paper builds upon this foundation by exploring the

due to time constraints, it will be discussed in the conclusion section and is identified as a potential area for future research within the scope of this doctorate.

socio-economic dimensions of water affordability. Specifically, it evaluates how current policies impact low-income families, providing a more focused perspective on the practical consequences of the regulatory frameworks discussed in the first paper. Together, these papers offer a comprehensive view of the issue, addressing both the structural aspects and the lived realities of vulnerable populations.

Methodologically, the chapter employs a mixed-methods approach, combining legal analysis, policy review, and empirical data from various Spanish cities to examine the variability in water access and affordability. The legal analysis focuses on identifying gaps in protecting vulnerable populations, while the empirical data provide concrete evidence of how affordability issues and governance models impact water access, revealing important regional disparities. The policy review synthesizes these findings into actionable recommendations aimed at improving water affordability and strengthening legal protections. This integrated approach ensures a thorough exploration of both theoretical and practical challenges, leading to informed conclusions and solutions.

In providing a comprehensive analysis of Spain's progress towards achieving SDG 6.1, this chapter focuses on the challenges of ensuring equitable access to water for all, especially vulnerable populations. The findings are intended to inform policy debates and contribute to the development of more effective strategies for protecting the human right to water in Spain.

It is worth noting, however, that recent years have seen a significant expansion in the body of literature on water affordability in developed countries (Cardoso and Wichman, 2022; Skerker et al., 2024; Pérez-Foguet, 2023; Yoon et al., 2021). The papers included in this thesis, for example, precede the more extensive body of work that specifically addresses affordability issues in the United States, particularly in the context of disconnection debates and broader concerns about affordability (Swain et al., 2023; Gaber et al., 2021). Moreover, this thesis does not encompass the most recent discussions on the rise of water tariffs in Europe and other developed countries, which have been driven by increasing energy costs and other contributing factors (WAREG, 2023). Furthermore, these papers do not cover the relationship between water affordability, the impact of the coronavirus pandemic, and the associated health implications, as they were written prior to these developments (Zhan et al., 2022). Nevertheless, it is important to highlight that there is a separate publication, not included in the main compendium of articles, that specifically evaluates the impact of the coronavirus on SDG 6, with a particular emphasis

on hygiene and its interplay with water affordability (López-Ruiz, 2022). This additional work helps to address some of the emerging challenges related to water access in the context of the pandemic.

Ultimately, by addressing the intersection of affordability, governance, and human rights, this chapter contributes to the broader goals of sustainable water management. It emphasize the importance of strategies that are not only environmentally sustainable but also socially equitable. The integrated analysis offered here advances the discourse on sustainable water management by demonstrating that it must also ensure that all individuals, regardless of socio-economic status, have access to the vital resources they need for a dignified life.

Chapter 2.

HUMAN RIGHTS IN SPAIN: PROTECTION OF THE RIGHT TO WATER IN FAMILIES WITH AFFORDABILITY PROBLEMS. CRITICAL ANALYSIS FOR LEGAL REFORM[6]

Miguel Ángel García-Rubio
Samara López-Ruiz
Francisco González-Gómez

Abstract

Although the main problems of access to water occur in poor countries, these can also have some impact on developed countries. In this case, the problem has to do mainly with affordability, that is, with the ability of families to pay the water bill; and this is aggravated when, as a result of non-payment, supply cuts occur. This situation may arise if the regulatory and legal framework does not guarantee, or not sufficiently, the access of the most vulnerable and disadvantaged groups to a basic good such as drinking water. In this essay, based on a critical approach, the protection of the human right of access to water in Spain is analysed against situations of risk of poverty and social exclusion to propose a legal reform. Situations of social exclusion justify a differentiated treatment of the right to a basic good for life, apart from the whole social protection against poverty, given that this reality limits the opportunities for access to social protection mechanisms. A first conclusion is that in Spain there is insufficient legal regulation in relation to the protection of this right. A second conclusion is that normative decentralization leads to social action measures in the matter of water supply being very heterogeneous, so that there is an unequal protection of the human right to water according to the place of residence.

Keywords: Human rights · Public Administration· Legislation · Right to water · Affordability

[6] The original version of this article was published in Spanish. A translation is provided to offer a complete document in English. You can refer to the original article at: https://doi.org/10.17561/at.13.4381

INTRODUCTION

In 2002, the United Nations Committee on Economic, Social, and Cultural Rights issued a comprehensive statement defining the human right to safe drinking water. This right entails the continuous and adequate provision of water for personal and domestic use, ranging from 50 to 100 liters per person per day. The water must meet specific criteria: it should be safe, devoid of microorganisms and chemicals; acceptable, possessing appropriate organoleptic qualities of color, odor, and taste; physically accessible, situated within 1,000 meters of the home with a collection time not exceeding 30 minutes; and affordable, with costs not surpassing 3% of household income (UN, 2002).

However, it was not until 2010 that the United Nations General Assembly explicitly recognized the human right to water (UN, 2010a), establishing that access to sufficient and safe water is a precondition for the realization of all human rights. Nevertheless, according to WHO and UNICEF (2017), 884 million people lacked secure access to safe drinking water in 2015, although this figure may underestimate the reality of the water access problem (Guardiola et al., 2010; Martínez-Santos, 2017; Grigg, 2018). The primary issues of water access are prevalent in impoverished countries. Consequently, the majority of research on water access coverage and quality has focused on these nations (Smiley, 2017; Adams et al., 2018). However, issues of water access can also arise in developed countries. This is paradoxical when examining WHO and UNICEF statistics indicating that the coverage of urban potable water service is nearly universal in these countries (WHO & UNICEF, 2017). In this case, the problem is primarily related to affordability, i.e., the ability of families to cope with the water bill payment. Indeed, among the objectives of the sixth Sustainable Development Goal unveiled by the United Nations in 2015 is the achievement of "universal and equitable access to safe and affordable drinking water for all by 2030," without distinguishing between developing and developed countries.

Among the scarce studies on affordability not focused on impoverished nations is the work of Fankhauser and Tepic (2007), who concluded that affordability is a concern for low-income consumers in the Commonwealth of Independent States. Other researchers propose a methodology for measuring the affordability of water access in developed countries (García-Valiñas et al., 2010a, b), while others analyze factors that may diminish affordability based on a sample of Portuguese households (Martins et al., 2016). The

affordability issue in developed countries is exacerbated when water supply is cut off as a consequence of unpaid water bills. This situation can arise if the regulatory framework does not sufficiently guarantee access to potable water for the most vulnerable and disadvantaged groups. This problem is part of the current political debate in Spain, where the adequacy of existing legal and institutional mechanisms to ensure the human right to water in situations of poverty and social exclusion is being questioned.

Although the cost of water in Spain is relatively low compared to other developed countries (OECD, 2010; IWA, 2016; GWI, 2017), ideological left-wing parties, unions, consumer and user organizations, environmental groups, and various social platforms question whether the Spanish legal and institutional framework guarantees the human right to water as a basic service and vital resource. Specifically, concerns are raised about water supply cutoffs to low-income families in cases of non-payment, leading to situations of water poverty that impact the well-being of the population. The economic and financial crisis that began in 2007 has had a significant impact on Spain (Guardiola and Guillen-Royo, 2015), with job losses and the consequent reduction in income placing a considerable number of families at risk of poverty and social exclusion. In 2017, 26.6% of the resident population in Spain was at risk of poverty and/or social exclusion[7].

The debate on water poverty in Spain precisely motivates this essay, which relies on a critical analysis of the guarantee of the human right to water from a normative perspective. Does the Spanish legal and institutional framework ensure the human right to water in households at risk of poverty and social exclusion? Following this introduction, the paper is structured as follows. The second section provides a brief overview of the human right to water in international regulations – within the frameworks of the United Nations and the European Union – as well as at the national, regional, and local levels. The third section focuses on the local context, specifically examining social action measures related to water supply and exceptions to supply cutoffs due to non-

[7] A person at risk of poverty is defined as someone living in a household with an income lower than 60% of the median equivalent national income in consumption units. In 2017, 13.7% of the Spanish population fell into the category of individuals in poverty who did not experience severe material deprivation and did not live in households with low work intensity. The 4.7% were individuals in poverty living in households with low work intensity but without severe material deprivation. Additionally, 1.6% represented individuals in a state of severe poverty, experiencing material deprivation, but not residing in households with low work intensity. Lastly, the 1.7% comprised individuals in poverty experiencing severe material deprivation and living in households with low work intensity.
Social exclusion is a dynamic process of disadvantage or inequality influenced by various factors, not solely those related to economic deprivation, which limits access to protective mechanisms. In 2017, 5% of the Spanish population was in a situation of social exclusion, according to data from Llano Ortiz (2018).

payment. The fourth section introduces a discussion on the topic. Finally, the fifth section presents the main conclusions and recommendations.

THE HUMAN RIGHT TO WATER IN INTERNATIONAL AND NATIONAL REGULATION

United Nations

The human right to water is not explicitly recognized in any of the instruments that constitute the *International Bill of Human Rights*[8]. Awareness of the strategic value of water resources began with the United Nations Water Conference in 1977. Initial partial recognitions of the human right to water emerged in the *Convention on the Elimination of All Forms of Discrimination Against Women* (1979) and the *Convention on the Rights of the C*hild (1989). The *Dublin Declaration* (1992) established basic principles of water management, recognizing water as a finite resource essential for sustaining life with economic value.

Goal 7.C of the Millennium Development Goals (UN, 2000) aimed to halve, by 2015, the proportion of people without access to improved drinking water and basic sanitation services; this objective was not achieved in the most disadvantaged areas of the world, particularly in Sub-Saharan Africa.

The first relevant document shaping the human right to water *is General Comment No. 15 of the Committee on Economic, Social and Cultural Rights* (UN, 2000), which defined the human right to water as the right of everyone to have sufficient, safe, acceptable, accessible, and affordable water for personal and domestic use. States are obligated to facilitate, promote, and guarantee this right; furthermore, as part of the normative content of the right to water, it emphasized the right not to suffer arbitrary water supply cuts. Basic obligations were identified, including ensuring access to the essential minimum amount of water sufficient and suitable for personal and domestic use, and guaranteeing this right on a non-discriminatory basis, especially for vulnerable or marginalized groups. The *Optional Protocol to the International Covenant on Economic, Social and Cultural Rights* (UN, 2008), which came into

[8] The International Bill of Human Rights encompasses the Universal Declaration of Human Rights (1948), the International Covenant on Economic, Social, and Cultural Rights (1966), the International Covenant on Civil and Political Rights (1966), and its two Optional Protocols of 1966 and 1989.

force in 2013, allowed for formal complaints about violations of the human right to water as defined in General Comment No. 15.

The Guidelines for Achieving the Right to Drinking Water and Sanitation (UN, 2005), ratified by the Sub-Commission on the Promotion and Protection of Human Rights of the Economic and Social Council in 2005, outlined that nations should ensure that access to water supply services is not restricted in cases of non-payment until the financial capacity of the involved party has been thoroughly assessed. Additionally, it stated that no one should be deprived of the minimum essential amount of water. The Report A/HRC/6/3 from the Office of the High Commissioner for Human Rights (UN, 2007) determined the scope and content of human rights obligations related to equitable access to drinking water. In 2008, the Human Rights Council agreed to appoint an independent special rapporteur for the analysis of obligations and rights related to access to water. As a result, reports A/RC/18/33/Add.1 (UN, 2011a), focusing on best practices, and A/HRC/24/44 (UN, 2013a), regarding the sustainability of the exercise of the human right to water, were prepared. In 2014, this independent rapporteur presented the report A/69/213 (UN, 2014a) to the General Assembly, examining the right to participate in the exercise of the human right to water. These reports developed the normative content of the right based on General Comment No. 15 (UN, 2002) and have been a decisive push for its practical realization.

In 2010, through Resolution A/RES/64/292 of the United Nations General Assembly (UN, 2010a), the human right to water was explicitly recognized as an autonomous and essential human right for the full enjoyment of life and all human rights. The principles contained in this resolution were reaffirmed and expanded by the United Nations General Assembly through resolutions A/RES/68/157 (UN, 2013a) and A/RES/69/215 (UN, 2014b). The Human Rights Council, tasked with scrutinizing the human rights landscape to identify potential infringements and provide recommendations, has issued several resolutions pertaining to the human right to water:

- A/HCR/RES/15/9 (UN, 2010b), which called on states to give special consideration to individuals from vulnerable and marginalized groups, emphasizing the principles of non-discrimination and gender equality;

- A/HRC/RES/18/1 (UN, 2011b), which encouraged states to evaluate the alignment of existing legislative and policy frameworks with the right to drinking water and sanitation;
- A/HRC/RES/27/7 (UN, 2014c), which urged states to ensure that, in the face of violations of the human right to drinking water and sanitation, all legal, quasi-legal, and other appropriate remedies are accessible to all without discrimination.

Lastly, Goal 6 of the current global development agenda, known as the Sustainable Development Goals, aims to ensure the availability and sustainable management of water and sanitation for all by 2030.

European Union

The 1968 European Water Charter constitutes a concise declaration of principles regarding the proper management of water. It recognized water as a common, vital, finite, and vulnerable resource. In 2001, it was replaced by the European Charter of Water Resources (ECWR, 2001), which acknowledged the right of all individuals to have access to a sufficient quantity of water to meet their essential needs.

On the other hand, the reference document for water resource management in Europe, the Water Framework Directive (WFD, 2000), considered water not as a commodity but as a heritage that needs protection. Among the fundamental principles of this Directive is the cost recovery principle, aimed at ensuring efficiency in the use of water resources. However, it was in 2003 when the European Commission made a declaration (European Commission, 2003), in line with General Comment No. 15 of the UN Committee on Economic, Social, and Cultural Rights, recognizing that access to sufficient and quality drinking water is a human right.

In 2009, on the occasion of the V World Water Forum in Istanbul, the European Parliament adopted a resolution (European Parliament, 2009) declaring water as a common good of humanity. It emphasized that access to drinking water should be a fundamental and universal right and expressed the desire for a compensation mechanism in water tariffs to supply water to the most disadvantaged population at an affordable price.

In 2015, the European Parliament endorsed the "Right2Water"[9] citizens' initiative, which aimed to guarantee the right to water for all people and the incorporation of the human right to water into the legislation of member states (European Parliament, 2015). The Parliament criticized Communication COM (2014)0177 (European Commission, 2014) for not addressing the specific demands expressed in the citizens' initiative and only reiterating existing commitments. It also expressed concern about the increasing number of people facing difficulties in paying water bills since 2008, due to excessively austere policies that have increased poverty in Europe and the number of low-income households. The Parliament rejected water cutoffs and forced suspension of water supply, highlighting the growing concern about affordability.

In February 2018, the European Commission approved a proposal to revise the Drinking Water Directive (European Commission, 2018). The proposal included the obligation for member states to improve and ensure access to water, especially for vulnerable and marginalized groups

National and Regional Legislation

While the Spanish government has committed to the Human Rights Declarations, there is no national law explicitly guaranteeing the human right to water. The Spanish Constitution does not explicitly recognize this right, and it must be considered implicitly included within the rights to life (Art. 15), health (Art. 43), the environment (Art. 45), and adequate housing (Art. 47). Likewise, the Royal Legislative Decree 1/2001, of July 20, approving the consolidated text of the Water Law (Government of Spain, 2001), also does not explicitly guarantee the human right to water. It states that water supply for the population is the use that enjoys absolute preference (Art. 60), and while it refers to the establishment of tariff structures to meet basic needs at an affordable price (Art. 111bis), it does not specify what constitutes an affordable tariff or introduce a minimum vital supply in case of non-payment due to socio-economic circumstances.

At the regional level, two autonomous communities (Aragon and Valencia) have recognized in their Statutes of Autonomy the right to have sufficient access to quality

[9] The "Right2Water" initiative, registered in 2012 by the European Federation of Public Service Unions, aimed primarily at urging both European Union institutions and Member States to ensure that all citizens can exercise their right to water and sanitation. It advocated for water supply and water resource management not to be governed by internal market rules and called for the exclusion of water services from the scope of liberalization. Furthermore, it called on the EU to intensify its efforts towards achieving universal access to water and sanitation.

water. However, according to a Constitutional Court ruling (STC, 247/2007), the Statutes of Autonomy cannot autonomously establish subjective rights in a strict sense. Regarding water laws enacted by the autonomous communities[10], seven of them do not have a water law (Balearic Islands, Castile and León, Extremadura, Region of Murcia, Navarre, La Rioja, and Valencia). Another four autonomous communities, even with a water law, do not explicitly outline user rights concerning domestic water supply (Principality of Asturias, Canary Islands, Catalonia, and Madrid). And five autonomous communities include some user rights in their water laws concerning domestic water supply, generally the right to receive the service under conditions of quantity and quality, but without guaranteeing supply in case of non-payment due to socio-economic circumstances (Andalusia, Aragon[11], Castilla-La Mancha, Galicia, and the Basque Country).

Therefore, only in Law 2/2014, of November 26, on Water Supply and Sanitation in the Autonomous Community of Cantabria, is a minimum vital supply guaranteed in case of non-payment of the bill for vulnerable groups at risk of poverty (Government of Cantabria, 2014). In these cases, it is stipulated that recipients of the basic social income will be guaranteed a minimum availability of 100 liters of water supply per inhabitant per day. In Catalonia, while its water law may not explicitly delineate user rights in the context of domestic water supply, there exists a legal framework. Law 24/2015, enacted on July 29, addressing urgent measures to combat emergencies in the housing and energy poverty sector (Generalitat de Catalunya, 2015), articulates a protocol. This protocol acts as a safeguard, precluding the termination of essential drinking water supply services in instances of non-payment attributed to the economic constraints faced by affected families.

Therefore, no regional law (except for Cantabria and Catalonia) expressly prohibits water cutoffs due to non-payment because of an inability to meet the bill, but they also do not explicitly state the possibility of cutting off the supply due to non-payment. In contrast, Andalusia is the only autonomous community where a regional regulation, Decree 120/1991, of June 11, approving the Regulation of Home Water Supply,

[10] The regional water laws can be consulted at the following address: https://www.boe.es/legislacion/codigos/codigo.php?id=139&modo=1&nota=0&tab=2.

[11] The Law 10/2014, of November 27, on Waters and Rivers of Aragon explicitly refers to the United Nations human right to water (Art. 9), but it only formulates it as the "[...] preferential right to have access to a public water supply service under conditions of sufficient quantity and quality to meet their vital needs [...]" (Government of Aragon, 2014).

considers the non-payment of bills within the established period by the supplying entity as a cause for suspending water supply (Government of Andalusia, 1991), without taking into account the socio-economic situation of the user.[12]

Local Regulation

In accordance with the Law 7/1985, of April 2, regulating the Bases of Local Government (Government of Spain, 1985), the domestic supply of drinking water is an essential service (art. 86.3) that municipalities must provide obligatorily (art. 26.1). Thus, in the Spanish legal system, municipalities are responsible for providing water services within their municipal boundaries. Local governments have the authority to approve regulations or ordinances regulating the supply of domestic drinking water (art. 84), specifying the supply conditions, user rights and duties, service interruptions, complaints, or the sanction regime, among other matters.

As a result, with more than 8,000 municipalities and the absence of a general law – except for Cantabria and Catalonia – guaranteeing the protection of the human right to water in situations of poverty and social exclusion, the prevailing feature is the dispersion and fragmentation of regulations in this matter. This is reflected in a significant variability in the implementation and design of social action measures related to water depending on the municipality. On the other hand, what local governments ensure is that the public water supply network reaches all households and the possibility of contracting a connection to the network. However, municipalities with regulations or ordinances regulating the supply of domestic drinking water that guarantee supply in case of non-payment in situations of poverty and social exclusion are exceptional.

Furthermore, according to the Royal Legislative Decree 2/2004, of March 5, approving the revised text of the Law Regulating Local Finances (Government of Spain, 2004), municipalities also have the authority to approve fiscal ordinances establishing the fee for the provision of services related to water supply. This leads to significant differences in fees between municipalities (FACUA 2017), causing affordability to vary depending on the place of residence. This variability in fees may be acceptable when it is due to differences in the costs of providing the service not controlled by the water supply

[12] At the time of writing these lines, the Andalusian Regional Government is working on the development of a Regulation for the Comprehensive Urban Water Cycle, which would repeal Decree 120/1991. This new regulation is expected to include a guaranteed minimum vital supply in case of non-payment due to a lack of economic resources.

manager (topographic conditions, source of the resource, population size, urban planning model, etc.) (González-Gómez et al., 2015). However, a different consideration is warranted when these differences are due to the political ideology of the local government (González-Gómez et al., 2012) or the form of ownership in management (Martínez-Espiñeira et al., 2009; 2013) – public or private. In these cases, it can be rightfully argued that there is a discriminatory element based on residence.

However, the most serious affordability issue affects households with lower incomes. According to the Living Conditions Survey (INE, 2018a), the at-risk-of-poverty and social exclusion rate (AROPE) is 26.6%, and 7.4% of households struggle to cover payments related to their main residence, such as electricity or water bills. Faced with this situation, some social organizations propose that the economic consideration for the domestic water service be graduated according to the economic situation of the service users, using the cadastral value of the property for this purpose[13]. However, the water bill is not a suitable instrument for income redistribution due to its low relative weight for an average Spanish family (0.89% of the family budget), and the cadastral value is not an appropriate proxy for the level of family income (AEAS, 2018).

MUNICIPAL SOCIAL ACTION MEASURES REGARDING WATER SUPPLY

Since the early years of this century, and particularly after the economic crisis that began in 2007, many municipalities and service providers have implemented processes or tools through which more favorable economic benefits are offered to specific groups (large families, retirees, pensioners, disabled individuals, etc.) to facilitate access to the service in situations of inequality, poverty, or social exclusion. According to AEAS (Spanish Association of Water Supply and Sanitation), 94% of the population resides in municipalities where water service providers have some form of social action measure in water supply matters (AEAS, 2018), and 1.2% of users would benefit from one of these assistance measures (AEAS, 2016a). These measures can be grouped into tariff bonuses and discounts, social or solidarity funds, and exceptions to the suspension of supply due to non-payment.

Traditional social action measures: Tariff bonuses and discounts

[13] Some municipalities (e.g., Bilbao) set the fee for the sewerage service based on the taxable amount of the Property Tax register.

Bonuses and discounts are established in the tariff structure or regulatory regulations, and they are the most widely spread mechanisms of social action – 87% of the population resides in municipalities with these types of bonuses (AEAS, 2014) – especially in large and medium-sized municipalities. In those municipalities – generally small ones – where the service is managed by the city council itself, without a specialized management body, bonuses and discounts are much less frequent.

These measures have been in place for years, targeting vulnerable groups (large families, retirees, pensioners, disabled, etc.). But more recently, as a result of the economic crisis, specific bonuses and discounts have emerged with the aim of improving affordability for groups with low income levels (mainly the unemployed).

The access criteria, amount, and method of applying discounts and bonuses for income reasons are established according to each municipality's criteria, resulting in a highly heterogeneous design across the entire national territory. However, some common patterns can be pointed out.

Regarding access to these measures, the most required and common criterion is that all members of the household, not just the contract holder, must prove the situation that entitles them to the discount – generally, being unemployed. More exceptionally, families with only one unemployed member are also included as recipients of the assistance. In both cases, the household must not exceed a certain income level[14]. In addition, contract holders cannot owe payment for past bills, and bonuses are only granted for consumption in the primary residence. In no case are these measures granted for an indefinite period; their concession is generally limited to one year, although there is the possibility of renewal if the situation that prompted the bonus persists. On the other hand, regarding the method of application, bonuses and discounts for income reasons are applied to the variable part of the bill only for the first consumption tiers; that is, those that include essential uses for maintaining life. In some municipalities, some type of discount, total or partial, is also applied to the fixed part of the tariff.

Alternative social action measures: Social funds

The social funds—economic allocations that urban water service management entities allocate to fully or partially subsidize bills for groups at risk of exclusion—are not

[14] The most commonly used references to set the income threshold are the IPREM (Public Indicator of Multiple Effects Income) and the SMI (Minimum Interprofessional Salary).

associated with the tariff structure. They are alternative social action measures that respond to income criteria. They are less widespread than discounts and reductions: only 37% of the population resides in municipalities with social funds. Their implementation, which is related to the economic crisis that began in 2007, can, in some cases, complement social measures set in the tariff structure for 24% of the population or operate independently for the remaining 13% (AEAS, 2014). These measures aim to address specific situations of social emergency where insufficient family income prevents payment for the service. The processing and assessment of submitted applications fall under the jurisdiction of municipal social services.

Social funds can be funded from various budgetary sources; they may come from public resources (Cádiz, Huelva, Tarragona), or the service manager may fund the pool from tariff income from other users (Palma de Mallorca), making them also known as solidarity funds. In this case as well, the competence dispersion results in significant variability in the types of aid between municipalities. While it is most common for aid to consist of bill payments for a period, in other cases, a minimum flat rate per bill (Murcia) or even progressive assistance plans are adopted, so the amount of aid depends on the degree of risk of poverty and social exclusion of the family unit (Alicante, Zaragoza). There are also cases where aid consists of installment or deferral systems without surcharge, or addressing overdue debts as a grant or through interest-free financial assistance (Málaga). In any case, these aids have limited scope, so beneficiary families cannot indefinitely rely on these social protection measures.

Municipal exceptions to supply disconnection due to non-payment

The municipal regulations or ordinances governing the supply of drinking water to homes consider it the subscriber's obligation to pay the invoices issued in return for the service, and non-payment of these is grounds for suspending the supply. Furthermore, if, after a certain period from the service cutoff date, the outstanding bills are not settled, the supply contract is considered terminated. In these circumstances, the reformation of a new contract requires the user to once again pay the connection fees. However, some local governments have established exceptions to service disconnection due to non-payment in situations of poverty and social exclusion risk (Córdoba, Gijón, Puerto Real). For instance, the city council of Puerto Real approved the following proposal in its session on October 1, 2015:

> *"Implement provisional measures for an immediate cessation of electricity and water disconnections for families that can demonstrate their unemployment or social exclusion status, with the aim of preventing any cutoff of these services in our municipality."*

In other cases, agreements have been established that suspend the disconnection actions when municipal social services identify a situation of economic vulnerability. An example is the Protocol regulating measures against water poverty and economic vulnerability maintained by the Vega-Sierra Elvira Consortium and the Aguasvira company since 2016. Finally, a relatively common accompanying measure in cases where a social fund exists is the prohibition of water supply disconnection, not only when one is a beneficiary of the aid but from the moment the application is submitted until the social services resolve the case (Bilbao, Granada, Lleida, Palma de Mallorca).

DISCUSSION

The definition of water poverty through macro-indicators, such as the percentage of the population with access to water or the relationship between the minimum vital bill and the average income of family units, allows us to conclude a priori that the human right to water is guaranteed in developed countries. Thus, considering data such as the universalization of service coverage or that the water bill does not represent more than 3% of the family budget (UNDP, 2006) – 5% including sanitation – for a family with an average income in Spain, access to water would be guaranteed. However, although the price of water in Spain is low compared to developed countries (OECD, 2010; IWA, 2016; GWI, 2017), in the presence of a high unemployment rate – with a significant structural component – aggregate information conceals an affordability problem. Therefore, in these circumstances, it is evident that those Spanish families with incomes much lower than the average income do not have guaranteed access to water from their own resources.

While the human right to water is not protected in Spain through a national law, and only Cantabria and Catalonia among the autonomous communities guarantee its protection in situations of poverty and social exclusion, it is crucial to assess whether municipal-level

measures are effectively safeguarding the human right to water in households with lower incomes across the rest of Spain.

The tariff for water supply services, the system of bonuses and discounts in the tariff, social funds, or exemptions from supply cuts due to non-payment experience significant variability in Spain. Thus, access to water in Spain differs substantially between regions, cities, and types of users (García-Valiñas et al., 2010a). Competence dispersion is, at least, responsible for the lack of equity in access to water in Spain, and factors such as the ideology of the local government or the form of ownership in the management of urban water services could be determining factors in guaranteeing the human right to water for families at risk of poverty and social exclusion.

In the absence of official statistics, it is not possible to precisely determine the extent of the problem. According to the Spanish Association of Public Water Supply and Sanitation Operators (AEOPAS), there are over 500,000 service cutoff notices in Spain annually, with approximately 60% of them being executed, totaling around 300,000[15]. Meanwhile, AEAS (2016b) estimates that cutoffs affect 1.82% of residential users[16]. In Andalusia, the highest supply cost figures occur in provincial capitals and large population centers, with lower incidence in small municipalities (DPA, 2015). Therefore, it is an undeniable reality that service cutoffs exist in Spain, but it is not possible to precisely determine how many of them may be related to the inability of families at risk of poverty and social exclusion to meet the economic obligation for urban water services[17].

AEAS estimates that 0.02% of residential users whose water supply service is interrupted due to non-payment are reconnected after benefiting from municipal social action mechanisms. Implicitly, it is recognized that approximately 3,700 service cutoffs due to non-payment occur annually in families at risk of poverty and social exclusion in Spain. While this number of cutoffs may not seem significant in relation to the total number of

[15] The same association proposes the prohibition of supply disconnections and the establishment of a minimum of between 60 and 100 liters per person per day in the case of justified non-payment (Babiano & Giménez, 2015)

[16] The percentage estimated by AEAS leads to a number of supply disconnections similar to the estimate by AEOPAS; however, the manner in which these results are presented either downplays or exacerbates the issue of water disconnections in Spain. This may serve as a clear example of the differing stances of public (AEOPAS) and private (AEAS) water operators.

[17] According to AEAS, most interruptions of water services in the residential environment are due to dwelling abandonments resulting from non-renewal of lease contracts, changes in contract ownership or unreported changes in the bank account to the service provider, second homes or vacant residences, and instances of fraud (AEAS, 2016a).

households in Spain, it is concerning as it conceals genuine family crises, and it cannot be claimed that the human right to water is effectively protected in Spain (AEAS 2016b).

These situations reveal that some families, despite lacking sufficient economic resources, have not been able to utilize available public resources to address such circumstances. Alternatively, when these social mechanisms are activated, it may be too late to prevent the service cutoff. However, there are also circumstances where, even with sufficient economic resources, the service cutoff occurs due to the user's lack of awareness of their own default status, having not received timely notice of the impending service cutoff (DPA, 2015). Moreover, service cutoffs may impact vulnerable individuals—such as the sick, disabled, or elderly in vulnerable situations—who, regardless of economic resources, may lack the capacity to resolve a water service-related issue. This includes cases where 48% of complaints are related to possible billing errors, and 12% are attributed to meter reading services (AEAS, 2018). Such situations should not be grounds for service interruption. All these scenarios arise from a lax and/or insufficiently protective application of procedural steps preceding service suspension.

On the other hand, AEAS (2016a) argues that "*the service cutoff procedure is a tool to ensure payment from those citizens who can afford it."* However, even though municipal ordinances regulating urban water services in Spain generally contemplate the possibility of service cutoffs for non-payment, this measure is of questionable legality. The consistent doctrine of the Supreme Court (STS, 2012; 2014; 2015) establishes that the fees paid by the user of the potable water supply and sewerage service should be considered a fee, regardless of the municipality's chosen method of service provision (direct or indirect management). This implies that the non-payment of the fee can only be demanded through the enforcement procedure. This procedure, which includes certain guarantees and limitations based on the debtor's economic capacity, does not allow for the pressure represented by the threat of service cutoff.[18].

In practice, the risk of water cutoff increases when the consideration is viewed as a private price. This occurs when municipalities outsource water management, either to a private company through concession, a mixed company, or a public company. In recent years, there have been citizen initiatives against private ownership in the management of urban

[18] The establishment of this administrative procedure could involve the forced execution of the debtor's assets (seizure). However, service cutoff would not occur even if the user had sufficient financial resources, thus configuring it as a more protective instrument for the human right to water.

water services. In the Spanish context, the Social Pact for Water[19] initiative stands out. Various NGOs, social movements, unions, foundations, political parties, and related entities have expressed their commitment to public, integrated, and participatory management of the urban water cycle in Spain. Among their arguments, they maintain that as the United Nations recognizes access to water as a human right, water management should be independent of market rules and private enterprise to ensure comprehensive management of the water resource that is socially equitable, ecologically sustainable, politically democratic, and culturally acceptable. They also call for tariff policies based on social equity, which would mean, according to the Social Pact for Water, guaranteeing a minimum vital supply of between 60-100 liters per person per day, complemented by the commitment not to cut off the supply in cases of justified non-payment (Babiano and Giménez, 2015).

Finally, the safeguarding of the human right to water in Spain stands at a crossroads in the forthcoming decades, marked by both the prevailing infrastructure deficit, posing implications for affordability, and the challenges emanating from climate change (Cabrera-Marcet, 2015), which could jeopardize physical access to the water resource. A substantial surge in investments is imperative for the renewal of supply and sanitation networks in the foreseeable future. However, this surge, along with indispensable financial commitments for wastewater treatment (with Spain persistently breaching Directive 271/91 concerning urban wastewater treatment in smaller municipalities) and the imminent allocations for water treatment for consumption (in response to the ongoing amendments to Directive 98/83/EC pertaining to the quality of water for human consumption), will invariably translate into escalated costs. Should these augmented costs be indiscriminately reflected in water bills, the repercussions on affordability will be adverse. Until a robust assurance of the human right to water materializes, this scenario will disproportionately impact the most marginalized segments of society.

CONCLUSIONS AND RECOMMENDATIONS

Social rights constitute the core of citizenship, and the concept of citizenship implies belonging to a political community that ensures these rights (Zurbriggen, 2014). Therefore, the acknowledgment of the human right to water necessitates the existence of

[19] The Social Pact for Public Water can be consulted at the following link: https://fnca.eu/images/documentos/DOCUMENTOS/pacto_agua_p%C3%BAblica.pdf.

a norm that allows the right holder the effective possibility to appeal to courts or administrative bodies to enforce this obligation. However, even though the Spanish government has pledged its commitment to Human Rights Declarations, there is no national law guaranteeing the human right to water. The only autonomous communities ensuring its protection in situations of poverty and social exclusion are Cantabria and Catalonia. Thus, at the municipal level, where the human right to water is generally not explicitly guaranteed by law, social action measures related to water supply and exceptions to the suspension of supply due to non-payment are established. This distribution of powers results in varying levels of protection of the human right to water based on the place of residence.

To eliminate any potential for discrimination, safeguarding the human right to water should be established through a nationwide law outlining the essential obligations tied to the right. These obligations should include, at a minimum, the prohibition of water service disconnections in situations of poverty and social exclusion, coupled with the universal assurance of a minimum vital water consumption during such circumstances. Meanwhile, autonomous communities should specify certain aspects of the human right to water, such as the definition of minimum vital consumption[20].

On the other hand, and despite the fact that the water bill represents 0.89% of the average family budget, it is undeniable that water supply disconnections due to non-payment occur in Spain in situations of poverty and social exclusion where the economic compensation for water consumption constitutes an excessive burden. In the absence of official data, it is not possible to precisely ascertain the scale of the problem, and this results in a highly ideologically mediated debate. It is recommended that different levels of administration coordinate to have a reliable information registry on water supply disconnections for residential purposes, specifying the reason for the service interruption. Considering it is a vital resource subject to intervention, it is difficult to justify that the only available information on the discussed matter comes from associations with clear interests in either direction, publishing occasional reports. Until regulatory bodies provide information, a biased and partisan use of the discussed issue will prevail.

[20] This implies that billing should necessarily be based on the number of residents in the dwelling, a practice that only occurs sporadically in some cities (Málaga, Sevilla).

In any case, in the face of the threat of supply disconnection due to non-payment, there should be regulations specifying scenarios in which the suspension of service is prohibited: residence in a home with minors, adolescents, the elderly, and disabled individuals. Additionally, there must be prerequisites and procedural requirements in all cases before interrupting the service. Notification procedures should be under the jurisdiction of municipal authorities, who are responsible for service provision – this would allow the activation of corresponding protocols of municipal social services even if there is no prior request from the debtor user. The competent Department of the corresponding autonomous community should expressly authorize such supply cuts. Procedural requirements should include prohibiting supply cuts from the moment the user requests assistance from the relevant municipal social services until the resolution of the case, as well as preventing such interruptions on holidays or requiring a minimum debt amount to initiate the procedure. Finally, there should be punitive mechanisms for management companies that fail to comply with established procedures.

However, the use of the threat of supply disconnection in case of non-payment, which the private sector considers a simple tool to ensure payment from citizens who can afford it, lacks adequate respect for the human right to water. Therefore, considering that this measure is also of dubious legality, actions against the debtor should only proceed through the enforcement procedure in the event of non-payment, unequivocally prohibiting supply cuts in all cases. This approach would provide special protection for especially vulnerable users, ensuring that supply cuts do not occur in these circumstances.

Lastly, the long-term assurance of universal compliance with the human right to water in Spain requires the implementation of public policies and government programs aimed at addressing the challenges of climate change and maintaining the urban water service infrastructure in good condition. Special attention should be given to small and medium-sized municipalities. Accessibility to the water resource under suitable conditions of quantity and quality should not depend on the financial capacity of the municipality or the socioeconomic conditions of the resident population. Even though the cost recovery principle is an appropriate instrument to ensure efficiency, it must be subordinate to the effective recognition of the human right to water.

Chapter 3.

IS THE HUMAN RIGHT TO WATER SUFFICIENTLY PROTECTED IN SPAIN? AFFORDABILITY AND GOVERNANCE CONCERNS

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Abstract

Most research on water poverty focuses on developing countries. However, research is also needed in developed countries, where water may be too expensive for some households. This paper examines the case of Spain, using data from 16 cities that combined are home to 35% of the Spanish population. We study both national and local systems of regulation and governance. The objective is to determine whether low-income families face a genuine threat of exclusion from water supply. To this end, we analysed whether the Spanish legal framework allows that water supply is cut off for non-payment of the bill. We also did different estimates of the percentage of the family income spent on the water bill, which in some cases can surpass 10%. The estimates account for tariff discounts, as well as assistance programmes available to those who are struggling to pay their water bill. Although there is no problem of affordability for an average Spanish family in general, we conclude that families at risk of poverty face a real threat of exclusion from water services because they are not able to pay for them and the institutional framework does not sufficiently protect them.

Keywords: Affordability · Water tariffs · Access to water supply · Water poverty · Human right to water· Spain

INTRODUCTION

The United Nations recognizes access to water as a human right. This implies access to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use (United Nations, 2010). Roughly 3 out of every 10 people in the world, that is, 2.1 billion people, do not have access to clean water (World Health Organization & UNICEF, 2017), although this figure may underestimate the real situation (Guardiola et al., 2010; Grigg, 2018; Martínez-Santos, 2017). The main problems of access to water occur in developing countries (Biswas and Tortajada, 2018). Consequently, most of the research on access to water in terms of coverage and quality has focused on developing countries (for example, Smiley, 2017a, 2017b; Adams et al., 2018).

Nevertheless, problems of access to water can also occur in developed countries (González-Gómez et al., 2020). One might not think so when looking at the statistics provided by World Health Organization & UNICEF (2017), which show that drinking water supply reaches practically every household. However, in these countries, the problem refers to low-income families who cannot afford to pay their water bills becoming water poor. The sparse research on water poverty in developed countries includes United States (Mack and Wrase, 2017; Teodoro, 2019), England and Wales (Bradshaw and Huby, 2013; Zetland, 2016), Belgium (Vanhille et al., 2018), Portugal (Martins et al., 2016, 2019), Spain (García-Valiñas et al., 2010a; Yoon et al., 2019) and some of the Commonwealth of Independent States (Fankhauser and Tepic, 2007). Lack of information and statistics make water poverty in developed countries an "invisible" problem (Jones and Moulton, 2016) and thus very difficult to solve (Josset et al., 2019).

The problem is exacerbated when families are excluded from the service for not paying their water bill. This can happen in countries where the regulatory framework does not protect vulnerable populations' access to drinking water.[21] Spain is one of the developed countries in which the institutional protection of the human right to water is an issue of concern. The 2007 economic crisis in the country has had a major impact on all sectors of society; in fact, its effects are still being felt (Guardiola and Guillen-Royo, 2015). Job

[21] Some developed countries such as France, Great Britain, Belgium, the Netherlands, and Ireland prohibit cutting off the water supply services as a result of no payment.

losses and the consequent loss of income have pushed many families into poverty and social exclusion. In 2017, the AROPE (At Risk of Poverty or social Exclusion) rate stood at 26.6% (INE, 2018a). In this context, around 1.6% of Spanish households cannot afford paying basic services such as water supply, and 7.5% have serious problems paying both the electricity and water supply bills (INE, 2018a; FOESSA, 2019). Information by non-public institutions on percentage of families affected by water supply cut offs is consistent with those of the National Institute of Statistics (INE). According to the Spanish Association of Water Supply and Sanitation (AEAS), water supply cut offs affect 1.82% of households in the country (Asociación Española de Abastecimientos de Agua y Saneamiento (AEAS), 2016a). The Spanish Association of Public Supply and Sanitation Operators (AEOPAS) estimates that there are more than 500,000 non-payment warnings per year that are sent to some 2.75% of families all over the country. Of these, approximately 60% or 300,000 are actually implemented (Babiano and Giménez, 2015).[22]

This issue forms part of the current Spanish political debate. Although the price of water in Spain is relatively low for a developed country (OECD, 2010; IWA, 2016; Global Water Intelligence, 2017)[23], left-wing parties and some community organizations question whether the human right of access to water—an essential good, fundamental for life—is guaranteed in Spain (García-Rubio et al., 2019). In particular, there have been reports of low-income families having their water supply cut off for not paying the bill, which in turn has affected their well-being. Left-wing political parties, with some public support, also call for private companies to be excluded from managing water services; one of their arguments for doing so is that public service is the best way to guarantee access to water supply. This is further explained in the section on water utility ownership.

Motivated by the growing debate, this research studies access to water services from the perspective of water poverty or lack of affordability. We ask whether the combination of the legal and institutional frameworks and pricing policies can lead to families within the poverty line or at risk of poverty being denied access to water for domestic consumption. The study is carried out on a sample of large Spanish cities. The empirical strategy

[22] It would not be correct to assume that suspension of water supply services is always because people cannot afford to pay the water bill. There can be other reasons. A main limitation to study this topic is that there are no official data on the number of families whose water supply is cut off and the reasons for it.

[23] According to the European Federation of National Associations of Water Services (EurEau, 2017), average water supply bills in Spain are for approximately 220 Euros annually, while in 22 other countries in the European Union, water supply bills are for approximately 380 Euros per year.

consists of estimating the percentage of the family budget spent on the water bill, on average, and under different assumptions. The analysis takes into account discounts on the water tariff and assistance programmes for low-income families. The hypothesis to be tested is that, although the water bill represents a small percentage of the average family's budget, families at risk of poverty who are unable to pay the water bill, face a real threat of having their water supply cut off.

Following this introduction, the paper is structured as follows. Section 2 presents a brief review of the legal and institutional frameworks related to access to water and water pricing, as determinants of affordability. Section 3 explains the methodology used in this research. Section 4 discusses the results. The last two sections present discussions, recommendations and policy implications, and, conclusions.

LEGAL AND INSTITUTIONAL FRAMEWORK IN SPAIN

This section briefly describes the legal and institutional frameworks related to the provision of domestic water services. It provides an idea of how responsibility the provision and regulation of the service is apportioned, especially in regard to pricing and on the possibility of exclusion from the service for non-payment.

Do Spanish regulations allow water supply to be cut off for non-payment of the bill?

Although the Spanish government has signed the Declarations of Human Rights, there is no national regulation in Spain regarding the human right of access to water (García-Rubio et al., 2019). Neither the Spanish Constitution nor Legislative Royal Decree January 2001 adopting the revised text of the Water Law (Government of Spain, 2001), supports the right of access to a minimum, essential amount of water.

At the regional level, 10 of the 17 autonomous communities have passed water laws,[24] only one of which—Law 2/2014 on Water Supply and Sanitation of the Autonomous Community of Cantabria—guarantees access to water supply in case of non-payment of the bill (Government of Cantabria, 2014). In such cases, it is stipulated that recipients of basic social income[25] have a guaranteed minimum water supply of 100 litres per person

[24] The regional water laws in Spain can be seen on the website of the Spanish Official Bulletin, https://www.boe.es/legislacion/codigos/codigo.php?id=139&modo=1&nota=0&tab=2.

[25] The Cantabrian Institute of Social Services defines "basic social income" as an economic benefit that is obtained regularly by persons with no economic resources. It represents the right they have for social

per day. In contrast, in Andalusia, Decree 120/1991 approving the Regulation of Domestic Water Supply, states that failure to pay water bills within the period stipulated by the provider can be cause for disconnecting the water supply (Government of Andalusia, 1991). The other regional laws neither guarantee a minimum access to water supply for families with limited financial means, nor do they explicitly allow cutting off the supply in such cases.

Given the legal vacuum at the national and regional levels—with the exception of Cantabria—local governments normally assume responsibility for regulating access to water supply. In this regard, it is common to have local-level regulations for the provision of water supply services. These local regulations usually include an article explicitly allowing cutting off the water supply in the event of non-payment of the bill.

Water utility ownership

Under Local Government Regulatory Law 7/1985, municipalities are responsible for the provision of water supply services. However, the responsibility for providing the service to the population does not necessarily imply that the municipality itself must manage the service (Government of Spain, 1985). In accordance with Law July 1985 and Law September 2017 on Public Sector Contracts, water supply services may be outsourced. Local government can decide whether the service should be under the city council or managed by a public company, a private company or a mixed public-private company.

At present, urban water supply services are provided by a private company in 23% of Spanish municipalities, whether through an entirely private company or through a public-private partnership. However, in terms of the population served, private companies represent a 55% share of the industry (González-Gómez et al., 2014). The bigger the municipality, the more likely it is that the water services will be managed by a private company (González-Gómez et al., 2011).

There is currently a debate on the ownership of the management of water services in Spain. This includes left-wing political parties, principally Podemos and Izquierda Unida; interest groups, such as the Spanish Association of Public Operators of Water Supply and Sanitation (AEOPAS); and non-governmental organizations, such as the New Water

protection. The objective is that those who suffer social exclusion, or are at the risk of suffering it, can cover their basic needs.

Culture Foundation, have recently been calling for the remunicipalization of water services that are currently under private management in many Spanish cities (Ruiz-Villaverde et al., 2015). These groups argue that public management is more likely to protect society's interests, among them the human right of access to water supply (Babiano and Giménez, 2015). Private companies, it is presumed, are more likely to set high prices, and to cut off supply in case of non-payment.

In the programme presented by Podemos for the April and November 2019 general elections, the Party discussed that public sector should become responsible, with as much transparency as possible, for all activities related to water management within one term of election. This would mean reversing and stopping private sector involvement on water supply, irrigation, sanitation and wastewater treatment (Podemos, 2019). In the case of AEPAS, the Association provides legal advice to the city governments that are planning to remunicipalize water management-related activities (Ávila et al., 2019).

Setting water tariffs

In the context described above, it is important to clarify which entities are responsible for approving water tariffs. The remit for water pricing for residential uses is decentralized, and there is no national regulation that establishes specific criteria for tariff systems in each municipality (González-Gómez et al., 2012, 2014). Moreover, there is no nationwide regulatory body or monitoring agency. Therefore, water pricing decisions are mainly made at the local level.[26]

The tariff approval procedure begins with a tariff review proposal prepared by the municipal water utility, whether public or private. Any proposal must be justified by an increase in the costs of the service, the implementation of technical improvements or the

[26] The diversity in tariff structures becomes apparent in a country encompassing 8,124 municipalities, as outlined by García-Valiñas et al. (2013). Primarily, disparities manifest in the variable part of tariffs, notably in the number of blocks and the corresponding block prices. However, these distinctions extend beyond these aspects. Notably, small municipalities often entail a nominal yearly fee, the fixed quota in northern Spain commonly incorporates a minimum free water consumption, and in Sevilla and Málaga, water tariffs are computed per person, contrasting with the national norm of per household. Further variations include the implementation of summer rates exclusively during this period, and unique bonuses and discounts tailored to each municipality. In response to this intricate scenario, AEAS has advocated for the establishment of an independent regulator through public forums. This regulatory body would be tasked with harmonizing norms governing both the governance and administration of urban water services and the diverse tariff structures (Morcillo, 2015). Analogous regulatory bodies in other European countries, such as OFWAT (Office of Water Services in England and Wales), ERSAR (The Water and Waste Services Regulation Authority in Portugal), and ARERA (The Italian Regulatory Authority for Energy, Networks, and Environment), serve as potential models for standardization.

extension of the service to new areas of the city (García-Rubio et al., 2015). The tariff review proposal is then sent to the city council, where, after a process of public consultation, it is approved during a plenary session of the city council. The background for the justification to propose a tariff increase dates from early 1980s, when tariffs for water supply were responsibility of the Spanish government. When the autonomous communities were recognized as legal entities, they started developing their own norms to set tariffs. In practice, even though there is a norm on each region, the process is the same in all the cases.

Once the tariff review proposal has been approved during a plenary session of the city council, it is sent to the public institution responsible for matters related to treasury and public administration in each autonomous community. In practice, this public institution checks the proposal from the administrative viewpoint. However, it does not carry out a financial analysis of the proposed new prices (García-Rubio et al., 2015).

Lastly, once the competent authority in each autonomous community has given its approval to the city council on the new tariffs, these must be published in the official gazette of the province or the autonomous community for public information.

OBJECTIVE, DATA, AND METHOD

The objective of this paper is to assess the affordability of the drinking water supply service for domestic users in Spain. We study whether, in the abovementioned legal framework that allows the service to be cut off, water prices may be a genuine cause of exclusion from access to water supply.

Scope of the study

We studied 16 Spanish cities. They were selected for having more than 100,000 inhabitants and a local regulation that explicitly states that water supply may be cut off in case of non-payment of the water bill. The sample thus comprises large Spanish cities where population is at risk of exclusion from water supply services.

Table 3.1 list the municipalities includes in the study. All together, the companies managing the water services in these cities serve just over 35% of the entire Spanish population. In seven of the municipalities, the water utility is wholly publicly owned, while in the other municipalities there are different forms of private participation. Table 3.1 also includes the regulation that allows cutting off the water supply in the event of

non-payment. It should be noted that public ownership of the utility is no guarantee that the regulatory framework does not allow cutting off the water supply.

Table 3.1. Municipalities in the sample and water utility ownership (2019).

City	Population served	Utility	Ownership	Water supply cut off regulation
Madrid	6,250,000	Canal Isabel II	Public	Decree 2922/1975, Regulation for the water distribution service of Canal de Isabel II (BOE nº 272)
Barcelona	3,000,000	Aguas de Barcelona	Public-private partnership: 85% Private; 15% Public	Regulation on the metropolitan service of the integrated water cycle, approved in the session of the Metropolitan Council of the Metropolitan Area of Barcelona (BOP nº 222 of November 20, 2012), modified in the session of the Metropolitan Council of the Metropolitan Area of Barcelona (BOP nº 124, of July 01, 2013)
Valencia	790,201	EMIVASA	Public-private partnership: 85% Private; 15% Public	Regulation on the drinking water supply service of the City of Valencia (BOP September 14, 2004)
Sevilla	1,064,032	EMASESA	Public	Regulation on the water supply in Andalusia. Decree 120/91, modified by Decree 327/2012, of 10 July
Zaragoza	661,108	City Council	Public	Municipal ordinance for eco-efficiency and quality in integrated water management
Málaga	569,009	EMASA	Public	Regulation on the water supply in Andalusia. Decree 120/91, modified by Decree 327/2012, of 10 July.
Murcia	445,086	EMUASA	Public-private partnership: 49% Private; 51% Public	Regulation on the municipal drinking water supply service of Murcia (B.O.R.M. nº 247 of October 27, 1986 and B.O.R.M nº 74 of March 30, 1987)
Palma de Mallorca	402,949	EMAYA	Public	Municipal regulation on the water supply service of Palma de Mallorca (BOIB nº 115 of September 24, 2002)

Las Palmas de Gran Canaria	378,998	EMALSA	Public-private partnership: 66% Private; 34% Public	Regulation on the municipal water supply service of Las Palmas de Gran Canaria
Bilbao	975	Consorcio de Aguas de Bilbao	Public	Regulatory ordinance on the provision of the water supply service by Consorcio de Aguas Bilbao Bizkaia (Bilbao Bizkaia Water Consortium)
Alicante	535,586	Aguas de Alicante	Public-private partnership: 50% Private; 50% Public	Regulation on the provision of water supply and sanitation services in Alicante (Official Gazette of the Province of Alicante, nº 90, of April 21, 1987)
Cádiz	118,919	Municipal company Aguas de Cádiz	Public	Regulation on the water supply in Andalusia. Decree 120/91, modified by Decree 327/2012.
Huelva	145,468	Aguas de Huelva	Public-private partnership: 49% Private; 51% Public	Regulation on the water supply in Andalusia. Decree 120/91, modified by Decree 327/2012.
Tarragona	145	Municipal company Aguas de Tarragona	Public-private partnership: 49% Private; 51% Public	Regulation on the drinking water supply service of the municipality of Tarragona (BOP nº 132 of June 07, 1996)
Lleida	138,144	Aigües de Lleida	Private	Regulation on the water service of the municipality of Lleida
Granada	502,335	EMASAGRA	Public-private partnership: 49% Private; 51% Public	Regulation on the water supply in Andalusia. Decree 120/91, modified by Decree 327/2012.

Source: Compiled by the authors from data published by utilities themselves and the regulations on water supply services in each city

Empirical strategy

To measure affordability, we estimate the financial effort a typical family has to make to pay the water bill for essential levels of consumption. To that end, we estimate the billing amount under the assumption of a three-person household, with consumption of 100 L of water per day per person, for one month; that is, 9 m3 per month per household.

The household size was chosen because the average household in Spain has 2.5 people (INE, 2018b). The water consumption per person was based on the finding that people need between 50 and 100 L of water per person per day to meet their basic needs (United Nations, 2010). We selected the upper limit to avoid levels of consumption that could indicate social exclusion in a developed country. For example, in Spain, not being able to use a washing machine is an indication that a person is at risk of poverty.

We also made calculations considering a consumption of 12 m3 of water per household/month. In this case, we considered a consumption of 133.33 L/person/day. This is an average of the last two official statistics in Spain in 2014 and 2016, of 132 and 136 L/person/day, respectively (INE, 2018c).

This study makes a number of estimates of the payment a family has to make. The following conditions are considered, depending on the tariff system in place in each municipality: the basic water bill, including all the stages of the integrated water cycle—supply, sanitation and wastewater treatment—as well as related value added tax (VAT). In some cases, the rate for solid waste is also considered. Some municipalities include solid waste in the water bill in order to reduce administrative costs. Consumers cannot choose which services to pay in a water bill: they have to pay for all the ones that are included in the bill. The only aspect users can decide on is on the water meter size on which the fix quota depends. Water bills may include discounts for families below a certain income threshold as well as other types of support available in emergency situations.

To get an approximate idea of the budgetary effort required by families to pay their water bill, three different situations have been considered:

1. The household's income is equal to the average salary for the city in question.
2. The household has a single income equivalent to the national minimum wage. The national minimum wage is reviewed annually by the Spanish government and is set at the same level nationwide.

3. The family has a single income of 430 Euros. Spanish households can receive this amount under different aid programmes: Family Assistance Subsidy, Extraordinary Subsidy for Unemployment, and Active Insertion Income Programme. Any of these programmes can be considered as a standard assistance for families in different situations of vulnerability who cannot benefit of unemployment benefits.

Data

The information on tariffs and tariff discounts was obtained from the official gazettes of the relevant provinces and autonomous communities. In addition, a search was conducted of the webpages of city councils and water utility companies to obtain information on the support provided to families suffering of water poverty.

The data on income were obtained from the following sources. The average income in each city was taken from the Urban Indicators published by the Spanish National Institute of Statistics (INE, 2019). The national minimum wage set for 2019 was approved by Royal Decree 1462/2018 (Government of Spain, 2018). Finally, we also used the information provided on the website of the Ministry of Labour, Migrations and Social Security for families whose employment benefits have expired[27].

RESULTS

First, the billing amount for consumption of 9 m^3 of water per month was estimated. As an indicator of the budgetary effort a family has to make to pay the water bill, the billing amount was set in relation to three different levels of family income: average salary, national minimum wage, and income of 430 Euros, amount that is similar to the one vulnerable families receive (Table 3.2). We also estimated billing for consumption of 12 m^3 per home. This is assuming families' water consumption is similar to the national average.[28]

[27] The website of the Public Employment System, Government of Spain, provides information on the subsidies available for people whose unemployment benefits have expired: https://www.sepe.es/HomeSepe/Personas/distributiva-prestaciones.html

[28] Assumptions are based on an average-size family of three persons and water consumption of 9 m^3/person/day. Nevertheless, there are more factors that influence whether families can pay for the water bills. These include: number of persons who actually live in the house, how many of them are employed and receive a salary, total family income, how efficiently people use the water available, and the meter size, among others.

Table 3.2. Monthly billing amount for consumption of 9 m^3 and 12 m^3 of water (2019).

	Bill (€) 9 m^3	As a percentage of income			Bill (€) 12 m^3	As a percentage of income		
		Average salary	National minimum wage	Aid programmes		Average salary	National minimum wage	Aid programmes
Madrid	20.04	0.60	1.91	4.66	22.43	0.67	2.14	5.21
Barcelona*	39.19	1.24	3.73	9.11	57.51	1.81	5.48	13.36
Valencia*	29.14	1.12	2.78	6.77	40.47	1.55	3.85	9.40
Sevilla*	41.46	1.65	3.95	9.64	56.89	2.27	5.42	13.22
Zaragoza*	16.04	0.59	1.53	3.73	19.78	0.73	1.88	4.60
Málaga	19.47	0.86	1.85	4.52	27.44	1.22	2.61	6.38
Murcia*	40.52	1.61	3.86	9.42	47.03	1.87	4.48	10.93
Palma de Mallorca*	40.77	1.46	3.88	9.48	47.65	1.70	4.54	11.08
Las Palmas de Gran Canaria	24.23	0.95	2.31	5.63	31.98	1.26	3.04	7.73
Bilbao	16.44	0.55	1.57	3.82	21.02	0.71	2.00	4.89
Alicante	23.16	1.01	2.21	5.38	30.71	1.34	2.92	7.14
Cádiz*	31.19	1.22	2.97	7.25	40.72	1.60	3.88	9.46
Huelva*	30.74	1.38	2.93	7.14	38.95	1.75	3.71	9.05
Tarragona	17.52	0.63	1.67	4.07	31.88	1.14	3.04	7.41
Lleida	19.77	0.77	1.88	4.59	34.57	1.35	3.29	8.03
Granada*	30.81	1.25	2.93	7.16	38.69	1.57	3.68	8.99

Source: Compiled by the authors based on information collected from the utilities, municipalities, official gazettes of the provinces and autonomous communities, and the Ministry of Labour and Social Security.

* In these cities, water and solid waste services are included in the same bill.

It is important to note that, even at minimum levels of consumption, water tariffs differ by area. Comparing the extremes, water is most affordable in Zaragoza, where the price of the minimum essential level of water (100 lcpd) is €16.04, while the equivalent price in Sevilla is €41.46. Previous studies in Spain have already shown the differences in the price of water by city (Martínez-Espiñeira et al., 2009, 2012). Our research shows that there are also differences in the affordability of water supply services at minimum consumption levels.

The price of water supply in Spain is low in relative terms (OECD, 2015). On average, access to water to meet basic needs represents a relatively small budgetary effort for a

typical family in Spain (AEAS, 2016a). However, there are differences in the percentage of the family budget allocated to the water bill in the three household income scenarios. For an average household, the water bill rarely exceeds 1.5% of the family income in only two cities: Sevilla and Murcia However, in households with below-average incomes, the water bill may exceed the affordability threshold of 3% (Howard and Bartram, 2003; United Nations, 2006). For households with a single income equivalent to the national minimum wage, the water bill would represent more than 3% of that income in four cities of the sample: Sevilla, Barcelona, Murcia and Palma de Mallorca. In four other cities — Cádiz, Huelva, Granada and Valencia— it is close to the 3% threshold. Calculations considering consumption of 12 m^3 per household indicate a more difficult situation for households to access water supply in all the municipalities, mainly in cases where all family members are unemployed and when the only income is 430 Euros from aid programmes.

Due to the high rate of unemployment in the country, the government was forced to provide additional aid for unemployed population who was no longer entitled to standard unemployment benefits. In all cities in the sample, families whose members are all unemployed and who depend on aid programmes face a problem of affordability. For example, in Sevilla, Barcelona, Palma de Mallorca and Murcia, the water bill in such cases represents more than 9% of the family income.

From the beginning of the 21st century, but most notably following the 2007 economic crisis, water utilities and city councils in many Spanish municipalities have jointly approved systems of tariff discounts and reductions. Factors taken into account include the number of family members, whether all family members are unemployed, on income levels, and on retirement status. In Table 3.3, the amount of the water bill has been re-estimated taking into account tariff discounts approved by local governments when families fall below a certain level of income. Table 3.A1 (supplementary material) explains the requirements that must be met to obtain a discount and how the discount is applied.

Table 3.3. Monthly billing amount for consumption of 9 m^3, after discounts due to low family incomes (2019).

	Bill (€) 9 m^3	As a percentage of income		
		Average salary	National minimum wage	Aid programmes
Madrid	12.58	0.38	1.20	2.92
Barcelona*	18.86	0.59	1.80	4.38
Valencia*	29.14	1.12	2.78	6.77
Sevilla*	41.46	1.65	3.95	9.64
Zaragoza*	7.31	0.27	0.70	1.70
Málaga	19.47	0.86	1.85	4.52
Murcia*	5.50	0.22	0.52	1.28
Palma de Mallorca*	19.30	0.69	1.84	4.49
Las Palmas de Gran Canaria	24.23	0.95	2.31	5.63
Bilbao	10.88	0.37	1.04	2.53
Alicante	23.16	1.01	2.21	5.38
Cádiz*	30.19	1.22	2.88	7.02
Huelva*	23.33	1.05	2.22	5.42
Tarragona	12.63	0.45	1.20	2.94
Lleida	19.77	0.77	1.88	4.59
Granada*	4.46	0.18	0.42	1.04

Source: Compiled by the authors based on information collected from the utilities, municipalities, official gazettes of the provinces and autonomous communities, and the Ministry of Labour and Social Security.

* In these cities, water and solid waste services are included in the same bill.

Differences can also be seen in the measures approved by local governments to facilitate access to water for low-income households. For example, not all service areas offer discounts based on income. Moreover, there are differences in the criteria for eligibility, as well as in how to access these assistance programmes. A standard requirement is that all members of the household should be unemployed or that they do not exceed a certain level of income. In some municipalities, however, assistance programmes are also open to families who do not exceed a certain income threshold even if some members are employed. The most commonly used references to set the threshold are the IPREM — Public Indicator of Multiple Effect Income (Government of Spain, 2017) — and the national minimum wage (Government of Spain, 2018).

In six of the cities studied (Valencia, Alicante, Sevilla, Malaga, Cádiz and Las Palmas de Gran Canaria), there are no income-based discounts of any type, though in all of these cities the water bill for families benefitting from a family aid programme exceeds 3% of their income, the threshold indicating problems of affordability. In fact, in five of these cities it exceeds 5%. The situation for families on the national minimum wage is less pressing in these municipalities. Indeed, after the minimum salary increase in 2018, only the invoices in Sevilla represent more than 3% of a family monthly budget. In addition, as shown in the third column of Table A1, in those cities where discounts are available, there are differences in the level of assistance offered. While in Huelva and Tarragona the discounted bill for low income families represents no more than a 30% of the total bill, in Murcia and Granada it is around 85%.

Furthermore, a common element to all the discounts is that, where available, they only apply to the first consumption block, which usually covers the equivalent of 9 m^3 of water per month. That is, the discounts are applied for levels of around 100 lcpd. Some municipalities also discount service charges. We should point out that to benefit from the discounts, contract holders cannot be in arrears on the payment of any past bills.

In no case are the income-based discounts granted for an indeterminate period; they are generally limited to one year, although with the possibility of renewal if the specific situation persists and the appropriate documentation is presented. Likewise, discounts are only granted for main residences, without exception.

As with the water tariff discounts and reductions, in many municipalities (some of which are included in this study) water utilities and city councils have jointly approved Social Funds for families who cannot afford to pay their water bill. The processing of applications and granting of aid is carried out in close collaboration with the social services of these municipalities.

Table 3.A2 (supplementary material) details the assistance programmes, apart from the tariff discounts, which are available in the municipalities that compose the sample of this study. There are notable differences in the allocation of this assistance, both in the scope of the assistance and in the associated administrative procedure. Assistance is limited, either in amount or in time, meaning that families cannot be beneficiaries of social protection indefinitely.

In all cases where assistance programmes are offered, applicants must provide a report from municipal social services certifying that the household in question is in a situation of special vulnerability. The only city where municipal social services are not referred to as an intermediary is Alicante, where the relief organization Cáritas acts as the intermediary.

Differences can be seen in the measures approved at the local level to help families who face problems paying their water bill. In four municipalities (Lleida, Granada, Bilbao and Palma de Mallorca) cutting off the water supply is prohibited when the families in question are beneficiaries of assistance programmes (see Table 3.A2). This represents a partial amendment to the regulations in those cities, which allow the water supply to be cut off in case of non-payment. In other cases, if families are beneficiaries of an assistance programme, it means their bills are paid from an Emergency Social Fund created for that purpose with public funds (Tarragona, Cádiz, Huelva). In other cases, the utility pays for the bills (Palma de Mallorca).

There are important differences between the municipalities that have decided to create a progressive assistance plan, where the measures to be adopted depend directly on the degree of social risk of the family in question (Alicante and Zaragoza), and others, where the cities have decided to create a flat-rate social tariff of €5 per water supply bill (Murcia). Finally, some municipalities, rather than guaranteeing families "free" access to water supply —at least up to the essential minimum recognized by WHO, of up to 100 lcpd— have decided to facilitate systems for paying off overdue debts in instalments, whether systematically (Madrid, Bilbao) or on a case-by-case basis (Malaga).

DISCUSSIONS, RECOMMENDATIONS AND POLICY IMPLICATIONS

Water poverty is typically assessed using aggregate information at the country level. One indicator that is commonly used is the percentage of the population with access to water supply. The main sources for this information are the World Health Organization and the United Nations, which provide annual data at the global level (World Health Organization and UNICEF, 2017). Another approach is to estimate the financial efforts that individuals or households make to pay the water bill. In this case, a widely used indicator is the ratio between the billing amount for the minimum essential level of water consumption and the average income in the country (OECD, 2003). Assessing water poverty through macro-indicators leads to the conclusion that this problem is restricted to developing

countries, such as those in Africa, Asia and Latin America. However, this approach conceals another reality. Although at the macro level the problem of access to water supply occurs primarily in developing countries, within any country, access to water supply can differ substantially among regions, cities, and user types (García-Valiñas et al., 2010b).

In Spain there is no nation-wide regulations that guarantee access to water supply, and the Spanish Constitution does not specifically recognize this right. At best, the Constitution could be interpreted as implicitly including access to water through other rights, such as the right to adequate housing (Article 47) or the right to health (Article 43). However, as access to water supply does not fall within the category of fundamental rights, the population does not enjoy special protection under the Spanish legal system.

Furthermore, the law governing water at the national level, Royal Legislative Decree 1/2001, of 20 July, adopting the Revised Text of the Water Law (TRLA), does not explicitly make this relation to human rights. It does mention the need for water tariffs to be set at a price that is considered affordable, but it does not specify what should be considered as affordable. Based on the notion that the water bill should not represent more than 3% of the family budget, Tables 1, 2 and A1 show that, at least for a typical family with an average income, the principle of affordability is met. However, it can be a serious problem for families with below-average incomes. Therefore, although the price of water is low in relative terms, in a country with such a high unemployment rate (which has a strong structural component), the macro-data may conceal a problem of affordability.

The regulations on local taxation, as well as court judgments, especially those at the level of the Supreme Court, allow water supply to be cut off for non-payment of the water bill. This situation occurs when municipalities outsource water supply services to a private company, a mixed public-private company, or a public company (for example, a municipal company). This means that just over 75% of the Spanish population who live in cities where services are outsourced, could have their water supply cut off (AEAS, 2016a). This includes practically all large and medium-size municipalities in Spain. Therefore, in situations where people are at risk of poverty and exclusion, there is a high degree of arbitrariness at the local level about the decision to cut off the water supply when families cannot afford to pay the bill.

As discussed earlier, in recent years, a number of initiatives by community organizations have risen up against private management of urban water services. Particularly notable in Spain is the Social Pact for Water (Fundación Nueva Cultural del Agua, 2015). Various NGOs, unions, political parties and related entities have expressed their support to public, integrated and participatory management of the urban water cycle. One of their key arguments is that, since the United Nations recognizes access to water as a human right, water management should not be subject to the laws of the market and private companies (Fundación Nueva Cultural del Agua, 2015).[29] They also call for tariff policies based on social equity, which would mean, according to the Social Pact for Water, guaranteeing a supply of between 60 and 100 lpcd, along with a commitment not to cut off the supply in cases of justified non-payment (Babiano and Giménez, 2015). However, we should stress that public management does not guarantee access to water in Spain either. In fact, in this research, we have shown cases of municipalities under public management in which the local regulation allows the water supply to be cut off for non-payment, even if this is justified.

Local initiatives have emerged in response to the lack of national regulations. Cities such as Córdoba, Puerto Real and Gijón have already drawn up regulations to guarantee access to water supply. For example, the city council of Puerto Real resolved on 1 October 2015: "Provisional measures shall be articulated in order to immediately halt electricity and water supply cuts for those families who demonstrate their unemployed status or social exclusion, with the aim that no such cut in supply shall occur in our municipality."

Regarding controversies on provision of water supply in urban areas when management is under public or private utilities and how this affects price of water, earlier studies that consider $9m^3$ of water/month/household, have not found a direct relationship (e.g. Garcia-Valinas et al., 2013). Considering these parameters ($9m^3$ of water/month/household), only in four cities (Sevilla, Palma de Mallorca, Barcelona and Murcia) water bills represent more than 3% of family income. In Sevilla and Palma de Mallorca, water utilities are

[29] Movements against private sector participation are mainly ideological. However, they also indicate lack of trust to both the private and the public sectors. In the case of the private sector, the reasons have been discussed before. In the case of the public sector, lack of trust is due to its questionable performance regarding overall regulation and public management roles.

public, while they are private in the cases of Barcelona and Murcia. This means that in Spain, water bills represent more than 3% of family income only in three cities (Sevilla, Palma de Mallorca, Cádiz) when water utilities are public, and eight when they are private (Barcelona, Valencia, Murcia, Palmas de Gran Canaria, Huelva, Tarragona, Lleida, Granada).

AEAS introduces nuanced perspectives to the ongoing discourse surrounding the protection of the right to water access for low-income households. Noteworthy is the assertion that the suspension of water supply services typically does not arise from non-payment issues within low-income families (AEAS, 2016b). According to the association, service suspension is employed strategically to secure bill payments in specific scenarios. These scenarios encompass instances such as domestic companies with water supply contracts that permanently cease operations without formally terminating their agreements with utility providers. Additionally, situations involving unrenewed rental agreements leading to vacated premises with outstanding water bills, alterations in contract holders without prior notification to utilities, second homes or vacant properties with signed contracts but discontinued payments, and instances of fraud are identified as circumstances where service suspension is deemed necessary to ensure financial accountability.

According to AEAS (2016a), suspension of services normally go into effect after two warnings by the management company. They estimate that the suspensions affect 1.82% of domestic users; 1.31% are reconnected after paying the outstanding amounts, and 0.02% are reconnected thanks to the support of social assistance mechanisms.

In any case, in the framework described above, decisions that can result in water poverty are of local nature and involve local governments and local companies that manage water supply services.

Within the outlined framework, decisions with the potential to precipitate water scarcity are inherently localized, necessitating the involvement of municipal administrations and indigenous enterprises responsible for water supply management. Affordability considerations, in this context, revolve around the intricacies of tariff structures applicable within specific municipalities. This encompasses nuanced aspects such as tariff concessions and reductions, some contingent upon the financial capacity of

individuals or households. Furthermore, a range of subsidy assistance programs has been established to mitigate the financial strain associated with non-payment of water bills.

Comprehensive regulations play a pivotal role in delineating the responsibilities and entitlements of both water utilities and end-users. These regulatory frameworks may extend to delineate circumstances under which water supply entities are authorized to discontinue services, adding a layer of legal clarity to potential service suspensions. Furthermore, political determinations concerning the implementation of service suspensions due to non-payment contribute to the multifaceted landscape of decisions impacting water access and affordability.

As discussed earlier, in terms of the amount of the water bill as a proportion of an *average* Spanish family's income, we can say that water services all over the country comply with the principle of affordability. However, for families in a situation of social exclusion, the guarantee of access to minimum essential levels of water is more the result of agreements between local governments and water utilities than compliance with a higher-level law aimed at protecting the human right of access to water.

With respect to situations of extreme poverty, the Spanish legal framework is not in line with Resolution 64/292 of the General Assembly of the United Nations (2010). Families in extreme poverty face a real threat of having their water supply cut off. Neither the Spanish Constitution nor the Water Law (Government of Spain, 2001) guarantee access to minimum essential levels of water. The only families that are protected in this sense are those living in the Community of Cantabria and in municipalities where, at the initiative of local government, access to a minimum essential level of water is guaranteed by local ordinances.

Based on our findings, we recommend that the Spanish government starts a dialogue with all stakeholders on whether it would be possible to draw up national regulations to universally guarantee the right to a minimum amount of water, whether this can be paid or not. If access to health care and basic education is universal in Spain, it is important to discuss what measures would need to be taken so that the Spanish government guarantees access to a minimum essential level of water for the entire population.

In our opinion, one aspect that would come out in the discussions will be lack of political will. Water as a human right has never been a proposal taken into account by the political parties that have been in the government since 1997 - Partido Socialista Obrero Español

and Partido Popular-, the year in which the first general elections took place in Spain. At least, there are two reasons that would explain the absence of political will. In the first place, the small number of persons affected by lack of water supply in the whole of the Spanish population if this is cut off - something for which there are no official figures, as neither the public administration nor the management units of the municipal water service seem to be interested in publishing related data. Second, the lack of social pressure, due most probably, to the low educational level and the lack of organization of the affected population.

If the universal right to water was incorporated into the Spanish legislation, it would be necessary to address very relevant issues that are not discussed in this study because, as important as they are, they go beyond our objectives. First, under what conditions families that are not able to pay their water bill should be supported? This would require a decision on the amount of water consumed that should be subsidized. Second, establish criteria to decide who would benefit of aid programmes and what would be the per capita income threshold that should be guaranteed. Both would ensure that the right of access to water is recognized. In the context of water scarcity, innovative solutions that consider specific conditions of low-income families would also be necessary (Pinto and Marques, 2017). For policy- and decision-making purposes, it would be essential that all interested parties (including low-income families) would express their views through participatory processes. This is the case in Australia, for example, where water tariffs are discussed in meetings that are open to the public (Pinto et al., 2018).

A very important issue that also needs to be discussed is how to finance access to water supply for low-income families who are not able to pay their water supply bill. There are two alternatives that could be considered: increase the price of water supply to users who can pay for it or increase taxes to population in general. Considering the current situations of water stress and low prices of water supply in Spain, it would also be worth considering increasing the progressivity of tariffs. An increase in the price of higher consumption blocks, would allow utilities to obtaining financial resources to guarantee access to water to low-income families and, at the same time, promote a more efficient use of water.

Lastly, we would like to mention several areas of knowledge on which more research is necessary. First, accurate and reliable information is needed on suspension of water supply services for domestic users, including the reasons why families at risk of poverty are affected and how, or if, families themselves could improve this situation. For instance,

there may be families with very limited access to the usual sources of information on tariff discounts and assistance programmes, or those who choose not to apply for assistance for whatever reason. Another topic of study is whether complex regulations and procedures adopted by governments and water utilities are, at least in part, involuntary causes of suspension of water supply services for low-income families. In some cases, it may be that tariff systems and assistance programmes are difficult for some users to understand and that they do not receive enough help from municipal social services.

Essentially, there should be an understanding of the reasons for suspension of water supply services, one of which would be the fact that low-income families are not always able to pay for their water supply bill. In the absence of official statistics, reliable information is needed to inform the ongoing debate in Spain, driven by left-wing parties, which questions whether access to a minimum essential level of water should be guaranteed for all families. Having this type of information would also allow a more rational debate on whether public or private management best protects interests of the society.

CONCLUSIONS

As we show in this paper, water poverty is found not only in developing countries but also in developed ones. In the later cases, it has to do with affordability. It occurs in families that struggle to pay their water bill and where the regulatory framework allows their water supply to be cut off if not paid. Countries that do not have a regulatory framework to guarantee access to water for low-income families, risk generating social exclusion in relation to water supply services. The Spanish case is an example of how poverty can be associated with difficulty in paying the water bill and suspension of water supply services.

In Spain, the lack of a legal framework at the national level guaranteeing essential levels of access to water supply means that responsibility is passed down to the local level. The price of water, discounts people may receive, and whether the management company may decide to cut-off supply due to non-payment, varies from one city to another. This makes access to water supply more difficult for some people simply because it depends on the regulation of the city where they live.

We have discussed at length whether the management of the water utilities alone have an impact on water affordability all over the world. This is a very relevant question for which, unfortunately, there are no straight-forward answers (González-Gómez y García-Rubio, 2018). Some studies indicate that private water utilities affect negatively access to water supply compared to public utilities, while others have found just the reverse. In France, for example, studies indicate that low-income families have been negatively affected when the management of water has been privatized (Renaud, 2010). This has been the contrary, however, in some cases in Portugal and Brazil. In Portugal, affordability problems have been identified when water supply services are directly provided by town councils (Martins et al., 2016). In Brazil, the number of households connected to the water network has increased when participation has been private (Oliveira, 2008). In the case of Spain, water prices have been found to be lower for essential consumption levels when the management of water has been under local governments, as they are considered as basic good (García-Valiñas et al., 2010a). More research is needed.

Finally, the Human Right to Water and Sanitation, recognized as such by the United Nations General Assembly in 2010, states that this right "entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses". Due to societal pressure, governments and water utilities, be they public or private, are being forced to acknowledge the fundamental role of water as a basic good, a human right, and not as a commodity. Institutional, legal, governance, and management changes are necessary to achieve the goal of providing clean water at affordable prices for all. As complex as it may be, it is also possible. In the 21st century, with so much progress in every socio-economic sector, it is time for clean water provision to stop being a challenge, one that affects quality of life of billions of people, and become a reality.

SUPPLEMENTARY MATERIAL

Table 3.A1. Monthly billing amount for a consumption of 9 m^3 of water with a discount based on income (2019)

	Discounted water bill (Euros)	*Discounted charge**	*Billing amount as a percentage of income*		*People eligible for an income-based discount*	*Implementation of the income-based discount*
			National minimum wage	Unemployment extraordinary subsidy		
Madrid	12.58	37.24	0.38	2.92	Contract holders or water users who prove they cannot afford to pay the water bill	The total amount of the variable part of consumption up to 25 m^3 per two-month period is subsidized—equivalent to an average daily consumption of up to 417 liters; and 50% of the service charge
Barcelona	18.86	51.89	0.59	4.38	People who are part of a household in which all members are unemployed and the monthly income is not more than twice the limit set by the adequate income indicator for Catalonia; people who receive a minimum contributory pension (or SOIV, the obligatory old-age and disability insurance) for retirement or widowhood; people who receive a minimum contributory pension due to permanent disability; recipients of a non-contributory pension for retirement, disability retirement; recipients of economic integration assistance funds; recipients of social	25% reduction in the cost of the water service, that is, the service fee plus the unit price of the first block. The subsidy is applied in the bill; and only in those that do not exceed the consumption limit in the second block. 100% discount on reduction on wastewater collection, treatment and disposal

					financial benefits to cover certain situations of basic needs	
Valencia	29.14	0.00	1.12	6.77	No discounts available	No discounts available
Seville	41.46	0.00	1.65	9.64	No discounts available	No discounts available
Zaragoza	7.31	54.44	0.27	1.70	Unemployed individuals (until the unemployment card is updated), people working (for two years) and pensioners (for three years), who have all their water bills charged to their bank accounts and do not owe any municipal levy, can benefit from the discounts. To qualify, the income of all the individuals living in the same household should not exceed the amounts considered by the municipality; nor can they have financial or non-financial assets or properties (excluding the main residence) that amount to 3.5 times the national minimum wage.	In general, there is a 50% reduction of the fixed charge for water, 99% reduction in the first consumption block, and 75% for the second block. In addition, there is a 100% reduction on wastewater collection, treatment and disposal.
Málaga	19.47	0.00	0.86	4.52	No discounts available	No discounts available
Murcia	5.50	86.43	0.22	1.28	Individuals reliant solely on pension income and whose household's total income does not surpass the national minimum wage are eligible for the discounted tariff. Applicants must not have two or more outstanding bills; in	Murcia has a social tariff consist of guaranteeing 110 liters per person for just 5€ plus IVA

					such instances, access to the discounted tariff will be postponed until the subsequent financial year.	
Palma de Mallorca	19.30	52.66	0.69	4.49	Households in which the annual income does not exceed €12,385. If there is more than one source of income, the highest amount is considered in full, and the rest of the salaries are considered at 50%.	The first 10 m^3 are subsidized in the monthly balance, for both water and sanitation. The rest (which is not applicable to our case) would be subject to standard tariffs. 100% discount on the service charge, and 80% on reduction on wastewater collection, treatment and disposal
Las Palmas de G.C.	24.23	0.00	0.95	5.63	No discounts available	No discounts available
Bilbao	10.88	33.80	0.37	2.53	Beneficiaries of the Income Guarantee Grant, who have an individual water meter and have paid quarterly charges within the voluntary payment period. The household should have three or more people registered as living in the same premises, a consumption of less than 30 m^3 in 90 days, plus 12 m^3 per person after the second person also in 90 days	Rebate of 80% of the sanitation charge paid for domestic use
Alicante	23.16	0.00	1.01	5.38	No discounts available	No discounts available
Cádiz	30.19	0.00	1.22	7.25	No discounts available	No discounts available
Huelva	23.33	24.12	1.05	5.42	Pensioners and retirees (for a maximum period of two years), and families whose members are all unemployed (for a maximum of one year, renewable on presenting the required documentation),	50% reduction on the standard tariff for the first two consumption blocks

					who are not in arrears on any payment for water supply and sanitation services, and who do not have a second contract for water supply for any other property. In addition, total household income should not be more than twice the national minimum wage.	
Tarragona	12.63	27.89	0.45	2.94	Contract holders considered as living in vulnerable conditions supported by a vulnerability report provided by municipal social services	The tariff for the first consumption block is extended to the second, resulting in a discount of €0.206 per m^3 consumed after the first block.
Lleida	19.77	0.00	0.77	4.59	Families eligible for social water pricing offered by the Agència Catalana de l'Aigua. Contract holders must be either over 60 years old and receiving a minimum pension for retirement or permanent disability, or water supply contract holders who belong to a family whose members are all unemployed.	The application of the social tariff depends on the consumption billed. If this exceeds the monthly allowance of 9 m^3, the beneficiary is not eligible for this rate and standard tariffs is applied. The social tariff is applied together with the social water charge, consisting of a reduction of more than 50% applied to the first block, provided that the consumption billed does not exceed the first block.
Granada	4,46	85.52	0.18	1.04	Main residence of the contract holder, where all household members are unemployed, and whose annual family income is not more than twice the IPREM. They must not be in arrears of any water and sanitation bill.	50% discount on the fixed rate, and 80% discount on the first two blocks of the variable rate. 100% discount on reduction on wastewater collection, treatment and disposal

This is the ratio between the billing amount, including income-based discount, for consumption of 9 m3 (second column of Table 3.3) and the undiscounted billing amount for a consumption of 9 m3 (second column of Table 3.2), expressed as a percentage.

Source: Compiled by the authors using information sourced from the utilities, municipalities, official gazettes of the provinces and autonomous communities, and Ministry of Labour and Social Security.

Table 3.A2. Assistance programmes for individuals unable to pay their water bill

	TYPE OF ASSISTANCE	SCOPE OF ASSISTANCE	ACCESS TO ASSISTANCE
MADRID	Possibility of deferring payment or paying in instalments	Not specified	Applicants should contact the company. A specific procedure is not specified.
BARCELONA	Following confirmation of qualification for the assistance programme, a discount is applied to the service charge and to consumption in subsequent bills.	Only one assistance programme is granted per account, regardless of the number of requests received. Valued at €57 per home, and applicable to subsequent bills until the entire amount has been used up, at a maximum of €28 per bill. The assistance does not exempt recipients from payment of the other items included in the bill (water tax, sewerage charge, municipal water waste treatment charge and VAT).	The recipient must be the contract holder of the domestic supply corresponding to his/her main residence. The contract holder should contact municipal social services, which, after evaluating the specific situation, will process the request with Aigües de Barcelona. Applicants can also contact Cáritas Diocesana or the Red Cross of Catalonia. The decision on whether to grant the assistance is at the discretion of Aigües de Barcelona.
VALENCIA	Regulatory Agreement on Payment of the Drinking Water Supply Service for People in Situations of or at Risk of Social Exclusion. The duration of the agreement will be one year, extendable for a maximum of two successive one-year periods, to cover all the amounts detailed in the *Scope of assistance* column.	The Social Welfare and Integration Service will pay the sewerage fee, the Generalitat's sanitation charge and the TAMER charge (for urban waste services). The Fundación de la Comunidad Valenciana Aguas de Valencia contributes a maximum of €60,000 to	The Social Welfare and Integration Service manages applications for emergency assistance to cover certain needs, including water. The service evaluates applications for assistance and sends a weekly email to the management company to inform them about which bills should be covered under the agreement.

		cover service charges, integrated maintenance fee/conservation and VAT.	
SEVILLE	Social loan with a possible 10-year term at 1% quarterly interest	Bill payment; possibility of receiving financing for up to four consecutive bills for water consumption. Funds to guarantee access to water and sanitation services for families who cannot afford payment. Up to €200 per year per household.	Users must demonstrate that they are in a situation of social emergency or financial precariousness by means of a certificate issued by the municipal social services for this purpose. They cannot have access to other grants from public administrations or their own resources that cover the need for which the assistance is requested.
ZARAGOZA	Social energy tariff for households that have been declared vulnerable.	Households living in extreme poverty receive subsidies for 100% of all their bills, including water, for as long as they remain in that situation, in line with progressivity criteria.	Certification as a vulnerable household can be obtained in three different and/or complementary ways: 1. Adult members of the household can make a request to municipal social services; 2. Households receiving Aragón Integration Income (or similar); 3. If the management company decides to cut off the water supply for non-payment, households can inform municipal social services. If the household has not been declared vulnerable, the situation will be studied prior to any restriction or supply cut being carried out.
MÁLAGA	Economic fund (€500,000 per year) to help families in specific financial difficulties; one-off support measure to resolve a situation that is undesirable for all involved	Specific, one-off, case-by-case assistance to cover unpaid debts. It may consist of a non-repayable loan and/or interest-free financial aid, according to the applicant's ability to pay. Assistance to ensure continuing service, authorizing up to three subsequent water bills to be charged to the social fund	Applications for assistance should be submitted to the appropriate regional social services centre, along with documentation of applicants' in-need status, as well as the debts that they intend to pay off using the fund. Applicants must not have any debts with EMASA other than those they are seeking to pay off by reaching an agreement with EMASA. The water consumption associated with the debts must be less than 133 litres per person per day (4 m^3 per person per month); otherwise applicants will receive monthly training by EMASA that promote the responsible use of water.

MURCIA	Social fund for flat rates from Aguas de Murcia, with a budget of €500,000 and additional budget, depending on the year	Rate of €5/month plus applicable taxes for families that meet the requirements and have a consumption of less than 110 litres per person per day. Any consumption in excess of this limit is billed at the standard rate.	Applications should be submitted to customer services; from there, they will be sent by EMUASA to the municipal social services of the city council. Social services certifies that the applicant requires financial assistance and has been a beneficiary of economic benefits, which has been approved by the City of Murcia's social services in the preceding two years. EMUASA will then extend the Social Fund Discounted Rate to the applicant, provided it is for the main residence and there is no debt owing prior to the date of application. If there are outstanding debts, a debt acknowledgement must be signed and a payment plan established.
PALMA DE MALLORCA	Suspension of disconnection from the drinking water supply service once this is communicated by municipal social services. The municipal water utility assumes responsibility for paying the water bill, sewerage and wastewater collection for families with limited financial means who are receiving support from municipal social services.	€60,000 budget to pay the water bill, wastewater collection and sewerage of families receiving support from municipal social services. In cases where the drinking water supply has been cut off, there is a commitment to reconnect it within 24 hours for families of limited financial resources.	Applicants must be families of limited financial resources who are receiving support from the social services of the city council in question and have submitted a request to social services for financial assistance to pay their water bills.
LAS PALMAS DE GRAN CANARIA	There is no assistance available for individuals who cannot pay their water bill.		
BILBAO	In no case will supply be cut off due to non-payment if the clients have communicated that they are in financial difficulties and cannot afford to pay their bill, pursuant to article 70.3 of the entity's ordinance.	Contract holders in financial difficulties can pay in instalments, with bills for as little as €3.	The order to disconnect the water supply will immediately be suspended on receipt of any communication from the city council. This communication should specify that a case has been opened to analyse the debtor's financial situation and the possibility of receiving financial aid to help paying their bill.

ALICANTE	Social Fund which sets the amounts allocated for individual assistance to the most severely financially disadvantaged individuals and/or households	Funds cover all or part of the families' water bills, with the collaboration of Cáritas Diocesanas, the Spanish Red Cross.	These institutions assess the applications submitted in response to the financial support. Applicants must be registered at and primarily live at the address for which the assistance is requested. They must also be an applicant for, or a beneficiary of, some type of benefit or assistance from Cáritas or the Red Cross.
CÁDIZ	Minimum essential supply provided and subsidized payment of billing items subject to discount, during an initial period of 12 months, subject to review at 6 months.	Exemption from paying the discountable billing items; they are charged to the social fund, which has €300,000 a year to cover such payments. The minimum essential consumption is covered, set at 100 litres per person per day.	Applications should be submitted to municipal social services, and applicants should be 18 years old or older. The residence in question, which must always be for domestic use, must have an individual meter. The per capita income of the family unit must not exceed 47.5% of the IPREM (€252.94). For single-person households, the limit is 75.34% of the IPREM (€401.19).
HUELVA	Guaranteed Minimum Essential Rate (100 litres per person per day) for six-month periods, renewable on submitting the appropriate documentation	Up to 3 m^3 per month is guaranteed for each person registered at the same address: there is no charge for this level of consumption. Standard tariff applies to anything over this.	Applicants must be the contract holders, the address must be their main residence, and they should not have another contract in their name for any other residence. Residents' income must not exceed the criterion stipulated in the minimum income table in force the year the application is made. In addition, if at the time of application, any debts have been incurred with the water utility, a debt acknowledgement and payment deferral must be signed.
TARRAGONA	Social fund managed in collaboration with the Municipal Institute of Social Services.	The allocation depends on the year, but it applies to all the items in the bill including VAT.	Applicants must have received economic benefits, or be a user of the City of Tarragona's social services. In addition, there must be documentation that indicates that their situation and "their needs due to lack of financial resources to cover basic needs" have been assessed during the previous two years They must be contract holders and have an individual meter. The home in question must also be the main residence.

LLEIDA	Those individuals at risk of losing their housing cannot have their water supply cut off for non-payment of bills.	The exact scope of the measure is not specified, nor how the problem is to be addressed.	The applicant must have registered with municipal social services as an individual at risk of losing his/her house. This information has to be included in the report that social services must send to the company before it decides to cut off the water supply.
GRANADA	Agreement between the city council and the water utility that the decision to cut off either water supply or electricity should be automatically suspended when the city council, through its social services, informs the company that either a person or a family are an at-risk situation.	Direct communication between companies and municipal technical officers to analyse and take action to guarantee water supply for people at risk of exclusion	Applicants must appear in the records of the city's social services as individuals or families at risk of exclusion. Disconnection is also halted if the user agrees to pay in instalments or to a deferral of payment.

Source: Compiled by authors based on municipal ordinances.

PART II.

Integrating water reuse in Spain: A pathway to SDG 6.3 compliance

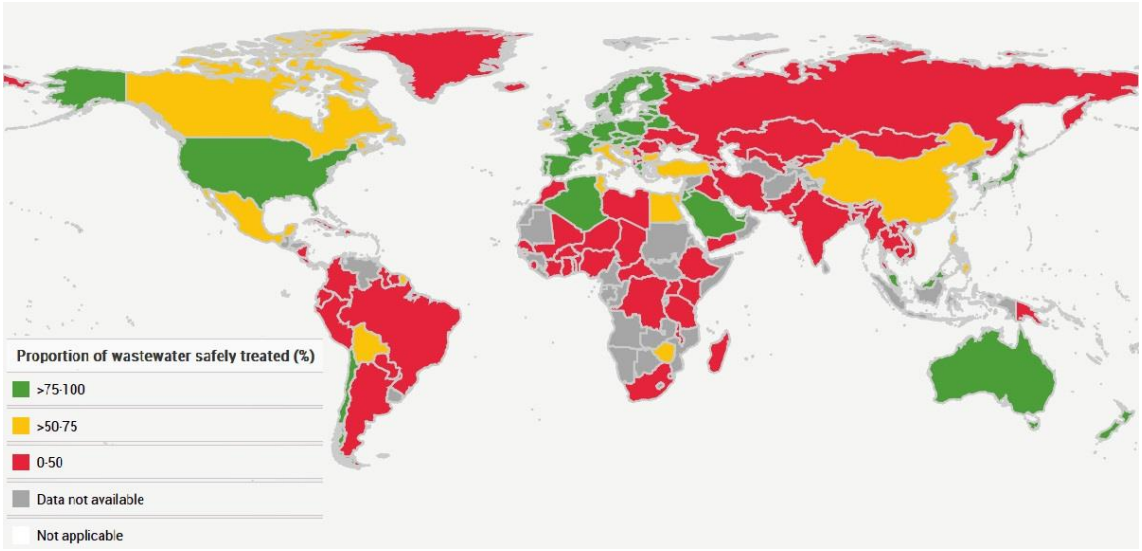
SDG 6.3. Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

INTRODUCTION

The SDG 6.3 is a critical target within the United Nations' broader framework of Sustainable Development Goals, aiming to “improve water quality by reducing pollution, minimizing the release of hazardous chemicals, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally by 2030.” Addressing the global water crisis, exacerbated by climate change, urbanization, and agricultural expansion, is central to achieving this goal. As Wang et al. (2024) suggest, the number of sub-basins experiencing water scarcity is expected to triple by 2050 due to future nitrogen pollution, emphasizing the urgent need to incorporate water quality considerations into future water management policies for the SDGs.

A major part of the solution lies in producing less pollution and improving the management of wastewater. Governments have a significant opportunity to embrace more circular, sustainable economies by reducing ecosystem contamination and increasing the treatment, recycling, and safe reuse of wastewater. The benefits of improved wastewater management extend beyond environmental sustainability, driving progress in public health and economic development through the creation of new business opportunities and 'green' jobs (Bassi et al., 2022; Bassi et al., 2023). Moreover, wastewater has the potential to generate energy, producing up to five times more than is required for its treatment (UNEP, 2023). Despite these benefits, wastewater management remains undervalued globally, with only 11% of domestic and industrial wastewater currently being reused (UNEP, 2023) and just 58% of household wastewater being properly treated (UN-Water, 2023). Figure 1 provide an overview by country regarding the proportion of wastewater flow treated for domestic purposes in 2022 highlighting the differences between regions. Moreover, while progress in wastewater treatment has been positive on a global scale, significant regional disparities remain, particularly in Oceania (excluding Australia and New Zealand) and Eastern and South-eastern Asia.

Figure II.1. Global status of indicator 6.3.1 Proportion of wastewater flow (safely) treated> Domestic (2022)[30]



Source: WHO. Exported from Un-Water hhtps://sdgdata.org/en/indicator/6.3.1

Among the strategies to achieve SDG 6.3, water reuse plays a pivotal role. By treating and reusing wastewater, we can significantly reduce the volume of untreated effluents released into the environment, thereby minimizing pollution and supporting a circular economy. This approach creates a sustainable supply of water for various purposes, from agricultural irrigation and industrial processes to domestic use. Desalination[31] also contributes significantly to SDG 6.3 by providing a reliable source of potable water, particularly in regions facing severe water scarcity (Roggenburg et al., 2021; Swyngedouw, 2013; Bremere et al., 2001). However, this chapter focuses on water reuse, which not only addresses the immediate need for sustainable water management but also offers an opportunity to explore a non-conventional water source relatively under-researched in relation to domestic purposes, particularly in terms of public acceptance.

Although the literature on desalination technologies and their public acceptance is relatively mature, including in Spain (García-Rubio and Guardiola, 2012; Morote, 2017),

[30] Proportion of wastewater flows from households that is treated and discharged in compliance with national and local standards (or in the absence of such data, treated by secondary or higher processes). Includes household wastewater transferred through sewers to a wastewater treatment plant ('treated sewage'), released into an on-site treatment system ('treated in-situ') and released into an on-site system for which faecal sludge is emptied and transported to a treatment plant ('treated from on-site').

[31] Desalination provides a constant source of water in countries that face extreme scarcity and have access to the most abundant form of water found in seas and oceans. However, the 3 E issues -Ecosystems, Energy and Economics) should be taken into consideration in scientific and innovation development, as desalination requires energy and produces secondary effects with negative impacts on the environment (brines for Elsaid et al., 2020).

the reuse of water, especially for domestic purposes, remains largely underexplored. This chapter seeks to fill this gap by offering new insights into the challenges and opportunities of implementing water reuse strategies in Spain, with a focus on public perception and policy development. International research consistently shows that public acceptance of recycled water for domestic use is often met with hesitation (Dolnicar et al., 2011; Khan, 2013; Hui and Cain, 2018; Zhu et al., 2018). However, consumer engagement is crucial to the success of circular economy initiatives (Urbinati et al., 2017; Kuah and Wang, 2020). This highlights the importance of sociological research to better understand and potentially transform public perceptions, thereby facilitating broader acceptance of recycled water as a viable non-conventional resource for domestic use.

Spain, a country characterized by significant geographical and climatic diversity, faces particular challenges in water management. The country's southern regions, in particular, suffer from chronic water scarcity exacerbated by irregular rainfall and increasing demand from agriculture, industry, and tourism (OECD, 2019). The Spanish government's shift from traditional water management strategies, such as inter-basin transfers, to more innovative approaches like desalination and wastewater reuse, underscores the relevance of SDG 6.3 in this context (Molina & Melgarejo, 2015; Government of Spain, 2021). Notably, during the period of this research, the Spanish legislation concerning the reuse of water, particularly for domestic uses, had not seen substantial updates since 2007. However, in 2023, a draft Royal Decree was introduced, aiming to approve a new Regulation on the reuse of water, which was open for public consultation until December 2023. This draft decree reflects the significant advancements made in the reuse of water, highlighting it as a crucial source of supply capable of freeing up higher-quality water resources for more demanding uses. It also recognizes the considerable efforts made by various public administrations to promote these practices (MITECO, 2023). Considering this evolving regulatory landscape, the first paper of this chapter will explore Spain's specific water management issues, including historical context, and how these have shaped the country's current policies to later analyze opportunities to develop non-conventional water resources schemes for domestic purposes[32].

[32] Please note that Chapter 5 was accepted for publication in 2022. Therefore, do not include an analysis of the new Draft Royal Decree, which is not yet in force. However, these regulatory changes highlight the relevance of the topic and the need to generate scientific knowledge to continue informing policymakers for future changes.

This part of the thesis aims to explore the multifaceted challenges and opportunities Spain faces in meeting SDG 6.3, focusing on three key areas: the technical and regulatory landscape of wastewater treatment and reuse, public perception and acceptance of non-conventional water sources, and the broader socio-political implications of these findings. The first paper examines the legal and political frameworks that support or hinder the implementation of wastewater treatment and reuse in Spain, providing a critical analysis of the existing policies and their alignment with SDG 6.3. The second paper delves into the public's attitudes towards using recycled water, particularly for domestic purposes, and identifies the determinants of acceptance. The third paper synthesizes these findings and discusses the implications for future policy development and practice.

The three papers included in this chapter are interconnected through their focus on water reuse and recycled water management in Spain, each addressing a different but complementary aspect of the challenge posed by SDG 6.3. For instance, while the first paper provides a macro-level overview of policies and regulations related to water reuse, the second offers a micro-level analysis of societal attitudes towards recycled water, and the third integrates these perspectives to propose actionable recommendations for policymakers. This integrated approach ensures that the chapter presents a cohesive and well-rounded exploration of Spain's progress towards achieving SDG 6.3 through the lens of water reuse and recycling strategies.

The issues addressed in this chapter are situated within a broader scientific discourse on sustainable water management. Previous studies have highlighted the critical role of wastewater treatment and reuse in mitigating water scarcity, particularly in (semi) arid regions (Jodar-Abellan et al., 2019; Salgot & Folch, 2018). The chapter also draws on recent research that examines the socio-economic and cultural barriers to the acceptance of recycled water, which is crucial for the successful implementation of SDG 6.3 (Nkhoma et al., 2021; Pathiranage et al., 2024; Dolnicar & Schäfer, 2009; Hurlimann & Dolnicar, 2010).

The insights presented here are not only relevant for Spain but also for other regions facing similar water management challenges. By understanding the technical, regulatory, and social dimensions of wastewater treatment and reuse, this chapter provides valuable guidance for policymakers, practitioners, and researchers committed to advancing sustainable water use practices.

Chapter 4.

REGENERATE AND REUSE WATER IN SPAIN: FACTS AND POLITICS

Samara López-Ruiz

Francisco González-Gómez

Abstract[33]

Water scarcity, intensified by climate change and population growth, is a pressing global challenge. In response, the regeneration and reuse of water have emerged as pivotal strategies for enhancing water security. Spain, a country facing significant water stress, has become a European leader in water reuse. This paper examines the evolution of Spain's water reuse practices, focusing on the political, legal, and socio-economic factors that have influenced its development. Despite implementing regulations like Royal Decree 1620/2007 and various national plans, significant regional disparities and socio-economic barriers remain. The study highlights the need for further regulatory alignment with European Union directives and improved public perception of reused water. Key findings indicate that while Spain has made notable progress, maximizing the potential of water regeneration requires overcoming these challenges. This research underscores the importance of continued efforts to ensure sustainable water management, contributing valuable insights into the broader context of global water scarcity solutions.

[33] This abstract has been included for the thesis. The original publication lacks it because it is a chapter of a book.

INTRODUCTION

Climate change is challenging our societies with increasing pressure on all resources needed for life and economic growth. Water is undoubtedly one of the resources most affected by the current climate emergency. The current level of water use is expected to enlarge above 20-30% in 2050, with a growth rate of 1% per year mainly due to population growth, changing consumption patterns, and socio-economic development (UNESCO, 2019). Where urban, industrial and agricultural water demands are in continuous increase, water scarcity is indeed one of the major concerns for society and governments.

In this scenario, regenerating and reusing treated wastewaters must represent an essential tool to improve water security by not only tackling water scarcity but also the adaptation to climate change and facilitating the implementation of a circular economy (Voulvoulis, 2018). Wastewater treatment and reuse are linked, as the reuse of wastewater is associated with a previous regeneration, and both are crucial tools for maximizing circular economy outcomes (Jodar-Abellan et al., 2019). Water reuse can be considered a reliable water supply, largely independent of seasonal drought and weather variability, and able to cover peaks of water demand (European Union, n.d).

The environmental advantages related to water reuse are numerous. For example, they allow mitigating pollution by reducing the amount of wastewater discharged into the environment and benefits ecosystems. It is also well known that water reuse reduces the exploitation of surface water resources, groundwater, and inland water bodies (Gil-Meseguer et al., 2018). Thus, the promotion of reuse water contributes additional new resources along with leading to more sustainable use of the water. Despite reuse's technology is still a growing challenge step at a global level, societal and economic advantages must also be pointed out. Reuse profits are not limited to increased water resource availability. For example, the use of regenerated waters in agriculture decreases fertiliser consumption because nutrients involve in these waters can be leveraged by the terrain, producing general improvements in crop production (Salgot and Folch, 2018). Moreover, compared to other water supplies such as water transfer or desalination, water reuse often turns out to require lower investment costs and energy, also contributing to reducing greenhouse gas emissions (Cornejo et al., 2014; Kirhensteine et al. 2016). Most importantly, since current technology treatments allow producing water with sufficient

quality for most uses, it can spread the usage of water already used. Therefore, regenerated water allow to released volumes of better quality water for more demanding uses like drinking (Jodar-Abellan et al., 2019).

The implementation of these technologies is in line with the approach adopted by several international organizations. For example, United Nations has recently called for wastewater to be considered a valuable resource rather than a costly problem (UN, 2017). Furthermore, the UN is pressing for the worldwide adoption of non-conventional water resources as an essential tool to ensure water availability, sustainable resource management, and sanitation for all (SDG 6). Due to the Agenda 2030 proposal to helved the percentage of untreated wastewater by 2030, a substantial overall increase in the recycling and safe reuse of wastewater is required (SDG 6.3). The European Commission also speaks in the same direction not only in its New Circular Economy Action Plan (European Commission, 2020) but also in the previous ones in 2015 and 2000. Water reuse is also a top priority area in the Strategic Implementation Plan of the European Innovation Partnership on Water, and maximization of water reuse is a specific objective in the Communication "Blueprint to safeguard Europe's water resources". Moreover, as they contribute to ensuring sufficient quantities of high-quality water, water regeneration and reuse contribute to meeting the objectives of Directive 2000/60/EC of 23 October 2000 establishing the Community framework for action in the field of water policy (WFD) by generating sustainable growth, reducing waste and protecting the environment. However, there is much room for improvement. Reuse water is called to be essential in the circular economy paradigm because around 80% of all wastewater is discharged into the world's waterways without treatment causing health, environmental and climate-related hazards (IWA, 2018).

Countries facing water scarcity have been long aware of the potential of water regeneration and reuse for combating shortage. Lessons learned can be drawn from their experiences. Due to its suffering from chronic structural deficit, Spain, among others, has been forced to improve the use of available water resources. At the turn of the twenty-first century, the Spanish government moved away from a strategy based on inter-basin transfers as a response to water scarcity, instead focusing on the promotion of desalinated and to a lesser degree reused water. Especially in tourist areas and those where droughts are more likely. Water reuse is of crucial importance within the Spanish water management model, despite its use has been limited to sectors such as agriculture,

industry, or urban cleaning services, fundamentally. Notwithstanding that in 2016 only 10.43% of regenerated water was reused, Spain is a European leader in this field. Consequently, this chapter focus on the experience of Spain regarding regenerated and reuse water.

The remainder of the chapter is organized as follows. Following this introduction, Section 2 describes the water context in Spain. Section 3 analyse the situation of regenerated and reuse of water in the country, focusing on political and legal issues. Section 4 examines the measures of the national government for the promotion of recycled water in Spain. The chapter ends with a section detailing conclusions and recommendations.

AREA OF STUDY

The research focus on Spain, a country located in southern Europe that covers 505,983 km2 and has a population of almost 47 million. With gross freshwater abstraction, representing 28% of total available freshwater resources in the combination of its high agricultural, industrial and urban water demand (OECD, 2019) makes Spain an important area to investigate regenerated and reuse water. Spain is the third most water-stress country in the EU. Their renewable water resources are 60% below the EU average while their rate of abstraction is 62% higher (PwC, 2014). Currently, the spatial and temporal distribution of rainfall and its water resources is highly variable within the country, with annual mean precipitation ranging from less than 300 mm in the Southeast to 2000 mm in the North-West (Francés et al., 2017). Moreover, the situation is expected to worsen: climate change is expected to have a greater impact on Spain when compared to other EU countries. (Lázaro-Touza and López-Gunn, 2014). CEDEX (2017) points out that water resources are projected to reduce by 28-40% by 2050 as a result of climate change consequences. More than 74% of the Spanish territory is already at risk of desertification, with regions with a “high” or “very high” risk of desertification across 90% of their territory (WeAreWater, 2022).

Agriculture and tourism are the main water demanders in the country (Cruz-Pérez et al., 2020). As may be expected from *the vegetable garden of Europe*, agriculture is the most consuming water use in the country. Spain, which has the province with the largest concentration of greenhouses in the world (Caparrós-Martínez et al., 2020), is the third country with the highest proportion of irrigable area in the EU (WrAreWater, 2022. This sector accounts for about 80% of the total water use (INE, 2018), while in 2014 only

represents 67% (PwC, 2014). On the other hand, despite tourism being known as one of the cornerstones of the Spanish economy (OECD, 2020), it is also a massive consumer of natural resources, water included (Toth et al., 2018). In sooth, tourism is been quoted to be in a position to outcompete agriculture for water (Auernheimer & González, 2002). The literature points out that a significant share of renewable water sources is used in Spain to satisfy tourism needs (Gossling et al., 2012). One of the reasons is that the presence of tourists can substantially inflate the demand for water for residential uses, especially because tourists' consumption is different from that of residents (Gossling et al., 2012; Toth et al., 2018).

During the second half of the twentieth century, along with the expansion of the irrigated land and the development of tourism activities, Spain also experienced urban development, industrialization, and the expansion of hydroelectric power. All together have favoured a sharp increase in water demand, sometimes exceeding the natural supply of available resources (Marote, Olcina & Rico, 2017). During the twentieth century, the Spanish government mainly managed the situation following a strategy based on inter-basin transfers, reservoirs, and groundwater harnessing which do not increase the water volumes within the country (Molina and Melgarejo, 2015). However, many conflicts emerge between donors and the receiving basins, especially when the different political parties governed the participating regions. On the contrary, at the turn of the twenty-first century, state policies focus on increasing water volumes. To satisfy the current and future demand for water sustainably, the Spanish government is banking on the development of non-conventional resource schemes such as desalination and reused water, not only as complementary measures but also as a real strategy to replace transfers and avoid controversial related issues.

LEGAL FRAMEWORK AND POLICY ENVIRONMENT OF WATER REGENERATION AND REUSE

Until 2020, there were no Europe-wide regulations governing specific uses of regenerated water. Regulation (EU) 2020/741 applies only to the reuse for agriculture (by establishing 4 different water qualities for different conditions) and still leaves the rest of uses (industrial, environmental, etc.) up to the Member States, which shall apply from 27 June 2023. However, over the years, the EU has developed a portfolio of directives developed to protect the environment and human health, and regulate the water cycle becoming of major importance for water reuse. Water Reuse Europe, a not-for-profit association

provides an accurate chronology of these regulatory initiatives on its website[34]. This shows that water reuse regulation is being an issue of increasing importance for Europe in the past decade. However, it was partially ignored in the past.

In the European context, regenerated water must be under with what is established in the WFD since this regulation establishes the fundamental principles of water law in Europe. From its rules and principles, it can be inferred that the use of regenerated water must be carried out consistently with hydrological planning, not jeopardise the good ecological status of surface or groundwater bodies and comply with the cost recovery principle.

On the other hand, the first reference to water reuse in the European regulation is found in the Urban Wastewater Treatment Directive (91/271/EC), which imposes the collection and treatment of wastewater from all urban areas if more than 2,000 habitants aiming to protect the environment from adverse effects of urban wastewater discharges[2]. The Directive states in Article 12 that treated wastewater shall be reused whenever appropriate, providing disposal routes that minimize the adverse effects on the environment. In doing so, it defines the *appropriate* treatment that urban wastewater must follow before entering collecting systems. The use shall be appropriate when the quality standards for each type of use provided for the regulation are met, without the application of the regenerated effluents being considered a direct discharge and therefore subject to discharge authorisation.

The Spanish case follows a different path. The Water Act of 1985 legally recognised treated wastewater reuse and Article 109.1 of Royal Legislative Decree 1/2001, of 20 July, approving the revised text of the Water Law (RTWL) brought together a series of principles that laid the foundations for addressing the challenges posed by the use of these resources. Moreover, Act 11/2005, of 22 June, which amends the Water Act, established the Government as competent to establish the basics conditions for the reuse of water, specifying the water quality required for treated wastewaters according to the uses considered.

Contrasting with the European experience, Spain has a specific regulation that sets the legal framework for water reuse since 2007: Royal Decree (RDR) 1620/2007. Autonomous communities, local authorities and the National Water Council were involved in drawing up these regulations, but also the conjunction of several Ministries:

[34]See https://www.water-reuse-europe.org/about-water-reuse/policy-and-regulations/#page-content

the Ministry for the Environment, Agriculture, Food and Fisheries, and Public Health and Consumer Affairs.

The RDR develops the general principles on which Article 109.1 of the RTWL builds the legal framework for water reuse. Firstly, it defines what should be understood by reuse, differentiating between treated water and regenerated water. According to RDR, regenerated water is this that obtains an additional treatment to that which is mandatory for the treated waters, becoming water suitable for other uses (Article 2.c, RDR). The Royal Decree also fulfils the general purpose of the General Health Act. It names the need for competent authorities in this field to show an active involvement by monitoring public health, and by promoting and improving the systems necessary to satisfy water quality parameters compatible with public health conditions of the population at large.

The Spanish law allows the reuse of regenerated water for five types of uses: agricultural, urban, agricultural, recreational and environmental. Chapter II sets several forbidden uses; e.i. Drinking uses are only allowed under the previous declaration of a catastrophe situation, in which case the public health authority will specify the necessary quality levels for that water. This aspect of the regulation probably should be re-considered in a near future (López-Ruiz et al., 2021). The regulation deals with the aspects relating to the legal regime, such as the title required for its use, the procedures for obtaining the concession and/or authorization, and the contracts for the assignment of rights.

Lastly, it establishes the quality conditions that reclaimed water must meet for its use, indicating the permitted and prohibited uses and the regime of responsibilities concerning the maintenance of quality. The quality requirements set by this regulation require tertiary treatments of different types, depending on the characteristics of the effluent of each WWTP, and the intended use. Regarding the quality of regenerated water, Annex I. A provides 14 different values, grouped into five types of uses aforementioned, and Annex I. B sets minimum sampling and testing frequencies for reclaimed water.

Chapter III allows the possibility of contracts for the assignment of water use rights between the holder of the reuse concession or the authorization for reuse and another concessionaire or holder of rights of equal rank[35]. The procedures for obtaining a concession are three depending on who the applicant is, depending on whether it is a

[35] Annex II includes the model application for concession or authorization including all the documentation required to be able to reuse this water

concessionaire and/or has a discharge authorization[36]. Because the legislation aims to promote water reuse, applicants who already are discharging permit holders (for water they use and treat themselves) need only a supplementary authorization. As discharge permit holders already have the necessary infrastructure for wastewater treatment and will be able to take on the activity at a lower cost. According to article 5.4, the holder of the water reuse concession or authorization is responsible for the quality of the regenerated water and for monitoring it from the time the treated wastewater enters the WRF to the point of delivery. However, the user of the regenerated water is the responsible for preventing any deterioration in its quality from the point of delivery to its points of use (Article5.5).

Royal Decree applies exclusively when the destination of the treated waters is the hydraulic public domain or maritime-terrestrial public domain and its discharge is regulated according to a concession or authorization of discharge with the requirements provided for in the consolidated text of the Water Law. In general, discharges to the sanitation system that are regulated through municipal ordinances are excluded from the scope of the RD of reuse.

From the industry point of view, recycled water is understood to be water used more than once in the same place before being discharged into the water cycle. The water is recycled within the same process. Because it is not a discharge of treated water nor are they subject to the discharge authorization. Therefore, their use is not regulated in the RD of reuse. However, if industry intends to reuse treated water from its own treatment plant, for example, for the irrigation of its gardens they must apply RDR requirements. Moreover, the use of reclaimed water for cooling or heating applications is very restricted due to the fear expressed by the health authorities to legionella, which limits the largest potential use in the industry. This also generates mistrust in the potential users. On the other hand, for agricultural uses, when more than one petitioner requests the reuse, the RDR establishes the preference for the reuse of water of the discharge holder against the first

[36] The use of regenerated water in agriculture or other types of land uses (irrigation of gardens, golf courses, etc.) is not subject to discharge authorisation because it does not involve a direct or indirect discharge, but a diffuse discharge. Consequently, neither would the RTWL's sanctioning regime be applicable to unauthorized discharges.

user of the derived water and against third-party users who do not coincide with the figure of the first user.

Finally, public administrations can promote these initiatives both directly and through reuse plans and programs (Article 7, Chapter IV). The objective is to plan the necessary infrastructures (collectors, WWTP/ERAR, reclaimed water distribution infrastructures) and to plan their implementation by budgetary availability. These plans will specify the economic-financial analysis carried out and the tariff system that corresponds to apply in each case. The execution of these infrastructures makes it possible to make the facilities available to the interested parties, although they must obtain the corresponding concession, or where appropriate complementary administrative authorization, to dispose of the water. The Administration promoting the initiative itself must obtain a concession or authorization from the Confederation if it intends to use the reclaimed water directly; since one thing is the execution of the works and another, the ability to dispose of and enjoy a public property such as regenerated water. Its worth-knowing that If more than one applicant is a third-user but neither the holder of the discharge authorization nor the first user were petitioners of the concession, the preference will be determined based on those established in the corresponding basin hydrological plan. Failing that, the criterion established in Article 48.3 of the Water Law will be followed.

In 2009, with the limit of the first hydrological planning cycle (2009–2015), a preliminary sketch for the National Water Reuse Plan was written. Although it was intended to be developed alongside the Basin Hydrological Plans and the National Water Quality Plan, it was not approved. Therefore, the Royal Decree 1620/2007 remained the current basic regulation of regenerated waters in Spain. However, after the later proposals and decisions by the EU Commission and Parliament, 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 are more restrictive than those applied in Spain (CONAMA, 2019). Consequently, it is probably that Spain has to modify its regulation regarding regenerated water and water reuse in the following years.

SITUATION OF REGENERATED AND REUSE WATER IN SPAIN.

As appears from the fine imposed on Spain, in 2018, by the ECJ for non-compliance with the 1991 Directive on wastewater treatment[37], the European Commission considers that the state of wastewater treatment in the country is not satisfactory. The issues identified were (1) the existence of deficiencies in the treatment and collection of urban wastewater with some parameter values below mandatory requirements and (2) the failure to incorporate tertiary treatments in all towns above 10,000 habitants. Currently, more than 500 urban agglomerations do not treat their discharges as required by Directive 91/271/EEC, on urban wastewater treatment, whereby many of them are involved in infringement proceedings brought against Spain by the European Commission (MITECO, 2022).

Despite wastewater treatment being seen as a challenge in Spain, especially for small population centers, it is also an opportunity to manage water stress. The country has improved the proportion of the population connected to wastewater treatment plants during the last two decades. While in 2000 the population not connected to these facilities was 12 percent, in 2017 it decreased up to 3 percent. Additionally, the change in urban wastewater treatment in Spain is also felt in terms of technology improvement. In 2017, 69 percent of the population was connected to plants equipped with tertiary treatments, contrasting with the 60 percent in 2010 or 15 percent in 2000 (EEA, 2018). According to the Ministry for the Ecological Transition (2018), 73 percent of the water that reaches sensitive areas is subject to tertiary treatment.

Despite Spain being the fourteen country with the largest population connected to WWTP prepared to offer tertiary treatment, there is little use of wastewater. Around 55% of the regenerated water is discharged into the riverbed and about 33% has the sea as its destination (INE, 2020c).

Nevertheless, speaking of volume production, Spain is a European leader in water reuse. It is estimated that Spain already reuses between 7 and 13 percent of the treated water, which translates to more than 400 Hm3 per year (AEAS y AGA, 2020, INE, 2020C). In

[37] The amount of the fine increases by 10,950,000 milions per semester of delay in meeting the obligations to treat wastewater of nine urban agglomerations with more than 15,0000 inhabitants (MITECO, 2018). Already it reaches the amount of 63 million euros. https://www.miteco.gob.es/es/prensa/ultimas-noticias/el-tribunal-de-justicia-de-la-ue-multa-a-espa%C3%B1a-por-incumplir-la-directiva-de-saneamiento-y-depuraci%C3%B3n-de-aguas-residuales/tcm:30-479802

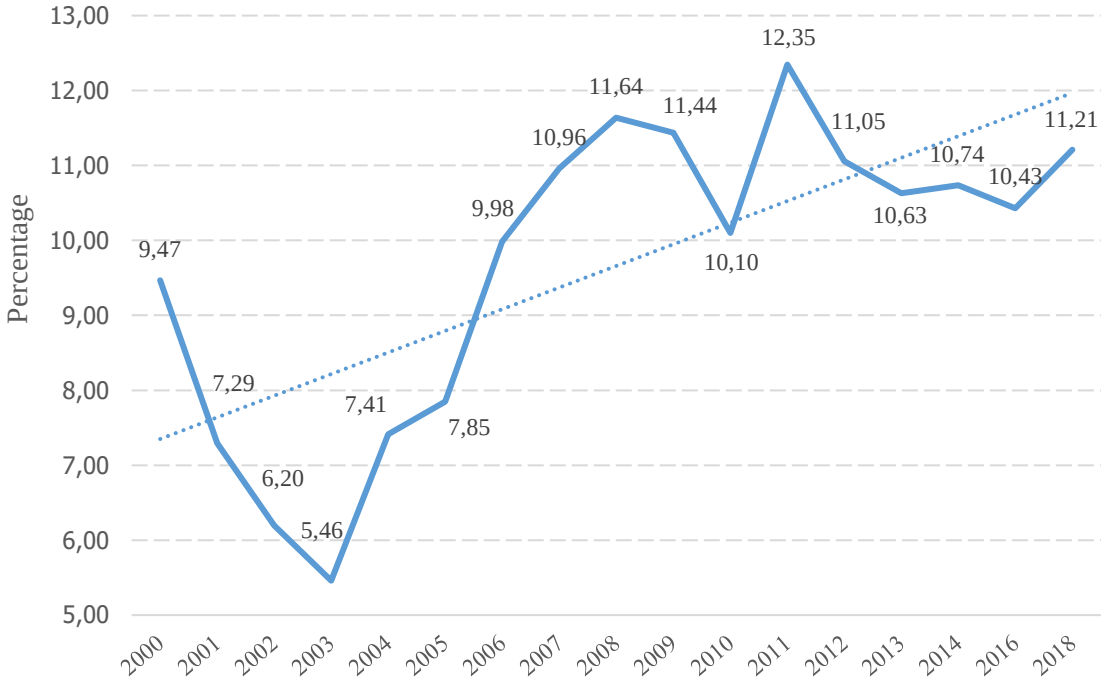
2018, at least 385 Hm^3 (8 percent) of the treated water was reused. Reuse not only responds to growing water demands but is also a crucial tool for environmental protection of water bodies (reducing extraction and discharges) which delves into water saving, sustainability, and circular economy. Compared to alternatives such as desalination or transfers, the regeneration of wastewater for subsequent reuse has clear advantages (General Directorate of Water, 2020b; Government of Spain, 2020):

- It is a less expensive option.
- It is an option that generates fewer environmental impacts.
- Compared to other alternatives, it is not a source of territorial tensions.

The production capacity of wastewater treatment in Spain is around 8000 hm^3 per year, while flows treated represent 4800 Hm^3 in 2018. Currently, 27 percent of the more than 2,000 wastewater treatment plants (WWTP) in Spain are technologically prepared to offer tertiary treatments that enable the reuse of water (AEDyR, 2019). It alone accounts for almost half of the total volume of reused water in the EU (493 Mm3/y) and represents nearly 40% of its projected potential in 2025 (TYPSA 2013). However, the current percentage of reused water is far from the forecasts made in the National Water Reuse Plan (General Directorate of Water, 2010), indicating there is room for action in this area.

As shown in Figure 4.1, the evolution of the percentage of reused water, concerning regenerated water, between 2000 and 2018 followed an increasing trend over time. However, the evolution seems to have stagnated in recent years.

Figure 4.1. Evolution of the percentage of reused water concerning treated wastewater (2000-2018)



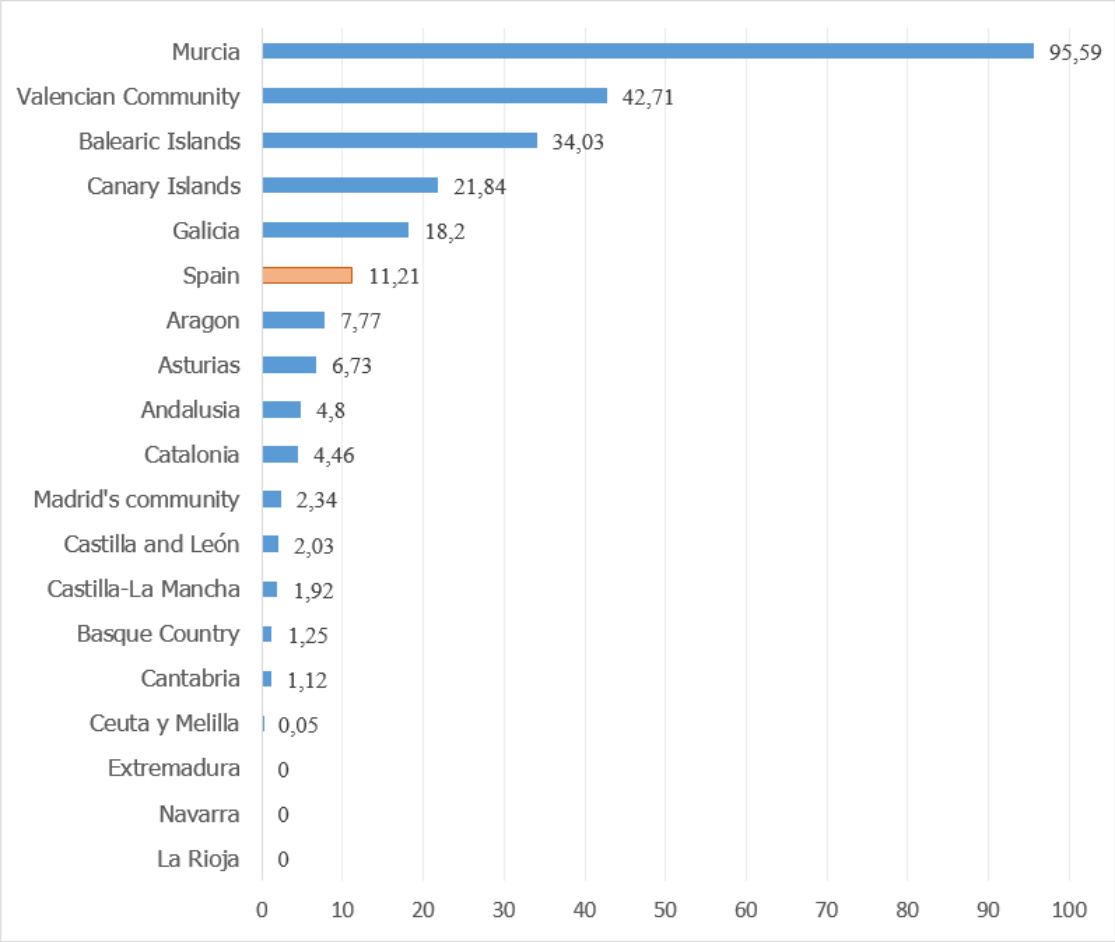
Source: Own elaboration based on INE data (2020)

Figure 4.2 clearly shows the huge differences between the Spanish regions. In Murcia, almost all treated water is reused (95.6 percent) while there are at least three Autonomous Communities – La Rioja, Navarra y Extremadura- that do not reuse water at all. Along with Murcia, only Valencian Community, Balearic Island, Canary Island, and Galicia show a percentage of water reuse above the national average, which corresponds to the territory of the river basin districts in which reuse plays a strategic role (Segura, Júcar, Balearic Islands, and Canary Islands). These two Basins, characterised by profitable irrigated fruit and vegetable production and structural water deficit, are responsible for more than 60% of the total reused volumes in Spain (Navarro, 2018). In these areas, regenerated water allows for more efficient use of freshwater by avoiding discharge to the sea. Additionally, it contributes to increasing resilience to drought and stabilising the water supply (Molina and Melgarejo, 2016). On the other hand, the reuse of water in most Autonomous Communities is a non-existent or practically non-existent measure. For example, in Guadiana and Guadalquivir, it represents only 2% of the national volumes.

Table 4.1 clearly shows the extensive differences between the Spanish River basin districts. From a total (or quasi-total) urban water desalination/reuse dependency (Melilla,

Ceuta, Segura, and the Canary Islands) to almost no dependency (Jucar and Inland Basins of Catalonia -Barcelona area-) through moderate dependency (the Balearic Islands, Andalusian Mediterranean basins). Focusing on river basins, the contribution of the Jucar and Segura river basins (SE of Spain, Mediterranean coast) represents about 60% of the whole reuse in Spain. Indeed, in most regions, traditional water resources are the only ones. However, according to forecasts included in the new hydrological basin plans for the 2022-2027 cycle, they will play a more relevant role shortly.

Figure 4.2. Percentage of reused water compared to wastewater by Autonomous Community (2000-2018)

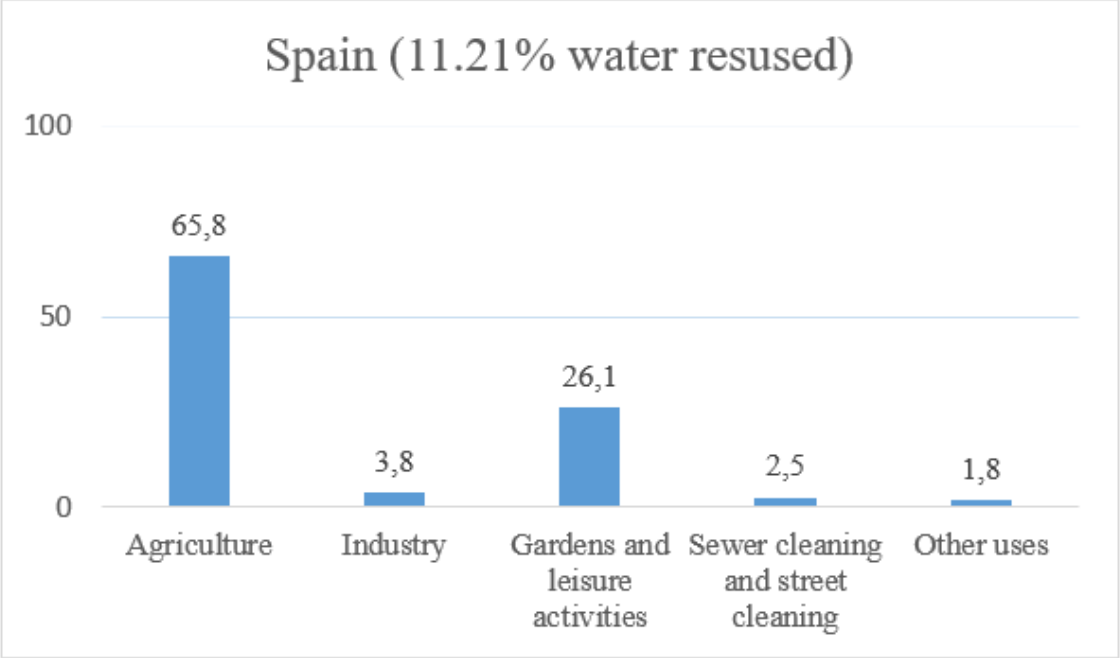


Source: Own elaboration based on INE data (2020)

By far, agriculture is the main destination of water reuse, ranging from 49 to 65.8 percent depending on the source consulted (INE, 2020; AEAS-AGA, 2020). According to INE

(2020) irrigation concentrates over 80 percent of water reuse[38]. Specifically, agricultural irrigation and irrigation of golf courses and public parks concentrate 65.8 percent and 26.1 percent respectively. Both activities are heavily concentrated in the Mediterranean, especially in Murcia and the Valencian Community, both regions with higher rates of water reuse.

Figure 4.3. Percentage of water reuse by actitity (2020)



Source: Own elaboration based on data from INE (2020)

Both regions along with western Almeria (Andalusia) have agriculture specialized in fruit and vegetable produce mainly for export. Because they suffer from insufficient and irregular precipitation, irrigation becomes necessary. In addition, as their agriculture orchards are close to urban areas, they can benefit from wastewater flows, which have been used to complement conventional water flows for growing crops. Summing up, several economic, environmental, and territorial characteristics helped explain why water reuse is more relevant in some areas. Moreover, water reuse for irrigation does not usually need large plants or expensive treatments, making this source more competitive compared to p.e desalination. Irrigation communities are the main beneficiaries of regenerated

[38] According to AEAS-AGA (2020) the destination of reused water in percentage terms would be as follows: agriculture: 49%; other uses; 28%; industry: 12%; gardens, sports, and leisure areas: 9%; sewer cleaning and street cleaning; 0.5%

water. Because of that, in some cases as Benidorm, where tourism is a main consumer of water, these communities relinquish their right to groundwater in exchange for regenerated water without the cost, improving the efficiency of water use (Ricart et al., 2021).

As for leisure and urban uses, irrigation of golf courses is the most significant item within the category. Despite water stress in Mediterranean Spain, golf courses proliferated during the first decade of the twenty-first century. There are at least 446 distributed in the whole country (Statista, 2021). Most courses are located in Andalusia (106). Although water is one of the main constraints for the development of golf courses, given the high requirements for maintaining grass cover[39], Valencia (38) and Murcia (19) showed the fastest development.

The interest in regenerated water, along with other non-conventional water resources, is increasingly required by legal regulations at the national and regional levels. This phenomenon is partly explained by the increasing pressure on available water resources due to the temporal coincidence of the increase in agricultural, tourism, and golf-related demands. Since late 1980, at least Catalonia, Balearic Island, Andalusia, and Murcia have passed legislation to make the use of regenerated water mandatory for golf irrigation when it is possible.

MEASURES OF THE GOVERNMENT OF SPAIN FOR THE PROMOTION OF RECYCLED WATER

The history of wastewater reuse experience in Spain is diffuse due to wastewater treatment challenge and, initially, lack of regulation. The Spanish Government has approved several Plans promoting water regeneration and water reuse which are being helpful in positioning Spain as top-ten worldwide country with the highest rates of wastewater reuse in 2018 (AEDyR, 2019).

The first experience took place in Gran Canaria (The Canary Islands) in the 1970 where regenerated water was used for agricultural irrigation. This practice was later extended to further regions such Balearic Islands or the Catalonian coast. Volume of water reuse for agricultural purposes increased in the beginning of 1980 due to the construction of plants with settling tanks in Murcia; most of them became conventional treatment plants with

[39] On average, an 18-hole golf course consumes between 1500 and 2000 m3/day during the period of maximum irrigation, usually summer, or up to 300,000 m3 per year

tertiary treatment that regenerate water from several cities located in the Valencian Community.

Large-scale purification began in the middle 90s with the National Plan of Sanitation and Water Treatment (PNSD) (1995–2005), aiming to abide by Directive 91/271/EEC. Due to wastewater treatment presenting autonomous competence, PNSD was designed to coordinate the actions of public administrations in this matter. During its implementation, the total volume of treated wastewaters increased 0.18m3/inhabitants/d (Jodar-Abellan et al., 2019). The total budget allocated for this program was 11.4€ billion; 25% was assigned to actions classified as general interest, and the remaining 75% to CAPEX and OPEX costs. Since its approval in 2005, it allowed the construction of around 700 water treatment plants, being crucial in Spain achieving a suitable compliance degree with Directive 91/271/EEC (84%). It was also in the 90s when the irrigation of golf courses with regenerated water began.

Law 11/2005 is an important measure for promoting water reuse through the national programme "Actions for Water Management and Water Use", known as the WATER programme. This new programme fixed numerous actions to improve Spanish water management, highlighting water reuse and desalination. With both it was planned to increase the water resources, already contributed to by reuse, by 170 hm3/year and , in 2012, the number of regeneration projects increased in Spain by three to six times more than in 2004 (Iglesias et al., 2010)

Later, in 2007, the National Water Quality Plan: Sanitation and Water Treatment 2007-2015 [PNCA] was approved. The basic objectives of the Plan are in line with those stated in Directive 91/271/EEC and the Water Framework Directive (WFD). Although PNCA's considered investment for a value of 19,645 M€, the implementation of most investments have been avoided because of the economic crisis of 2008. The PNCA fixed that around 1200 hm^3/y, 34% of the total wastewater volume that could be treated in 2015 (approximately 3500 hm_3), would be adequately generated and be potentially available for reuse. Nevertheless, this was not enough to comply with Directive 91/271/EEC.

On the other hand, the National Water Reuse Plan (2010–2015, PNRA) tried to obtain the support and involvement of the Spanish Basin Organizations, and the Autonomous Communities for the financing and implementation of infrastructures related with treatment, accumulation, and transport of regenerated waters. Among other objectives, it

tries to promote the sustainable reuse of regenerated waters for different uses and estimate the potential for future reuse. However, it must be said that because of the fines mentioned in the previous section that Spain has suffered throughout several years, the Government promoted a new watershed planning process in 2014, because the Water Programme largely failed in its main objective of replacing water transfer with non-conventional projects. Regeneration projects were here identified as appropriate strategies but not as the definitive solution. However, the CRECE Plan from 2014 do invest in 400-water treatment plans to improve water quality of rivers by purifying waters from city sanitation networks.

Finally, the recent response of the Government of Spain to comply with Directive 91/271/EEC is materialized in the National Plan for Purification, Sanitation, Efficiency, Saving and Reuse (DSEAR) Plan (Government of Spain, 2021a), which the main objective is to complete the investment policy necessary to comply with the requirements in terms of sanitation and water purification. Approved at the end of July 2021, the objectives established in will be implemented within the framework of the third cycle Basin Plans that are operational since early 2022.

Table 4.1. Programmed investment (in millions of euros) in desalination and water reuse by river basin (2022-2027).

River basin	Desalination and reuse	Total	%
MIN	0	312,26	0,00%
COR	0,55	454	0,12%
COC	21,05	673,49	3,13%
DUE	0	2742,35	0,00%
TAJ	105	3193	3,29%
GDN	0	1405,12	0,00%
GDQ	3,05	3762,37	0,08%
SEG	697	2715	25,67%
JUC	124,61	1788,42	6,97%
EBR	1	3077,5	0,03%
CEU	0	112,1	0,00%
MEL	24,18	100,29	24,11%
TOTAL	976,44	20335,9	4,80%

Source: own elaboration based on data from MITECO (2022)

Concerning the financing of actions, the recent Recovery, Transformation and Resilience Plan (Government of Spain, 2021b, p.148) dedicates in component 5 dedicated to the preservation of coastal space and water resources, aid for investments that allow the materialization of actions of purification, sanitation, efficiency, savings, reuse and security of infrastructures. Additionally, in the complementary document of the DSEAR plan called "improvement of the financing of the measures," purification and reuse measures foreseen in the hydrological plans can be seen (General Directorate of Water, 2020a).

According to the General Directorate of Water, there is still much to be done to increase the volumes of reused water in Spain (Government of Spain, 2021b). That is reflected in the complementary report of the DSEAR plan promotion of wastewater reuse. In this sense, as can be seen in Table 4.2, it will be necessary to face some challenges to achieve it.

Table 4.2. Summary of challenges and proposals for the promotion of reused water

Challenge	**Proposal**
Incentivize the use of reused water to free up resources in bodies of water under significant pressure	Analyze the potential for reuse in Spanish basins and its impact on the allocation and reserve of resources Prioritize reuse actions aimed at achieving good status in water bodies
Remove institutional and financial barriers that limit the use of reused water	Improving the regulatory and financial framework for reuse Review and adapt RD 1620/2007 to Regulation 2020/741
Improved perception and social acceptance of reused water	Develop a reuse section on the MITERD website Carry out a communication campaign to society about reused water

Within the framework of the impulse that the public administration wants to give to the reuse of water in the coming years, it is foreseeable that greater volumes of regenerated water will be allocated for irrigation. According to the OECD, the global availability of water for irrigation is expected to decrease as a result of the increase in other uses and sectors (OECD, 2012). In this scenario, unconventional sources of the resource will be increasingly present, mainly reused water. A higher destination of regenerated water for environmental purposes is also foreseeable. In this sense, it is somewhat surprising the

low relevance of the destination of regenerated water to the recharge of aquifers, wetlands or improvement of ecological flows. In this regard, industry operators highlight the need to establish a policy and rules to recharge some aquifers (AEAS, 2019).

In fact, the DSEAR Plan proposes to prioritize reuse actions aimed at achieving the good status of water bodies (Government of Spain, 2021a). In any case, of all the challenges that lie ahead to promote the reuse of regenerated water, there is an important issue to be resolved. Who should pay for water regeneration and reuse? In some cases there is doubt about the viability of the projects, in other cases it may be controversial to determine the ultimate payer. As Molinos-Senante et al. (2013) point out; the main obstacle to the implementation of reuse projects is economic viability. In these situations, the viability of the projects will be linked to the financing of the activity via taxes. In cases where it must be invoiced, from the point of view of pricing there is an obvious trade-off between the promotion of the use of regenerated water and the achievement of cost recovery; both objectives are incompatible. In the case of reused water intended for the conservation of the environment, especially the recharge of aquifers, situations may arise in which it is necessary to invoice and others in which it should not be invoiced. According to the principle of cost recovery, payment should be made by the cause or causes of the overexploitation of the aquifer. But this must be accompanied by more means and a greater determination for the control of the exploitation of aquifers than that shown to date by the public administration.

On the other hand, it is true that in cases where there are no single or clearly identifiable causes of overexploitation or pollution, the recharge of aquifers and the maintenance of reserve flows can be understood as actions of general interest that should not be billable (Molinos-Senante et al., 2013). In the case of agriculture, there is an obvious difficulty in reconciling the objective of cost recovery and the promotion of the use of regenerated water, since the price of drinking water is subsidized.

In addition, among the different sources of the resource, regenerated and reused water is the one that has the least acceptance among farmers and also among consumers of rural products. Therefore, the pricing of regenerated water requires a thorough debate and the necessary involvement of the public administration. Without the involvement of the public administration and the establishment of regulation and measures to make these projects viable, there may be a situation of excess capacity similar to what happened with

the desalination plants in the Mediterranean Arc. In this sense, it should be clear that to strengthen the use of reused water, it is not enough to free up resources from the administration to generate the necessary infrastructure. This aid must be seen in a broader framework of water and cross-cutting policies – such as agricultural and environmental – in which the administration creates rules that encourage the use of reused water. If the public administration successfully implements the different measures to achieve the challenges posed, it is expected that a market will be formed in which there is sufficient demand for the supply of reused water is generated by operators. In this context, it is expected that organizations and companies in the sector will be more involved in the coming years in the line of business of water reuse. The public administration will free up resources for investment in circular economy proposals, which will be an opportunity for companies in the sector.

Precisely, in the I Circular Economy Action Plan 2021-2023, the Axis of action Reuse and purification of water is incorporated. It states that in the new irrigation policy of the Ministry of Agriculture, Fisheries and Food, projects that allow replacing the extraction of surface or groundwater with regenerated water will be prioritized as bankable. In addition, it is expected that part of these investments will be bankable through the Recovery, Transformation and Resilience Plan of the Spanish economy (component 3).

In the DSEAR Plan, the generation of trust and the improvement of the perception and social acceptance of regenerated and reused water is considered paramount (General Directorate of Water, 2020b, p.30). In addition, the I Circular Economy Action Plan provides for a line for the dissemination and awareness of irrigators and the final consumer on the benefits of the reuse of treated water. And it is not enough in itself the intention to regenerate water for reuse and grant aid for the adaptation of existing facilities, as we warned we must also ensure the existence of a market for regenerated water. In addition to having potential buyers of that regenerated water, for investment in circular economy projects to be successful, the acceptance of producers and consumers is necessary (Urbinati et al., 2017; Kuah and Wang, 2020). However, the population is reluctant to use recycled water, both for agricultural and residential destinations. For example, as López-Ruiz et al. (2021) point out, there is high reluctant to recycled water to some domestic uses In agriculture, producers are reluctant to use reused water, mainly due to the high cost of the cubic meter of water compared to that obtained through conventional sources (Government of Spain, 2021c). Meanwhile, consumers are reluctant

to purchase products that have been irrigated with reused water, mainly due to a 'disgust factor' (Lahlou et al., 2021). In residential uses, perceived health risk and environmental awareness explain the consumers' reluctance (López-Ruiz et al., 2021)

CONCLUSIONS

Water availability is increasingly challenged by climate change, population growth, and changing consumption patterns worldwide. Countries facing water scarcity like Spain have been long aware of water reuse, among other nonconventional resources, potential to improve water security.

This chapter shows that despite Spain being a European leader in water reuse there is much room to improve in water regeneration. The inclusion of Spain in the European Economic Community implied its adaptation to the European regulation on wastewater treatment, which was more rigorous than the Spanish regulation. The country has improved the proportion of the population connected to WWTPs during the last two decades and almost 70% of the population is connected to plants equipped with tertiary treatments. However, as appears from the fine imposed on Spain, in 2018, by the ECJ for non-compliance with the 1991 Directive on wastewater treatment, Spain must still improve their capacity for regenerating water.

On the other hand, Spain not only leads Europe from a total volume of reused water point of view, but also as a pioneer in regulating water reuse. Despite the fact that until 2020, there were no Europe-wide regulations governing specific uses of regenerated water, Spain has a specific regulation that sets the legal framework for water reuse since 2007 (RD 1620/2007). The evolution of the percentage of reused water in the last two decades followed an increasing trend over time. However, it seems to have stagnated in recent years. Moreover, there are huge differences between the Spanish regions. Some are large above the national average while in others is a non-existent measure.

Over the years, the Government implement a huge number of plans to promote regenerated water within the country aiming to abide by Directive 91/271/ECC. Nevertheless, in recent years they also have passed plans, like the DSEAR plan and I Circular Economy Action Plan 2021–2023 that focus not only on regenerating wastewater but also on water reuse. This strategy is in line with international objectives of considering wastewater as a valuable resource. However, after the later proposals and decisions by

the EU Commission and Parliament, Spain probably has to modify its regulation of regenerated water and water reuse in the following years.

Chapter 5.

ACCEPTANCE OF DIRECT POTABLE WATER REUSE FOR DOMESTIC PURPOSES: EVIDENCE FROM SOUTHERN SPAIN

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Abstract

Under current Spanish law, domestic use of recycled water is only permitted during an officially declared disaster; however, it could be an option from a regulatory perspective. However, would Spaniards be willing to use recycled water in the home if necessary? This study investigates the public acceptance of recycled water use in Spanish households and identifies the determinants of acceptance. In data from 791 questionnaires administered in southern Spain, recycled water is the least acceptable option for alternative sources of water, behind both rainwater collection and desalination. Perceived health risk and environmental awareness explain the differences in acceptance.

Keywords: direct potable reuse · domestic water use · acceptance · Spain · Andalusia

INTRODUCTION

Given the growth of the world's population and the adverse effects of climate change, there is a heightened risk of water stress in many areas of the planet (Bastin et al., 2019). One possible response to water scarcity is to increase water availability through the use of non-conventional sources. Such sources include recycled water, desalinated water and harvested rainwater, all of which improve supply stability and redundancy, as well as providing many economic and social benefits. At the same time, these alternative sources help mitigate many negative environmental impacts, including those resulting from the overexploitation of natural sources (Hartley et al., 2019). Uses for this water include irrigating crops, replenishing groundwater sources (aquifer recharge), greening urban landscapes, and cooling power plants and oil refineries (USEPA, 2012).

The fact that conventional resources cannot meet the growing demand for water has sparked a debate on the domestic use of non-conventional sources of potable water. The UN has recently called for wastewater to be considered a valuable resource rather than a costly problem. It is also considering its use for domestic purposes (United Nations, 2017). Since existing treatment methods can provide water suitable for human consumption, reclaimed wastewater may well become an increasingly widespread alternative water source (Chen et al., 2013; Ong, 2016). In some countries, it is not just a temporary solution. So, the future sustainability of water resources could depend on its extensive implementation. However, like desalinating seawater, recycled water takes high technology and lots of energy, making the final product more expensive than water from conventional sources (Bell, 2015). Another obstacle to the acceptance of recycled ware is psychological distaste, or the "yuck factor" (Furlong et al., 2019). Despite the strictly enforced, high quality standards to which it is subject, many people hesitate to use recycled water (Furlong et al., 2019).

Studies have considered the degree of acceptance of the use of recycled water in various parts of the world, including Australia (Dolnicar and Schäfer, 2009; Fielding et al., 2015), the United States (Ormerod and Scott, 2013; Ishii et al., 2015; Hui and Cain, 2018), China (Gu et al., 2015; Liu et al., 2018; Zhu et al., 2018) and South Africa (Khan, 2013). In some cities, domestic use of recycled water already enjoys public approval. One such example is Windhoek, the capital of Namibia, where since 1968 direct potable reuse (DPR) systems have supplied recycled water for domestic consumption (Van Rensburg,

2016). In fact, recycled water covers 50% of the city's drinking water demand (NRC, 2012). In Singapore, indirect potable reuse (IPR) systems meet up to 40% of water demand, supporting a sustainable water distribution system (EPA, 2017; WHO, 2017). The Beaufort West water reclamation plant in South Africa also produces water that meets national standards for potability (Lahnsteiner et al., 2017). In addition, several US cities have operational IPR or DPR plants. These plants produce water that meets the standards established under federal law, specifically the Clean Water Act and the Safe Drinking Water Act, which regulate the quality of drinking water, regardless of its origin.

However, mention must also be made of places where such proposals have been rejected by the public. A prime example is the municipality of eThjekwini, South Africa, where a proposal to use recycled water (DPR) to ameliorate water scarcity was rejected due to negative reports circulating in the media (Khan, 2013). Similarly, in a referendum in Toowoomba, Australia, in 2006, residents voted against the construction of a wastewater recycling system to supply additional water to the area (Hurlimann and Dolnicar, 2010b). These experiences underscore the need to understand the factors that influence users' acceptance of recycled water, to ensure that investments are not wasted (González-Gómez et al., 2020).

Against the backdrop of these global experiences, this study focuses on southern Spain. Water is already scarce in this region, and the situation is expected to worsen, as climate change is expected to bring increasingly severe droughts to Andalusia and other Spanish regions (Mendez-Jiménez, 2012). At the turn of the 21st century, the Spanish government moved away from a strategy based on inter-basin transfers as a response to water scarcity, instead focusing on the construction of desalination plants along the entire Mediterranean coast. To a lesser degree, it also started to promote recycled water, but only for certain uses. Despite the water scarcity in the region, current legislation only allows the use of recycled water in the home in the event of a disaster declaration (Government of Spain, 2007). However, Royal Decree 1620/2007, which governs the reuse of reclaimed water, does not define ‘disaster’. In fact, the only definition of a disaster provided by the Spanish government is in Law 17/2015, on the National Civil Protection System (Government of Spain, 2015).

As of 2020, the Spanish Ministry for Ecological Transition and Demographic Challenge is working to promote the maximum possible use of recycled water, which may entail

regulatory changes to foster its use in the home. Therefore, although domestic use of recycled water is currently restricted to disaster situations, foreseeable episodes of severe drought (Mendez-Jimenez, 2012) make it an ever-more attractive option for increasing the amount of available water in Spain. But would Spanish people be willing to accept drinking water that had been produced from wastewater? The answer to this question would help inform the decision-making of politicians and policymakers. Hence, this study seeks to gauge public opinion on issues related to alternative sources of water for domestic uses and, more specifically, the possibility of using recycled water in the home, even for drinking. A questionnaire on this topic was administered to 791 people in southern Spain aged between 18 and 30. Using data from those questionnaires, we assess people's acceptance of recycled water, and especially of DPR. We also identify the factors explaining higher or lower acceptance. DPR was chosen because it is the quickest and least expensive non-conventional technique to increase the volume of water available. The first contribution made by this research is to assess people's acceptance of potable water reuse, using data from questionnaire respondents with no previous experience of domestic use of recycled water in their country. A second contribution is that this is the such first study in Spain. We find less acceptance of recycled water compared to other sources of water; and the closer the personal contact, the less acceptable the use.

The article is structured as follows. Following this introduction, Section 2 provides the background and sets out the main relationships to be investigated. Section 3 describes the empirical strategy used. Section 4 presents and discusses the main results. The article ends with a section detailing conclusions and recommendations.

BACKGROUND

This section on the state of the issue is in two parts. First, we briefly discuss the acceptance of recycled water compared to other non-conventional sources, taking into account the different intended uses for the water. Second, we address the factors that influence this acceptance.

Acceptance of potable water reuse for domestic purposes

Recycled water has been used in the agricultural sector for more than 5,000 years. It became more popular in the mid-1900s as farmers recognized the benefits of using water that had a higher nutrient content than freshwater or rainwater (Chen et al., 2013; UN,

2017). Indeed, according to Iglesias-Esteban (2016), around the 70% of the total reused water in Spain is used in agricultural irrigation. Reused water is also employed in industrial activity, for example for cooling and heating (Chiou et al., 2007; UN, 2017). Furthermore, in Israel, Singapore, some southern European countries and the United States (California), recycled water is used in some heavily urbanized areas for non-potable applications (Angelakis and Gikas, 2014; Opher and Friedler, 2016).

Currently there is no international norm on potable reuse (Iglesias-Esteban, 2016; Jodar-Abellan, 2019). Technically, however, the use of good-quality recycled water in the home is possible (Khan and Roser, 2007; Li et al., 2009). The most widely deployed reuse system is IPR, which involves mixing recycled water with surface water or groundwater sources before the water is treated again in order to make it potable. Another option is DPR, where the recycled water is introduced directly into a drinking water treatment plant, without any environmental buffer (Asano et al., 2007). Compared to IPR, the DPR process is cheaper and faster (Lahnsteiner et al., 2017; Gunda et al., 2019).

What's more, DPR is a globally proven technique. In addition to the project in Windhoek, which has been supplying domestic water to more than 250,000 people for over 40 years, four DPR initiatives have recently been implemented in Texas, one in New Mexico and one in South Africa (Van Rensburg, 2016; Lahnsteiner et al., 2017). Thus, along with the advances being made in water treatment and monitoring capacity throughout the process, public acceptance of DPR also plays an important role in its successful implementation. Although in the United States there seems to be a growing acceptance of recycled water for domestic uses (Rozin et al., 2015), the adoption of DPR tends to be viewed by the public as a radical change. Thus, sociological research is needed to identify and/or help overturn people's perception of DPR as a non-conventional source that is not widely accepted for domestic use (Chen et al., 2013; Hurlimann and Dolnicar, 2016). 'Acceptance' here is understood as the willingness to use the source,the degree to which that source is accepted by individuals (Adell et al., 2014). Therefore, concept of public acceptance of recycled water provided aligns with Booher and Innes's (2005) conception of the public support belief system, in which the goal is to gain support from the public for agency decisions. For example, studies on water recycling have identified the "yuck factor" as a major obstacle to its implementation (see, Leong, 2016a). For some people, the notion that the recycled water has been in contact with human waste triggers an aversive reaction. The knowledge that wastewater is the primary source of the recycled

water psychologically "contaminates" it and makes people feel less comfortable about using the resulting water, especially if it will come into direct bodily contact (Hui and Cain, 2018; Hurlimann, and Dolnicar, 2010a). Thus, the relevance of the “yuck factor” depends on the intended use of the water. Uses that involve direct personal contact, such as drinking or bathing, exacerbate the disgust reaction; cleaning the house or watering the plants seems more acceptable (Fielding et al., 2019).

Determinants of the degree of acceptance of recycled water use

The second stage of the research examines the factors that can influence people’s willingness to use recycled water. Here we assume that these factors have a role, all else being equal, in increasing or decreasing people’s acceptance of recycled water for domestic use. There are of course many other factors influencing acceptability (including pre-existing policy debates on water management, social fairness, water distribution, the distribution of the costs of the investment, and the impact of media campaigns), but here we limit ourselves to the examination of the public acceptance factors defined by Fielding et al. (2019). They distinguish between socio-demographic factors, psychological factors, and water characteristics. And because we want to understand these factors in the context of possible government investment in (or promotion of) recycled water for domestic use, we distinguish between the factors that are within the control of policymakers, and those that are beyond this control (Table 5.1).

Hence, there are some factors that are beyond the control of politicians or policymakers, and so cannot be used to influence public acceptance. Factors that cannot be controlled include age, gender, marital status, household size, income level and employment status. On the other hand, there are controllable factors, those that can be influenced, for example through media campaigns and environmental awareness campaigns. If people initially exhibit a low tolerance for the use of recycled water, measures can be taken to foster acceptance. It is clear that these communication and awareness-raising measures have a greater impact in contexts of water scarcity where alternative sources of water are limited. So far, only cities that tend to suffer from severe droughts have implemented DPR as a solution to their supply problems (EPA, 2017; Lahnsteiner et al., 2017).

Table 5.1. Factors that determine acceptance to use recycled water

Factors type	Controllable	Beyond-control
Socio-demographic	Education	Age Gender Income Religion Race/ethnicity Political affiliation Household size Marital status Employment status
Psicological	Disgust Health rishk perceptions General risk perceptions Trust Fairness Pricing concerns Social norm and social influence Percived benefits Knowledge, information and prior experience Percived water scarcity Belive in technology Environment concern	
Water characteristics	Treatment options Organoleptic properties	

Regarding controllable factors, one variable to consider is the perceived health risk. Some people may perceive recycled water as unhealthy. This perception may be linked with the idea of contagion, especially if, due to the source of the water, the individual associates the exposure of the water to contaminants with poor quality. Fu and Liu (2015) and Callaghan et al. (2012) conclude that the idea of contagion is a particularly strong factor in limiting acceptance.. The perception of risk may also be associated with a feeling of distrust. This has two components: trust in institutions and trust in technology. In fact, some researchers find that trust in science and government predicts greater acceptance of potable uses (Fielding et al., 2015). People's willingness to use recycled water is based in part on the credibility of politicians and scientists and the information they provide (Hurlimann and Dolnicar, 2016; Russell et al., 2008; Leviston et al., 2006).

An understanding of how the recycling process works is particularly important (; Po et al., 2005; Russell et al., 2008). It is generally observed that people accept water recycling schemes more when they have a better understanding of the wastewater treatment process (Alexander et al., 2008). Some studies conclude that a higher level of education is related to greater confidence in technology and, consequently, greater willingness to use recycled water (García-Cueva et al., 2016; Gibson and Burton, 2014). Although the results reported in the literature are not always significant, education tends to have a positive correlation with acceptance of recycled water in developed countries (Baghapour et al., 2016; Dolnicar and Schäfer, 2009; Wester et al., 2016).

Another factor to consider is people's emotional and psychological perception of recycled water. When they have no previous experience of reuse, the "yuck factor" is driven by their prior beliefs. According to Etale et al. (2020), the rejection of recycled water may be motivated by *trait disgust* and *state disgust*; in other words, the individual's general propensity to feel disgust and the specific feeling of disgust that may be caused by recycled water. Thus, in this study, we asked individuals about their a priori perceptions of the different organoleptic properties of recycled water.

Lastly, acceptance of recycled water for domestic uses may also be influenced by environmental awareness. Recycling water is an environmentally responsible behaviour. Several studies have demonstrated a positive relationship between environmental concern and acceptance of recycled water (Menegaki et al., 2007; Fu and Liu, 2017). As Hurlimann (2007) and Ross et al (2014) proved, recycled water acceptance may increase as people seek to exert less pressure on natural resources. Awareness of the negative effects of desalination—due to the potential environmental impacts of feedwater intake, brine discharge, and construction near sensitive shoreline habitats—may also play a role (EPA, 2017).

Given the experimental dimension of the research, carried out in a region with no previous experience of recycled water schemes for domestic use, there may be other factors influencing recycled water acceptance for domestic purposes that have not been discussed, for example, concerns regarding pricing or knowledge and information.

EMPIRICAL STRATEGY

Area of study

The research was carried out in Andalusia, a region of southern Spain which covers 87,268 km^2 and has a population of almost 8.5 million. It is an important area in which to investigate recycling water for domestic use, given its scarce water resources and its combination of high agricultural, industrial and urban water demand. Andalusia also has supply problems due to the progressive salinization of aquifers, the depletion and deterioration of traditional water sources, and insufficient precipitation (Jodar-Abellan et al., 2019). The water scarcity is particularly severe in two of its watersheds: the Guadalquivir Basin and the Andalusian Mediterranean Basin. The combined effect of the seasonally variable climate and the high demand, with ever-growing consumption of water for different uses, has given rise to a structural deficit. In the summer months, some municipalities have to take measures such as banning certain uses, cutting supply at specific times, and using tanker trucks to supply water.

In the residential sphere, several options have been proposed to foster better management of water resources: campaigns to encourage more efficient water use, investments to reduce unaccounted-for water in distribution networks—a figure which is too high, at around 28% (INE, 2018a)—and the installation of individual meters in apartment buildings (Tortajada et al., 2019). On the supply side, investment is focused on desalination plants. Homes along the coast of Almeria and Malaga are already supplied with desalinated water. But of all the water passing through wastewater treatment plants in Andalusia, only 6% is reused (INE, 2018a). The limited volume of water reused in urban areas is primarily allocated to cleaning the sewers and washing the streets.

Although domestic use of recycled water has not yet been implemented in Spain, Spanish legislation provides for this possibility in the event of a disaster declaration, specifically in Royal Decree 1620/2007, which governs the reuse of treated wastewater (Government of Spain, 2007). In light of the predicted effect of climate change on freshwater resources in Spain (Climate Change, 2006; Moreno et al., 2005), the current government remains committed to increasing the volume of water available from non-conventional sources, including recycled water (Government of Spain, 2018). This approach is in line with the strategy of the European Union, which for some years now has been promoting changes towards a circular economy. This entails a paradigm shift in water resources management,

moving from the concept of treatment and discharge to one of reuse, recycling and recovery (European Commission, 2015). In fact, EU cohesion policy involved a €15 billion investment in the water reuse sector from 2014 to 2020 (European Commission, n.d). As far back as 2012, the European Commission indicated the need for more research on closed-loop water recycling, such as how to improve testing and cleanliness, in order to respond to future challenges of water scarcity and climate change (European Commission, 2012). Thus, the EU seeks to foster reuse for agriculture and aquifer recharge by establishing a common regulatory framework (European Commission, 2018). Similarly, in the particular case of Spain and Andalusia, which have very high domestic water consumption (136 litres per person per day and 129 litres per person per day, respectively—INE,2018b), there are some factors that may prompt a change in legislation. The total demand for low-cost water for potable, industrial, agricultural, and environmental purposes is steadily increasing. Concurrently, there is a heightened recognition of the imperative for maintaining environmental flows to sustain the high quality of both surface water and groundwater resources. Notably, in numerous regions, the feasible extraction limits for both surface water and groundwater are approaching precarious thresholds, posing a potential risk to the quality of existing water resources. Furthermore, the escalating water requirements of urban and peri-urban areas are anticipated to amplify, further necessitating attention to address the burgeoning demand in cities. In 2020, the Ministry for Ecological Transition is working to encourage the use of non-conventional water sources. The planned measures include making greater use of recycled water. So, could DPR for domestic use be considered a possibility in Spain?

Data

Our questionnaire was given in 2018 to University of Granada students who lived in Andalusia and were 18 to 30 years old. This age range was chosen in accordance with UN General Assembly Resolution 70/1, which stipulates that this age group should contribute to the implementation of the Sustainable Development Goals. One of these goals is to ensure universal access to water and includes the objective of promoting non-conventional water sources. University of Granada was chosen because the composition of its student body is very representative of the Andalusian population (University of Granada, 2018). There are 1,129,505 Andalusians between the ages of 18 and 30. For representativeness, with a margin of error of 5% and a significance level of 95%, we need

a sample of at least 385 people. A total of 896 questionnaires given out, and 791 valid questionnaires were returned, more than twice the required number.

The questionnaire had three parts (Supplementary material). The first part asked about the respondents' attitude to certain aspects of their life, for example political ideology, environmental awareness, trust in institutions, credence in technological advances announced by the scientific community, and feelings about income inequality and social justice.

The second part asked about their preferences and willingness to use water from four different sources:

- *CURRENT:* refers to the water that currently comes out of the tap. This water is extracted from reservoirs, and is treated through physical and chemical processes in drinking water treatment plants before reaching our homes.
- *DESALINATED*: Refers to seawater that is treated in desalination plants. The most widely used technology for separating the salt from the water is reverse osmosis.
- *RAINWATER*: Refers to a hypothetical situation with a parallel water collection network—one to collect blackwater and another to collect rainwater. The collected rainwater would go directly to a drinking water treatment plant, where it would undergo basic treatment.
- *RECYCLED*: The source of the water is the sewage system, which collects water previously used in homes (kitchen and bathrooms). Sewage water is taken to wastewater treatment plants. After intensive treatment, without mixing with *CURRENT* water, and without any environmental buffer, the treated water would reach our homes through the supply network.

Following Dolnicar and Schäfer (2009), respondents were assured that the four choices satisfied the same economic and health criteria:

The price charged in the water bill would be the same in all four cases. Therefore, there would be no change in the amount of the water bill if there was a change in the source of the water supply.

In all four cases, the water meets the standards established by the regulations governing the health criteria for the quality of water for human consumption. In all four cases, therefore, water would be suitable for human consumption.

Respondents were then asked to rank the four water sources in order of preference. They were also asked about their willingness to use water from each source for 14 different purposes (Figure 5.1). The proposed uses were the same as in Hurlimann and Dolnicar (2010a). Respondents were also asked about factors that could influence their willingness to use recycled water.

Lastly, they were asked about socioeconomic elements, such as age, gender, income and educational attainment.

Thus, the questionnaires were designed to support two kinds of assessments: first, of the degree of acceptance of recycled water for different domestic uses compared to other water sources; and second, of the explanatory factors for the different levels of acceptance. Furthermore, we hoped that the data from the questionnaires would help us characterize the citizens with greater acceptance of recycled water for domestic use. These data might also allow us to identify key factors on which further research is needed, and they might guide public policy measures.

Data treatment

In order to investigate the relationships, set out in the previous section, the analysis of the data is carried out in two stages. The first stage focuses on respondents' willingness to use different water sources. The aim is to determine the position of recycled water in the individual's order of preferences, relative to other sources of water. This stage also examines the degree of acceptance of each of the sources according to how the water is to be used. The objective here is to identify the purposes for which the individual would accept to use recycled water, in order of preference.

The second stage examines the factors associated with the acceptance of DPR for domestic use. To this end, a regression analysis is performed using ordinary least squares.

Table 5.2 shows the variables introduced in the regression analysis.

Table 5.2. Variables. Description and descriptive statistics

Variable	Description	Mean	SD	Max.	Min.
	Dependent Variable				
RECYCLED	Average scores for acceptance of recycled water for 14 uses. Continuous variable with minimum value = 1 and maximum value = 7	3.7425	1.8339	7	1
	Controllable independent variables				
INSTITUTIONS	Degree of trust in institutions. Likert 1 (none) to 7 (absolute).	3.7052	1.0161	7	1
ENVIRONMENT	Importance given to the conservation and protection of the environment. Likert 1 (none) to 7 (Very high).	6.1154	1.0192	7	1
SCIENTISTS	Degree of confidence in the information provided by scientists on technological developments. Likert 1 (none) to 7 (absolute).	4.8337	1.0666	7	1
MONITORING	I would be distrustful of the controls that the authorities carry out to ensure the quality of recycled water. Likert 1 (strongly disagree) to 7 (strongly agree).	4.2829	1.8584	7	1
HEALTH_RISK	I don't think *RECYCLED* water will be of good quality and I think it will lead to health problems. Likert 1 (strongly disagree) to 7 (strongly agree).	4.3742	1.8082	7	1
SMELL	I don't think I will like the smell of *RECYCLED* water. Likert 1 (strongly disagree) to 7 (strongly agree).	4.4581	1.7365	7	1
TASTE	I don't think I will like the taste of *RECYCLED* water. Likert 1 (strongly disagree) to 7 (strongly agree).	4.5670	1.7205	7	1
TURBIDITY	I think *RECYCLED* water will have suspended particles. Likert 1 (strongly disagree) to 7 (strongly agree).	4.4806	1.6886	7	1
EDUCATION	1 = If respondent has an educational qualification in engineering or health sciences; 0=If respondent has an educational qualification in the field of social sciences, law, the arts and the humanities.	0.2134	0.4101	1	0
	Non-controllable independent variables				
GENDER	1 = Male; 0 = Female	0.4739	0.4996	1	0
AGE	Continuous variable	21.6551	3.1580	30	18
IDEOLOGY	Ideological orientation. Likert 1 (Far Left) to 7 (Far Right)	3.1575	1.4775	7	1

INEQUALTY	Opinion on the existence of excessive inequality in income distribution. Likert 1 (strongly disagree) to 7 (strongly agree).	5.7916	1.3173	7	1
INCOME	1 = Respondent gains income from work; 0 = Respondent does not gain income from work.	0.3652	0.4817	1	0

The model to be estimated can be summarized as:

where *RECYCLED* is the dependent variable representing individuals' willingness to use recycled water in the home (with *i* representing individuals, $i = 1,... 791$). M_i represents a set of variables that can be influenced in order to increase the willingness to use recycled water. These are the variables that represent the main relationships we want to test. In Table 5.2, they are classified as controllable variables. X_i is a set of variables related to the willingness to use recycled water which are not controllable, as specified in Table 5.2. Finally, ε_i is the error term.

RESULTS AND DISCUSSION

Preferences for alternative sources of CURRENT water

The respondent was informed that a critical level in the availability of water resources could be reached in the next few years, to the point where water might may not be available for certain uses. They were then asked to order the sources of water considered in the study according to their preferences. Despite the scenario laid out, only 34% of respondents chose any of the non-conventional sources of drinking water as the first option: 19% chose *RAINWATER*, 9% chose *DESALINATED*, and only 6% chose *RECYCLED* water.

Focusing only on non-conventional sources of water (since the objective of this research is to determine the degree of acceptance of non-conventional sources for inclusion in Andalusian and Spanish water policy), Table 5.3 shows the distribution of the order of preferences chosen by the respondents. The preferred order for 48% of respondents was *RAINWATER, DESALINATED, RECYCLED*. In second place, 29% opted for *DESALINATED, RAINWATER, RECYCLED*. Thus, 77% of respondents identified recycled water as the least acceptable option.

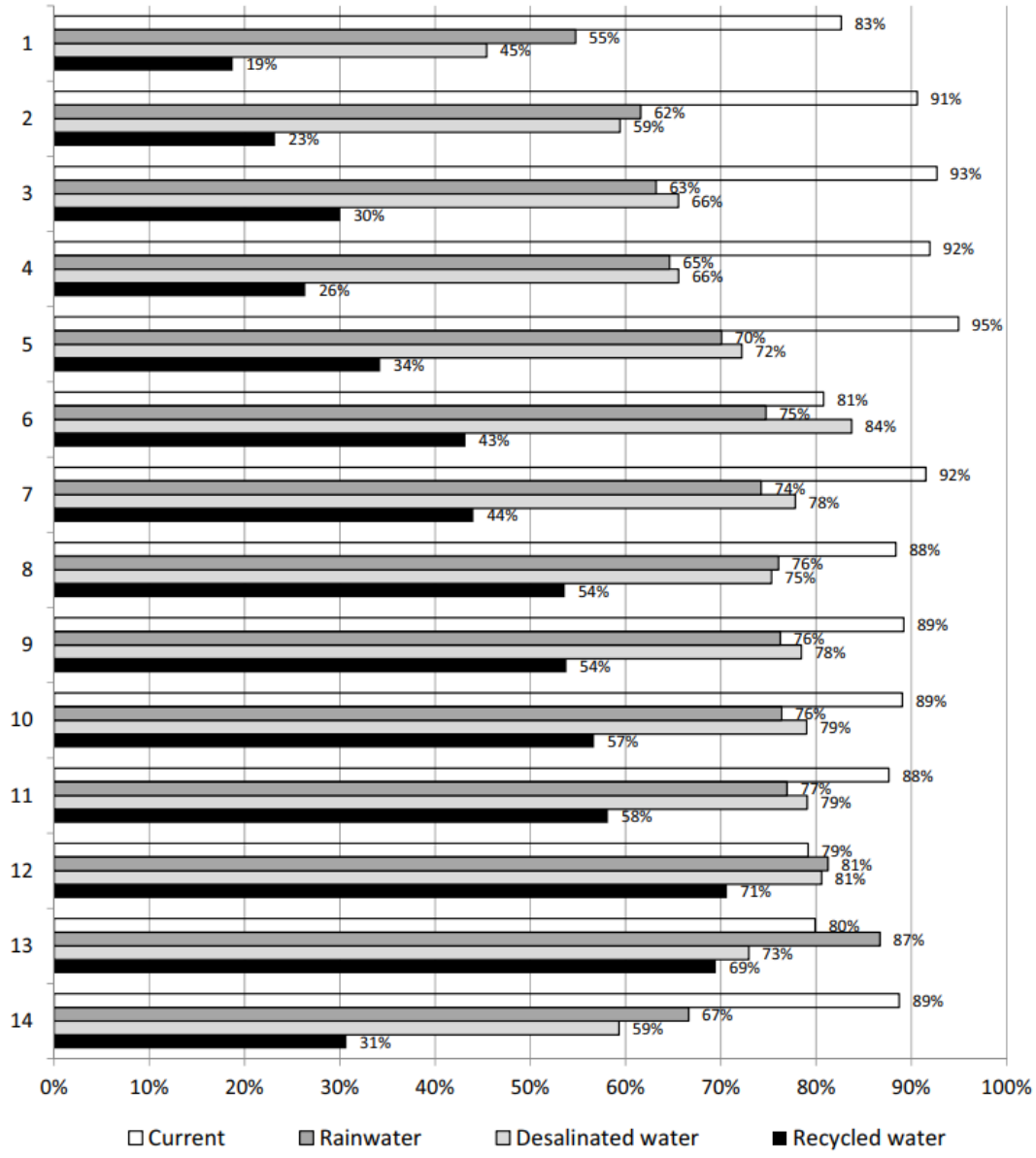
Table 5.3. Respondents' order of preference for unconventional water sources. In percentages

Order of preference	%	Order of preference	%
RAINWATER, *DESALINATED*, *RECYCLED*	47.77	*RAINWATER*, *RECYCLED*, *DESALINATED*	4.96
DESALINATED, *RAINWATER*, *RECYCLED*	29.03	*DESALINATED*, *RECYCLED*, *RAINWATER*	4.96
RECYCLED, *RAINWATER*, *DESALINATED*	8.44	*RECYCLED*, *DESALINATED*, *RAINWATER*	4.84

Respondents were asked about their willingness to use the water for specific purposes, with each purpose being independent of the others, but not mutually exclusive. Willingness was scored on a seven-point Likert scale, with 1 indicating that the respondent *would not* be willing to use the water for this specific purpose, and 7 that they *would always* be willing to use the water for this specific purpose. The intermediate options were (2) very rarely, (3) rarely, (4) sometimes, (5) quite often, and (6) almost always.

Figure 5.1 shows the results. Although in Spain the quality of conventional sources is not optimal—only 55% of surface water sources are classified as having good ecological status, and only 56% of groundwater bodies have good overall status (INE, 2018a)—and despite Spanish users' awareness that chemical pollution is the greatest threat to the aquatic ecosystem (Eurobarometer, 2012), *CURRENT* is the highest-scoring option for all purposes except watering plants. On average, the second-most favoured option is *RAINWATER*. However, although *RAINWATER* is the most commonly accepted option among the non-conventional sources, it is the least viable option in Spain, due to the scant and irregular rainfall in much of the territory. This underscores the need for sources that provide more water independently of climatological factors. In fact, Spain is one of the world leaders in desalinated water production (AEDYR, 2019a) and a European leader in water reuse. On average, 13% of treated grey water is reused, with this figure surpassing 90% in some cities (IDA, 2018). However, in the survey, *RECYCLED* always appears as the least acceptable option.

Figure 5.1. Acceptance of different water sources according to use. Average score for each use.



Min = 1; Max: 7.

Note: Ingestion: 1: Drinking; 2: Cooking; 3: Brushing teeth. Personal contact: 4: Bathing the baby; 5: Showering/taking a bath; 6: Refilling/topping up the swimming pool. Housework: 7: Washing dishes, glasses and cutlery; 8: Washing clothes/doing the laundry; 9: Cleaning the kitchen; 10: Cleaning the bathroom; 11: Cleaning the house (less bathroom/kitchen). Outdoor uses at home: 12: Washing the car; 13: Watering the garden-flowers trees and shrubs. Others: 14: Feeding my pets.

The results confirm the sign of the relationships presented in the first part of this research. Recycled water is the option that has the least acceptability among the people surveyed.

Acceptance of this source also depends on its intended use. When the use involves ingestion or bodily contact, there is stronger rejection of recycled water. This result is in line with the findings of previous studies (e.g., Hurlimann and Dolnicar, 2016; Browning-Aiken et al., 2011). However, compared to those and other studies (e.g., Dolnicar and Schäfer, 2009), we see lower acceptance in southern Spain for all intended uses.

For close-to-body uses, the sample registers values similar to those reported by Hurlimann and Dolnicar (2016), who studied the acceptance of non-conventional water sources for domestic uses in nine countries. However, in Spain, no significant increase is observed for uses involving less personal contact. Of the 14 intended uses studied, none achieves more than 71% acceptance. Recycled water is not well accepted for any use. It is always the option that is accepted the least, scoring at least 10 points behind the second alternative, whether *DESALINATED* or *RAINWATER*. This finding differs from those of other studies, where respondents in various countries tend to prefer recycled water to desalinated water for uses such as watering the garden or cleaning the house (Dolnicar and Schäfer 2009; Hurlimann and Dolnicar, 2016).

Although technology can provide water suitable for human consumption, the public administration in Spain has not invested enough in the required technology. Indeed, only 27% of the more than 2,000 wastewater treatment plants in Spain are technologically equipped to provide the tertiary treatments that yield water of even higher quality than conventional sources (AEDYR, 2019b). However, under Spanish law, domestic use of recycled water is restricted to disaster situations. In addition, there is little willingness to use recycled water in the home. In Spain, only 10% of treated wastewater is reused, most of it in agriculture (INE, 2018a). It may be that, until the public administration shows itself to be more committed to the use of recycled water, the public will not regard this option as a viable alternative source of domestic water. Hence, there seems to be a disconnection between technical, regulatory and social reality in Spain regarding recycled water.

Factors that influence the acceptance of recycled water use

This section analyses the factors related to willingness to use recycled water. The dependent variable, *RECYCLED*, is the average value of the scores given by the respondents to indicate their degree of acceptance of recycled water for the 14 uses shown in Figure 5.1. Table 5.4 shows the results of the regression analysis of 791 observations. We find

that some of the variables may have a significant influence on the acceptance of recycled water.

Table 5.4. Regression results. Dependent variable: *RECYCLED* (N=791).

VARIABLES	*COEFFICIENTS*
CONSTANT	5,02161***
INSTITUTIONS	-0.08109
ENVIRONMENT	0.20658***
SCIENTISTS	-0.02683
MONITORING	-0.04512
HEALTH_RISK	-0.14844***
SMELL	-0.14392*
TASTE	-0.07579
TURBIDITY	-0.01894
EDUCATION	0.41180***
GENDER	0.27199**
AGE	0.03433*
IDEOLOGY	-0.14386***
INEQUALITY	-0.13039***
INCOME	0.12792
R^2	0.2064
ADJUSTED R^2	0.1921
OVERALL SIGNIFICANCE	F (14,776) = 14.41***

Legend: * p<0.1, * * p<0.05, * * * p< 0.01

The variables representing the preconceived perception of the organoleptic properties of recycled water present the expected sign. However, only *SMELL* is significant. One interpretation of this finding is that, although the "yuck factor" is important in explaining the refusal to use recycled water in case of need, the expected health risk is even more important in decision-making. As Haddad et al. (2009) and Rozin et al. (2015) observe, psychological variables such as disgust and contagion are related.

In this sense, *HEALTH_RISK* could be interpreted as capturing part of the effect of organoleptic characteristics; indeed, as in Hurlimann and Dolnicar (2016), this study confirms the existence of a negative relationship between the perceived risk to health — *HEALTH_RISK*— and willingness to use recycled water. A greater perceived health risk reduces the acceptance of recycled water for potable uses, given the distrust of and ignorance about the treatment the water undergoes and its ability to eliminate all

pathogens and chemicals (Sokolow et al., 2019). This result is consistent with the relationship found for another controllable variable, *EDUCATION*.

Respondents educated in the health sciences, engineering, and related areas are more willing to use recycled water than those with an educational background in social sciences and the humanities, suggesting that greater technical knowledge is related to greater acceptance of recycled water. In this regard, experimental studies have identified a positive correlation between information provided and acceptance, highlighting the importance of confidence in the high quality of the water (Fielding and Roiko, 2014). That is, a better grasp of the physical and chemical water treatment methods and an understanding of the technological possibilities lowers the perceived risk. In fact, in the United States, the country with the most DPR projects, tours of water recycling plants are offered as a trust-building initiative (EPA, 2017). Singapore's water agency also makes a big deal of plant tours. In Spain, including Andalusia**,** some wastewater treatment plants and drinking water treatment plants have also opted to hold open days for the public to find out how they work (El diario de Ávila, 2019; Igua, 2017, 2014).

Finally, although some variables that refer to the degree of trust—*INSTITUTIONS*, *MONITORING* and *SCIENTISTS*—have the expected sign, they are not statistically significant. It is therefore not possible to confirm the relationship with people's trust in institutions and in the information provided by scientists on technological developments.

However, those individuals who show greater concern for the conservation and protection of the environment –*ENVIRONMENT*—report greater acceptance of the use of recycled water. Perceived level of water scarcity and support for conservation actions are related to greater acceptance (Dolnicar et al., 2012). The same result has been reported for other countries, including Belgium, Norway, Israel, Australia, the United States, Canada, and Japan (Hurlimann and Dolnicar, 2016). Greater awareness of the depletion of resources and the need for environmental conservation makes individuals more eager to exert less pressure on conventional water sources. Also playing an important role is the positive relationship with concern about the potential negative environmental impacts of water desalination, in terms of marine environment and its biodiversity (Lattemann and Höpner, 2008).

For the set of variables we refer to as non-controllable, the results are once again as expected. First, men seem to be more accepting of recycled water. On average, men's

acceptance of recycled water for domestic use is 0.27 higher than women's. As Fielding et al. (2019) point out, this is a constant in the related studies. It tends to be attributed to their greater confidence in scientific advances (Finucane, 2000). There is also a positive relationship between *AGE* and acceptance of recycled water. This result is in line with the findings reported by, for example, Bennett et al. (2016), although it conflicts with the results of several American studies (Glick et al., 2019; Probe Research Inc, 2017). Thus, the relationship between acceptance and age seems to depend on the country where the research is conducted.

We also find that the people who are most strongly opposed to excessive inequality in income distribution —*INEQUALITY*— are more willing to use recycled water, in line with Gibson and Burton, (2014) Alexander et al. (2008) and Leviston et al. (2006). This likely relates to the inherent positive relationship between notions of social justice and the concept of sustainable development underlying the development of non-conventional drinking water resources to ease pressure on conventional sources (Langhelle, 2000). Finally, people who consider themselves more left-wing (*IDEOLOGY*) are more willing to use recycled water, as they tend to be more environmentally aware (Fielding et al., 2015)

CONCLUSIONS

Environmental factors and human decisions are driving up levels of water stress and exacerbating water scarcity in many regions of the world. To ensure the availability of water, international agencies and some countries are backing an alternative that, until recently, seemed impossible due to technical and social issues: direct water reuse for domestic purposes, even drinking and cooking.

Our survey in southern Spain finds significant public reluctance to use recycled water, especially for certain uses, and thus suggests that implementing recycled water schemes for human consumption would be risky there. Given the public response, the recycled water option would seem to be contrary to the public interest: it would raise people’s water bills for the treatment of unwanted water, and increase families' spending on bottled water, along with greater exploitation of sources of mineral water and greater production of plastic.

However, Ching and Yu (2010) discount the importance of public opinion as a factor in policy feasibility. Studying water reuse in Singapore and Australia, and its treatment in the media, Ching and Yu conclude that policy outcomes are determined by the dominant

discourses and narratives, which in turn shape public opinion—rather than the other way round. If the stage of the narrative tide is this important, our research could be useful to Spanish policymakers. The government may have an indispensable role in the early stages to make a persuasive case for the initiative. Thus, it is important to identify some of the reasons for the rejection of recycled water that can be controlled by decision-makers, such as emotional aspects associated with the "yuck factor" (Leong, 2016b).

Information provided to the public can influence their willingness to use recycled water (Dolnicar et al., 2010; Fielding and Roiko, 2014). Awareness-raising campaigns regarding the protection and conservation of the environment and the human consequences of severe water scarcity could overcome at least some of the reluctance.

The results of the research also indicate that it is possible to overturn the low level of acceptance of the use of recycled water. Alexander et al. (2008) observed greater acceptance after scientists explained recycled water treatment. Thus, the water treatment technology should be explained, and its reliability highlighted, showcasing experiences in other countries. And to mitigate the notion that recycled water is unhealthy and or has worse organoleptic properties than water from other sources, demonstrative educational sessions could be organized, as is done in the United States, Singapore and Spain, timed to coincide with World Water Day. The sessions could include samples, allowing attendees to try recycled water for themselves and see whether it is really objectionable.

This is the first study on the acceptance of the domestic use of recycled water to focus on Spain. We acknowledge that it is a bold measure in the current debate on water governance in Spain, but rising water stress and scarcity and the experiences reported by other countries suggest that within a few years, recycled water could be considered a genuine alternative in areas of the interior of Spain. Before implementing any project, it is essential to test public perceptions, as we have done here. This study has focused on acceptance factors only among a group of individuals in southern Spain. It would be valuable to study a broader sample But there are also many factors beyond public acceptance that may determine policy feasibility. Further research is needed on the acceptance of the use of recycled water in Spain, looking into human psychology and the causes of the "yuck factor". For more insight, extended personal interviews should be considered.

Researchers on Spanish case has the advantage of being aware of investigations in other countries, including Singapore, where the use of recycled water at home is a reality, and Australia, where such schemes have been challenged. Another possible line of research would be to analyse the impact of awareness-raising and information campaigns on the acceptance of recycled water for domestic use, in a country that has no prior experience of such use. That would extend the research of Ching and Yu (2010), on how public discourses and narratives interact to create a positive or negative image of water recycling, to a country that has no prior experience of the reuse of water in the home.

Chapter 6.

DETERMINANTS OF THE ACCEPTANCE OF DOMESTIC USE OF RECYCLED WATER BY USE TYPE

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Jorge Guardiola
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Abstract

In the circular economy model, the recycling of water is an alternative option that can reduce the pressure on water resources and guarantee water supply. This water policy measure is currently widespread in agriculture, but thus far few countries have opted for the domestic use of recycled water. In part, this is because it is the source of water with the lowest levels of public acceptance, which poses a threat to the success of the necessary investment. We analyse the degree of acceptance of recycled water for different domestic uses. The main contribution of this study is the analysis of the determinants of acceptance of recycled water by use type. The research was based on data from a questionnaire given to 844 university students in Andalusia, southern Spain. Results are obtained from ordinary least squares regressions that relate the determinants of recycled water acceptance to each of the water use classes. The 'yuck factor'—variously defined as 'disgust' or 'psychological repugnance'—and the perceived risk are found to be the main determinants of the low degree of acceptance of recycled water for ingestion by people and pets. For other uses, such as body washing, laundry and cleaning, environmental awareness stands out as a determining factor. The main conclusion is that if authorities were to opt for measures to promote the use of recycled water, they should take into account the fact that the reluctance to use recycled water and the determinants of acceptance differ according to the intended use.

Keywords: Circular economy · Water reuse · Recycled water · Water sustainability · Spain

INTRODUCTION

According to the United Nations (2015), one of the main challenges facing the world's population is access to water for different uses. An increased risk of water stress is anticipated in many parts of the world in the coming years due to factors such as global population growth and the effects of climate change (Mekonnen and Hoekstra, 2016). Greater efforts are needed to implement measures that make it possible to reconcile access to water with water conservation and sustainability goals (United Nations, 2018).

In the circular economy model, water recycling is an alternative option to reduce the pressure on water resources and guarantee water supply (International Water Association, 2016). The United Nations recently called for wastewater to be considered a valuable resource rather than a problem to be dealt with, and is considering its use for domestic purposes (United Nations, 2017). Although water recycling is widespread in agriculture and for some urban uses—such as cleaning the streets and watering gardens—it is a much less common option for domestic uses (Cotruvo, 2016). However, current techniques enable the production of recycled water fit for human consumption and its widespread adoption is expected in the near future (Ong, 2016; Villarín and Merel, 2020). In many cities, ensuring the availability of urban water will require an increase in the use of recycled water, among other measures (Ananda, 2019).

Consumer participation is key to the success of investments in circular economy projects (Urbinati et al., 2017; Kuah and Wang, 2020). Nevertheless, the public is reluctant to use recycled water for domestic purposes. A discernible pattern of limited acceptance toward the utilization of recycled water is evident when compared to alternative sources, including conventional options such as surface water and groundwater, as well as non-conventional sources like rainwater harvesting and desalination. This phenomenon is observed across various geographical contexts, including Australia (Dolnicar and Schäfer, 2009; Dolnicar et al., 2011; Fielding et al., 2015), the United States (Ishii et al., 2015; Hui and Cain, 2018), China (Liu et al., 2018; Zhu et al., 2018), and Spain (López-Ruiz et al., 2020).

Furthermore, empirical evidence suggests a similarly subdued level of acceptance concerning the use of recycled water for irrigation, extending to reservations about consuming agricultural products cultivated with recycled water (Menegaki et al., 2007).

Although recycled water is a genuine alternative within a water policy framework, it is a risky investment. Without public acceptance of recycled water, people may turn to defensive actions such as buying bottled water (González-Gómez et al., 2020). Such consumer behaviour would detract from the economic, social and environmental effectiveness of the investment. Therefore, users' opinions should be taken into account before undertaking such an investment. In fact, some recycled water initiatives have been rejected by citizens. The most widely reported case is that of Toowoomba, Australia, where residents voted in a referendum against the construction of a wastewater reuse system to supply additional water to the area (Hurlimann and Dolnicar, 2010; Price et al., 2012).

In this study, we explore user acceptance of recycled water. The main contribution of this paper is the analysis of the determinants of the level of acceptance of recycled water, distinguishing between different household uses. For the study, a classification of uses is proposed that takes into account the proximity of people's contact with the recycled water, as well as the function of the water according to the hierarchy of needs proposed by the World Health Organization (WHO) (2013). This research is of evident interest as the results make it possible to predict the risk of investments aimed at making use of recycled water and, where appropriate, will help in designing plans to reduce the rejection of recycled water according to its intended use.

The research uses data from university students in southern Spain, a region facing extremely high water stress (World Resources Institute, 2019). To perform the estimations, we use ordinary least squares (OLS), and we apply a missing data imputation technique, which yields a sample size of 844 observations. Under Spanish law, domestic use of recycled water is currently only permitted in the event of a disaster declaration (Navarro, 2018). As such, it is not standard practice, but it is a measure that the Government of Spain could propose at some point to alleviate the situation of water scarcity affecting three-quarters of the country. As found in research conducted in other regions of the world, the degree of acceptance of recycled water is lower when there is close-to-body contact and the uses are of more vital necessity in people's lives. With respect to the previous literature, the main finding is the difference in the relative importance of the determinants of acceptance of recycled water according to the intended use. For essential uses, the perceived risk to health and the yuck factor are the most relevant factors in the acceptance of recycled water. However, for uses that are not

essential, factors such as environmental awareness, political ideology and education are more relevant. The main conclusion, which can be applied to different scenarios, is that diverse policy strategies must be adopted to increase the acceptance of recycled water in the home according to the intended use.

The article is structured as follows. After this introduction, Section 2 provides the background. The materials and methods are described in Section 3. The main results are presented and discussed in Section 4. The final section of article outlines the conclusions and recommendations.

LITERATURE REVIEW

Determinants of the degree of acceptance of recycled water use

For a thorough review of the determinants of recycled water use, readers should consult the recent comprehensive literature review by Fielding et al. (2019). This section sets out a brief theoretical framework conditioned by the design of the research and the hypotheses to be tested. This framework groups the determining factors into the following sets: sociodemographic; environmental awareness and perception; trust in institutions and the perception of risk; the yuck factor; and social justice and ideology. In this section, we follow this conceptualization to present the background.Sociodemographic variables

Different sociodemographic variables, such as age, gender and educational level, have been considered as determinants of the acceptance of recycled water use. There is evidence that women (Baghapour et al., 2017; Dolnicar and Schäfer, 2009), younger people (Dolnicar et al., 2011), those with lower incomes (Garcia-Cuerva et al., 2016; Marsden and Carr, 2014), the unemployed (Dolnicar and Schäfer, 2009) and people with a lower educational level (Baghapour et al., 2017; Wester et al., 2016) are less likely to use recycled water. However, Hartley (2006) and Marks (2004) warn that sociodemographic factors are not good generic predictors of acceptance because demographic associations are not consistent across studies and contexts.

Environmental awareness and perception

Acceptance of the use of recycled water is a form of environmentally responsible behaviour as it reduces the amount of wastewater and increases the amount of freshwater (Dolnicar and Schäfer, 2009). As such, people who are more environmentally aware can be expected to show greater willingness to use recycled water in order to reduce the pressure on conventional sources (Hurlimann, 2007; Ross et al., 2014). Although there

are studies (Po et al. 2005; Lease et al., 2014) that have not found a significant relationship between the variables, at least for potable uses, others such as Fu and Liu (2017) have shown a positive relationship between environmental awareness and water recycling. This relationship is conditioned by the perception of the state of the environment, as people who perceive less environmental deterioration will feel less of a need to undertake measures to ensure environmental sustainability. In this vein, Liu et al. (2018) conclude that raising residents' awareness of the environmental crisis and the need to protect the environment increases acceptance of the use of recycled water.

Trust in institutions and the perception of risk

Many people question the safety of recycled water (Hurlimann and Dolnicar, 2010). The perception of risk is usually related to public health problems associated with the safety and quality of recycled water. Since the source of recycled water is wastewater, there is a perception of exposure to contaminants in the water (Rozin et al., 2015). These authors argue that this supposed contagion is resistant to the technological purification of wastewater; therefore, a process of re-naturalization that purifies the water is needed in order to influence public acceptance of water recycling. This would explain why there is greater acceptance of indirect water recycling systems than direct ones, even if the former are unnecessary from a scientific perspective (Schmidt, 2008). Note that indirect Potable Reuse (IPR) involves the advanced treatment of wastewater and then delivering the water indirectly, via environmental buffers, to drinking water treatment facilities that further purify the recycled water before supplying it to consumers as drinking water. Direct Potable Reuse (DPR) involves the introduction of recycled water directly into a drinking water treatment plant, without any environmental buffer (Asano et al., 2007).

Haddad et al. (2009) point out that the perception of the possibility of contagion is negatively associated with willingness to use recycled water. The perception that the use of recycled water can be harmful to health is also a determining factor as it particularly limits levels of acceptance (Po et al., 2003; Fu and Liu, 2017; Callaghan et al., 2012). In this regard, having confidence in the properties of recycled water is a determining factor. According to Ross et al. (2014), community willingness to use recycled water depends on the exchange of information, which improves trust, reducing the perception of risk and increasing acceptance levels. Trust, in both institutions and in science, has therefore been identified as a key factor in the acceptance of non-conventional sources of drinking water, including recycled water (Ross et al., 2014; Fielding et al., 2015). For example,

Hurlimann et al. (2008) find a positive relationship between trust in water companies, the quality of the information provided and acceptance of recycled water in Australia. Applying a social-psychological model to the case of Toowoomba, Ross et al. (2014) show that higher levels of public trust led to a lower perception of risk, and the lower perception of risk led to greater public acceptance of the scheme. Furthermore, Massoud et al. (2018) point out that a high level of distrust in the ability of government and institutions to properly manage water recycling plants and provide safe, high-quality water has a negative effect on perceived risk and acceptance levels. Thus, citizens place value on the credibility and information provided by institutions (Po et al., 2005; Russell et al., 2008).

Yuck factor

The emotional distress generated by close contact with certain unpleasant stimuli, known as the 'yuck factor' (Russell and Lux, 2009), plays an important role in public opposition to water recycling programmes. Evolutionary psychologists have argued that the emotion of disgust has helped humans to avoid ingesting water and food contaminated by pathogens. Darwin (1872) himself characterized disgust as a feeling that readily arises from anything unusual in the appearance, smell or nature of food and that is offensive to the taste.

Regarding motivations for the possible refusal to use this non-conventional water source, Etale et al. (2020) differentiate between the individual's general tendency to feel disgust (trait disgust) and the particular feeling of disgust that can be caused by recycled water (state disgust). Furthermore, Massoud et al. (2018) point out that in the absence of prior experience, this emotional discomfort is determined by aprioristic beliefs. Along the same lines, Rozin's work on the concept of disgust incorporates three basic principles needed for an emotional response: a sense of oral incorporation, a sense of offensiveness, and contamination potency (Rozin et al., 2008). In the case of recycled water, organoleptic properties—smell, colour and taste—can be predictors of feelings of acceptance or disgust (Amaris et al., 2020; López-Ruiz et al., 2020).

Social justice and ideology

According to Ansell and Cansunar (2020) and Uslaner and Badesku (2003), citizens who perceive greater income inequality in their country are less likely to accept/positively evaluate government proposals. Greater inequality, as a proxy for social justice, could be

linked to greater rejection of any type of public project, including projects aimed at providing recycled water for domestic use.

Ideology is also considered a predictor of water conservation and pro-environmental attitudes and behaviours (Liu et al., 2014). According to these authors, social-liberal politicians, as well as citizens with a stronger social-liberal ideology, tend to care more about the environment. Hui and Cain (2018) also report that, even after accounting for socio-demographic characteristics such as income disparity or education, Americans who identified as Democrats were more willing to use recycled water than Republicans and independents.

Acceptance of recycled water for different domestic uses

One issue that has not been sufficiently explored in previous research is that there can be varying degrees of acceptance of recycled water depending on the intended use for it in the home. To study this, we propose a two-pronged approach. First, from a functional point of view, we ask whether the consumer considers recycled water to be a good substitute for water from a conventional source; and second, whether the consumer's relationship with recycled water can be affected by the proximity of personal contact.

From a functional perspective, water satisfies human needs in its dual role as a productive resource and a necessity good. In the area of domestic water use, and according to Maslow's hierarchy of human needs (1943, 1954), water is a good that meets first-order needs (drinking and food preparation). However, it is also used for personal hygiene, washing clothes, household cleaning, growing food for domestic consumption, sanitation, and various recreational uses (WHO, 2013). Water is therefore not only able to meet vital physiological needs, but it can also directly or indirectly satisfy needs relating to safety, social relations, self-esteem and self-actualization (WHO, 2013; Prevos, 2018). Fig. 6.1 shows a ranking of water uses according to the hierarchy of needs proposed by the WHO (2013). The question then is whether a person's acceptance of the use of recycled water is the same depending on the function of the water.

Figure. 6.1. Hierarchy of water requirements (after Maslow's hierarchy of needs). Version of the World Health Organization proposal (2013).

Despite the high quality standards to which recycled water is subjected, the literature notes the existence of a 'yuck factor' limiting its acceptance (Furlong et al., 2019, Leong, 2016). The perceived contamination and sense of unease caused by the origin of recycled water triggers rejection in some people. In the absence of previous experiences with recycled water schemes, the organoleptic properties of the water assume more importance. Hurlimann and McKay (2007) point out that the acceptance of recycled water for uses involving some degree of personal contact increases when the water is free from turbidity or odour, but these attributes are irrelevant for non-contact uses, such as water for flushing the toilet or for watering the garden. Thus, according to users, the attributes that would make recycled water suitable for domestic use vary according to what it is used for (Hurlimann and McKay, 2007). In this regard, previous research (e.g., Hui and Cain, 2018; Hurlimann and Dolnicar, 2016; Alhumoud and Madzikanda, 2010) indicates that when the use of recycled water involves personal contact, such as drinking and cooking, there is a notable drop in the acceptance of the use of recycled water. It can thus be concluded that, regardless of the method used, acceptance of recycled water drops with increasing proximity of personal contact (Fielding et al., 2019).

METHODS

Fieldwork, sample size and demographics

The research was carried out in Andalusia, a region of southern Spain covering an area of 87,268 km2 and home to almost 8.5 million people. Andalusia suffers from a high level

of water stress due to the combined effect of low rainfall and high demand pressure. To alleviate the situation, desalination plants have been built along the coast, but in inland areas some municipalities have to take certain measures during the summer months, such as a ban on specific uses, supply cuts and using tanker trucks to supply water. In these inland areas, recycled water is an option that could reduce pressure on water resources and guarantee the water supply, although under Spanish law the use of recycled water in the home is presently only permitted in disaster situations. Furthermore, the European Union and the Government of Spain, currently seeking to incorporate the principles of the circular economy into their action programmes, are focusing their water policies on water reuse in agriculture and industry, leaving aside the use of recycled water in the home (European Commission, 2020; Ministry for Ecological Transition, 2020). Nevertheless, given the growing pressure on water resources in Mediterranean arid and semi-arid regions and the lower production cost compared to other non-conventional sources of water, recycled water in the urban environment is an emerging solution (Voulvoulis, 2018).

Our questionnaire was given in 2018 to University of Granada students who lived in Andalusia and were aged between 18 and 30 years old (the full questionnaire is available in the Supplementary Information). Questionnaires were delivered to students in the classroom and took around 30 minutes to fill in. Students came from a variety of different areas of study: Business, Sociology, Political Science, Tourism, Marketing, Labour Studies, Nursing, Medicine, Pharmacy and different types of engineering.

This sample of young students was used as a case study because of the importance of the role young people must play in addressing the Sustainable Development Goals: according to United Nations General Assembly Resolution 70/1, this age group should contribute to the implementation of such goals. The sample size appears large enough to be representative of the student population in Andalusia in 2018, when the fieldwork was carried out, which was 244,212 students; with a margin of error of 5% and significance level of 95%, the sample size needed was 384. In the University of Granada (2018), there are 52,881 students, around 60% of whom are women.

Ideally, the study would have been conducted with a representative sample covering different strata of society and the different water realities they face. While using a sample comprised of students may not be the optimal way of addressing the objectives of the

research, it does allow us to provide new evidence on an innovative subject. We discuss the limitations of the dataset in more detail in Section 4.3 devoted to the limitations of the study.

Variables

Dependent variables

The main objective of the study is to evaluate the determinants of the acceptance of recycled water according to different uses. To achieve this objective, the questionnaire included 14 items about water use, as in Hurlimann and Dolnicar (2016). Each item was measured on a seven-point Likert-type scale, where 1 indicates the lowest acceptance of recycled water use and 7 the highest.

To determine the degree of acceptance, some important issues were first raised with the respondents. First, that current regulations do not allow the use of recycled water in the home and, therefore, what is being considered is a hypothetical situation that will not actually happen in the short term. Second, that the authorities could make this option a reality at some point for water security reasons, given the already high and growing water stress in the study area. Third, the option presented was direct potable reuse Note that there are two possibilities for reusing water: IPR and DPR (Brears, 2020). In both cases, the existing technology enables the production of water suitable for use in the home. DPR, an option used in Namibia and Texas, offers a twofold advantage: it is less expensive than IPR and it produces high quality water more quickly (Lahnsteiner et al., 2018; Sgroi et al., 2018). In addition, DPR provides potable water of the same quality as current IPR, or even higher (Hooper et al., 2020). In fact, the environmental barrier that often reassures people can result in high quality water being exposed to potential environmental contaminants (Chaudhry et al., 2017; Burgess et al., 2015; Leverenz et al., 2011)−. Specifically, the following situation was proposed: "The source of the water is the sewer system, which collects the water previously used in the home (kitchen and bathrooms). The sewage water goes to treatment plants. After intensive treatment, the treated water is transferred to a storage tank where it is blended with water from reservoirs and wells that has previously been treated to make it potable. Finally, the blended water would be delivered to our homes through the supply network." In addition, the respondent was informed that the water supplied to his/her home would meet the standards established by the regulations governing the health criteria for the quality of water for human consumption; in other words, it would be fit for human consumption.

Although respondents were asked about their acceptance for 14 uses of water, we established a posteriori five water use clusters to facilitate data processing and the interpretation of the results (see Table 6.1). The classification emphasizes the proximity of the personal contact with recycled water. Furthermore, although the two do not exactly correspond, there is a parallel between this classification according to the proximity of contact with the water and the hierarchy proposed by the WHO (2013) based on the need for the water. Thus, generally speaking, the closer the proximity to the water, the more the water is of vital necessity in people's lives. The main exception to the correspondence between the proposed classification based on personal contact and vital need is swimming in the pool. This action involves bodily contact with water, but does not cover a function that is essential to the person's life. In addition, feeding pets does not entail people coming into direct contact with recycled water. However, the function at the personal level is not so obvious, as for people living alone, pets can play a vital role.

Table 6.1. Classification of water uses.

World Health Organization (2013)	**Proximity (Research proposal)**	**Water uses included in the questionnaire**
- Short-term: Survival	- Level 1: Ingestion	- Drinking - Cooking
	- Level 2: Personal contact	- Brushing teeth - Bathing the baby - Showering / taking a bath - Refilling / topping up the swimming pool
- Medium-term: Maintaining	- Level 3: House cleaning	- Washing dishes, glasses and cutlery - Washing clothes / doing the laundry - Cleaning the kitchen - Cleaning the bathroom - Cleaning the house (less bathroom / kitchen)
- Long-term: Lasting solution	- Level 4: Pets	- Feeding my pets
Empty Cell	- Level 5: Uses outside the house	- Washing the car - Watering the garden – flowers trees and shrubs

Note: The water uses proposed in the questionnaire do not exactly correspond to those in the World Health Organization (2013) proposal. It should be noted that the research was conducted in a predominantly urban environment. As such, with respect to the World Health Organization proposal (2013), uses such as growing food and business (crops, livestock) have been removed and other options have been added, such as brushing teeth and having pets at home.

The first level involves maximum proximity to the water and maximum need for the water, as the individual ingests it for drinking and cooking. At the second level of proximity, there is direct contact with recycled water, but at a surface level. At the third level, the contact with recycled water is indirect, through personal and household items. At the fourth and fifth levels, there is no direct or indirect contact with people, since the water comes into contact only with pets, plants and the car.

Independent variables

The questionnaire also included questions to identify the relationships between personal characteristics and different degrees of acceptance of recycled water for the various intended uses. Table 6.2 presents the details of the variables used in the study, their description and main descriptive statistics. The variables are grouped according to the approach set out in Section 2.1. We are aiming to analyse the relationship between the degree of acceptance of recycled water for the five established levels of domestic use (Table 6.1) and the variables capturing sociodemographic characteristics, environmental awareness and perception, trust in institutions and perception of risk, beliefs about organoleptic properties, and social justice and ideology (Table 6.2).

Table 6.2. Independent variables. Description and descriptive statistics.

Variable	Description	Mean/%	Standard Deviation	Min	Max
	Sociodemographic variables				
Gender	1 = Man; 0 = Woman.	47%		0	1
Age	Years old	21.70	3.18	18	30
Residents	Number of residents in the household	3.47	1.04	1	8
Job	1 = In addition to studying, the respondent has a job; 0 = Other case.	37%		0	1
Education	1 = Education in engineering or health sciences; 0 = Other qualification (Social sciences and humanities).	23%		0	1
	Environmental awareness and perception				
Environmental_ awareness	Importance of environmental conservation and	6.12	1.01	1	7

Variable	Description	Mean/%	Standard Deviation	Min	Max
	protection. 1 (none) to 7 (very high).				
Environmental_Perception	Satisfaction with the state of the environment. 0 (utterly unsatisfied) to 10 (fully satisfied).	4.66	2.06	0	10
NGO	Membership of an environmental conservation NGO. 1 = Yes; 0 = No.	9%		0	1
Trust in institutions and perception of risk					
Health_Hazard	I think that recycled water will not be of good quality and will cause health problems. From 1 (complete disagreement) to 7 (complete agreement).	4.32	1.82	1	7
Control	I would not trust the controls carried out by the authorities, I would never drink recycled water. From 1 (complete disagreement) to 7 (complete agreement)	4.24	1.86	1	7
Technology	I do not trust the existing technology to produce safe recycled water. From 1 (complete disagreement) to 7 (in full agreement)	4.03	1.88	1	7
Inst_Credibility	Credibility of the information provided by the institutions. From 1 (none) to 7 (absolute)	3.71	1.01	1	7
Researchers	Credibility of the information provided by researchers on technological improvements. From 1 (none) to 7 (absolute)	4.83	1.08	1	7
Bottled_water	1 = respondent usually drinks bottled water; 0 = respondent rarely drinks bottled water.	31%		0	1
Beliefs about organoleptic properties (Yuck factor)					
Smell	I don't think I will like the smell of recycled water.	4.41	1.75	1	7

Variable	Description	Mean/%	Standard Deviation	Min	Max
	From 1 (strongly disagree) to 7 (strongly agree).				
Taste	I don't think I will like the taste of recycled water. From 1 (strongly disagree) to 7 (strongly agree).	4.52	1.74	1	7
Turbidity	I think recycled water will have suspended particles. Likert 1 (strongly disagree) to 7 (strongly agree).	4.41	1.73	1	7
Social Justice and Ideology					
Politics	Declared political ideology. From 1 (extreme left) to 7 (extreme right)	3.16	1.47	1	7
Inequality	Opinion about the existence of excessive inequality in income distribution. From 1 (complete disagreement) to 7 (in full agreement)	5.79	1.33	1	7

Although the description of the variables in Table 6.2 is sufficiently explanatory, it is worth making some clarifications. The block of sociodemographic variables does not include the educational level of the respondent. This is because all the respondents are university students. Instead, a dummy variable has been introduced to distinguish between students specializing in health sciences and engineering, where exposure to topics concerning water characteristics, quality, and technological approaches for treatment and purification is anticipated, and students in the realm of social sciences and humanities, who are not instructed on these matters.

The variable Bottled_water has been included in the block regarding trust in the use of recycled water. The variable captures information about whether the respondent usually drinks bottled water, compared to the possibility of drinking water directly from the tap. Like Graydon et al. (2019), we consider that people drink bottled water because of the perceived health risks and quality of tap water. In a region such as Andalusia, the choice of bottled water can be interpreted as a sign of distrust, since tap water in the study area is potable; it regularly meets the quality criteria stipulated in Royal Decree 140/2003, of

7 February, which establishes the health criteria for the quality of water for human consumption. It seems obvious that if the respondent distrusts tap water from a conventional source, he or she will have at least the same level of distrust of recycled water.

In the block of beliefs about organoleptic properties, we emphasize that the respondent has no experience with recycled water. Therefore, faced with the proposed scenario, the respondent's answers are based on aprioristic opinions or beliefs.

Imputation of data

A total of 896 questionnaires were given out and 844 valid questionnaires were returned. Of those, 791 contained complete responses and 53 were incomplete. In other words, 53 of the 844 valid questionnaires returned contained at least one missing value (item non-response). Missing data is a common problem in analyses based on survey data and is commonly caused by respondents not answering some questions (Little and Rubin, 2019; Fuller, 2011). Removal of incomplete cases is fairly standard practice but this solution may be unsatisfactory because it decreases the sample size and, as a consequence, reduces the power of statistical tests. In our case, the application of this method reduces the sample size by approximately 6.3%. Other common techniques used in the treatment of missing data include data imputation methods, which consist in replacing missing values with plausible values. The main advantage of data imputation methods is that they allow the use of the complete sample.

Even though our sample is representative enough for the population under study, a bigger sample is always better for our estimation purposes, because it increases the power of statistical tests. To address the issue of missing values, we employ a data imputation method, specifically, the kNNI (k-Nearest Neighbour Imputation) method. This technique has been utilized in numerous surveys conducted by Canada's national statistical agency and various national agencies in the United States (Chen and Shao, 2000). Additionally, it has found application in diverse contexts, including hydrologic time series analysis (Lall and Sharma, 1996). This method consists in assigning the median value of the variable taken from the nearest k cases with respect to the rest of the variables. In other words, consider an incomplete case with a missing value in one of the variables. To impute the value, the nearest k cases with respect to the rest of the variables are selected and used to calculate the median of the observations of the variable with the missing value in the incomplete case. A widely discussed issue is how to determine the value of k. We

define k=29 following the method proposed by some researchers such as Jonsson and Wohlin (2004), who propose the optimal value of k as the odd integer closest to the square root of the number of complete cases.

The method has been applied for the imputation of missing items in our questionnaires, using R software (Kowarik and Templ, 2016). The treatment of missing items through data imputation allows us to use the total number of observations in the sample for the application of the rest of the statistical techniques. Once the missing observations had been imputed, the dependent variables were obtained as the arithmetic mean of the corresponding water use items. That is, the first step entailed imputing the missing observations from the 14 questionnaire items on the use of water; and in a second step, the values of the dependent variables were calculated as the arithmetic mean of the scores of the corresponding items. In the case of independent variables, the values were obtained directly from the questionnaire item. Table 6.3 shows a count of the imputed observations for each variable.

Table 6.3. Number of imputed values per variable.

Variable*	**Number of imputed observations**	***Variable***	**Number of imputed observations**	***Variable***	**Number of imputed observations**
Level 1	3	*Gender*	0	*Technology*	7
Level 2	3	*Age*	0	*Inst_Credibility*	2
Level 3	2	*Residents*	7	*Researchers*	0
Level 4	2	*Job*	1	*Bottled_water*	0
Level 5	2	*Education*	0	*Smell*	7
		Environmental_awareness	0	*Taste*	7
		Environmental_Perception	35	*Turbidity*	7
		NGO	0	*Politics*	6
		Health_Hazard	7	*Inequality*	0
		Control	7		

Note: * Level 1: Ingestion; Level 2: Personal contact; Level 3: House cleaning; Level 4: Pets; Level 5: Uses outside the house

Data analysis

The analysis of the data has been conducted in two stages. In the first stage, we present descriptive information on the acceptance of recycled water according to different uses. In a second step, we analyse which variables in Table 6.2 are related to the acceptance of direct potable reuse for each of the five clusters of domestic use. We use OLS to relate each variable of different recycled water use with the independent variables described in the previous subsection. An advantage of this method with respect to others, and the main reason why it is used, is the simple interpretation of the regression coefficients.

The estimated model can be summarized as follows:

$$\begin{aligned} Accetance_Rec_Water_{ji} = {} & \alpha + \beta_1\ Sociodemographics_i \\ & + \beta_2\ Environmental\ awareness\ and\ perception_i \\ & + \beta_3 Trust\ in\ institutions\ and\ perception\ of\ risk_i \\ & + \beta_4\ Beliefs\ about\ organoleptic\ properties_i \\ & + \beta_5\ Social\ Justice\ and\ Ideo\log y_i + \varepsilon_i \end{aligned}$$

level of water use in the household (j=1,..., 5) by individuali (i = 1,..., 844). It takes values between 1 (lowest acceptance) and 7 (highest acceptance). εi is the error term. The model was estimated for each of the five levels of recycled water use (see Table 6.1).

Referring to the review of Fielding et al. (2019), we can make different predictions about the expected results. With regard to sociodemographic variables, we can expect to see greater acceptance of the use of recycled water among men, older people and people educated in the fields of engineering and health sciences. On the other hand, it is not clear what results to expect for the variables Residents and Job.

People who are more environmentally aware are expected to show a greater willingness to use recycled water to reduce the pressure on existing water resources. We also hypothesize that a stronger perception of the health risk associated with the consumption of recycled water—whether motivated by personal beliefs or a low level of trust in institutions, scientists, and technological capacity—will be related to a lower degree of acceptance of its use. Additionally, the belief that this water has worse organoleptic properties is expected to be negatively related to acceptance of the use of recycled water.

In the case of political ideology and social justice, there is no conclusive prior evidence regarding its relation to the acceptance of the use of recycled water.

RESULTS AND DISCUSSION

Acceptance of the use of recycled water by intended use

Table 6.4 shows the main descriptive statistics of acceptance for each level of recycled water use. According to the arithmetic mean, the lowest degree of acceptance of use corresponds to Level 1, which involves the closest personal contact with recycled water and greater vital need, while the highest acceptance is that of Level 5, which involves the least proximity and least vital need. Out of a maximum value of 7, the mean degree of acceptance of recycled water use ranges from a minimum of 2.68 for uses such as drinking and cooking to a maximum value of 5.01 for uses outside the house. Levels 2, 3 and 4 show mean acceptance values lying between the extreme values obtained for Level 1 and Level 5.

Table 6.4. Descriptive statistics for the acceptance of recycled water use according to the degree of proximity.

					Response frequency (in percentage)						
Variable*	**Mean**	**Standard Deviation**	**Min**	**Max**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Level 1	2.68	2.02	1	7	41.47	16.35	12.32	9.00	4.86	5.81	10.19
Level 2	3.31	2.03	1	7	25.83	16.00	15.76	12.91	7.70	10.31	11.49
Level 3	4.22	2.14	1	7	16.59	10.43	12.44	12.80	11.26	14.69	21.80
Level 4	3.17	2.18	1	7	34.36	16.00	9.95	11.49	8.29	5.33	14.57
Level 5	5.01	2.05	1	7	10.31	4.74	6.52	11.61	13.27	12.91	40.64

*Level 1: Ingestion; Level 2: Personal contact; Level 3: House cleaning; Level 4: Pets; Level 5: Uses outside the house

In the order established, the most striking result is associated with Level 4. Going from lower to higher degrees of acceptance, recycled water use for pets comes immediately after acceptance of recycled water use involving ingestion by people. This result indicates that even if there is no direct personal contact respondents would not be very willing to give their pets recycled water. This result is not surprising considering that, for many people, their pet is a member of the family and may even hold a central place in the lives of many people (Redmalm, 2020).

The distribution of responses reinforces the above comments. The greatest rejection of recycled water use is found for the case of ingestion by people (Level 1) and domestic animals (Level 4). It should be noted that the standard deviations are similar for each level. Regarding personal ingestion, 57.82% of respondents stated that they would never or only exceptionally consume recycled water. This percentage drops slightly, to 50.36%, for ingestion by domestic animals. At the other extreme, the highest acceptance of recycled water use is found at Level 5 and Level 3: 53.55% of respondents said they would accept recycled water always or almost always for uses outside the house, and 36.49% for cleaning the house.

These results are in line with those reported in previous research (e.g., López-Ruiz et al., 2020; Hui and Cain, 2018; Hurlimann and Dolnicar, 2016; Ormerod and Scott, 2013; Alhumoud and Madzikanda 2010). In general, willingness to use recycled water increases as physical contact decreases. In terms of the function fulfilled, the more vital the function of the water in respondents' lives, the less willing they are to use recycled water.

Table 6.5. Ordinary least squares estimations for the analysis of determinants of acceptance of recycled water use for each proximity level.

	Levels[+]				
Variables	**1**	**2**	**3**	**4**	**5**
(Intercept)	5.8614*** (0.0000)	4.5428*** (0.0000)	4.5255*** (0.0000)	4.8165*** (0.0000)	4.0684*** (0.0000)
Sociodemographic variables					
Gender	0.2107. (0.0906)	0.1964 (0.1225)	0.3189* (0.0234)	0.3900** (0.0061)	0.2073 (0.1341)
Age	0.0068 (0.7453)	0.0579** (0.007)	0.0524* (0.0271)	0.0449. (0.0608)	0.0748** (0.0014)
Residents	-0.0041 (0.9453)	0.0211 (0.7264)	0.061 (0.3605)	0.0260 (0.6992)	0.1567* (0.0172)
Job	-0.0389 (0.7562)	0.0159 (0.9012)	0.1014 (0.4743)	0.1039 (0.4679)	0.0967 (0.4882)
Formation	0.0366 (0.8104)	0.4083** (0.009)	0.4353* (0.0118)	0.2327 (0.182)	0.7509*** (0.0000)
Environmental awareness and perception					
Environmental_ awareness	0.1061 (0.1001)	0.1902** (0.004)	0.2305** (0.0016)	0.1022 (0.1652)	0.1366. (0.057)
Environmental_Perception	-0.0106 (0.7396)	-0.0117 (0.7192)	-0.0323 (0.3704)	-0.0118 (0.7454)	-0.0438 (0.2178)

	Levels+				
Variables	**1**	**2**	**3**	**4**	**5**
NGO	0.2218 (0.3194)	0.0347 (0.8789)	0.1017 (0.6858)	-0.101 (0.6909)	-0.0233 (0.925)
Trust in institutions and perception of risk					
Health_Hazard	-0.2394*** (0.0000)	-0.2145*** (0.0002)	-0.1603* (0.0106)	-0.1417* (0.0252)	-0.0583 (0.3438)
Control	-0.0312 (0.5185)	-0.0869. (0.0787)	-0.061 (0.2641)	-0.0063 (0.9092)	0.0097 (0.8561)
Technology	0.0262 (0.5897)	0.0631 (0.2036)	0.0451 (0.411)	-0.0002 (0.9978)	-0.0297 (0.5827)
Inst_Credibility	-0.049 (0.4405)	-0.0694 (0.285)	-0.0137 (0.8485)	-0.0548 (0.4498)	-0.0323 (0.6474)
Researchers	-0.0418 (0.4785)	-0.0563 (0.3503)	-0.0683 (0.3055)	0.0504 (0.4543)	-0.0542 (0.4084)
Bottled_water	-0.3682** (0.0055)	-0.1482 (0.2732)	-0.0433 (0.7718)	-0.3625* (0.0165)	-0.1749 (0.2346)
Beliefs about organoleptic properties (Yuck factor)					
Smell	-0.3303*** (0.0000)	-0.259*** (0.0000)	-0.1819** (0.0036)	-0.2465*** (0.0001)	-0.0776 (0.2064)
Turbidity	-0.0109 (0.8288)	-0.0216 (0.6742)	-0.0374 (0.5098)	-0.0861 (0.1334)	-0.072 (0.1977)
Social justice and ideology					
Politics	-0.0453 (0.3246)	-0.0991* (0.0352)	-0.1841*** (0.0004)	-0.0722 (0.1689)	-0.1636** (0.0014)
Inequality	-0.1416** (0.0042)	-0.1219* (0.0155)	-0.0858 (0.1232)	-0.1962*** (0.0005)	-0.0379 (0.4888)
F-test (p-value)	17 (0.000)	14.8 (0.000)	9.446 (0.000)	10.58 (0.000)	6.792 (0.000)
Adj. R2	0.2547	0.2275	0.1528	0.1697	0.1101
RMSE	1.744	1.7181	1.97	1.989	1.939
N	844	844	844	844	844

Note: ∗∗∗p < 0.001, ∗∗p < 0.01, ∗p < 0.05, . p<0.1

+Level 1: Ingestion; Level 2: Personal contact; Level 3: House cleaning; Level 4: Pets; Level 5: Uses outside the house.

In the block of sociodemographic variables, the variable Age is the most statistically significant in explaining differences in acceptance of use. In general, the degree of

acceptance of recycled water use increases with age (Dolnicar et al., 2011). This result has been influenced by the fact that there are few students between the ages of 25 and 30. Moreover, at a younger age just a few years can make a noticeable difference in terms of personal maturity. Gender is also a determining factor. Although the relationship is less robust, men are more willing than women to use recycled water, in line with the findings of Hui and Cain (2018) and Gibson and Burton (2014), among others. Additionally, Fielding et al. (2015) confirm that this trend holds for all non-conventional sources. This may be because women are more risk averse than men (Kim et al., 2018). As Miller and Buys (2008) point out, women report having less trust in the technology involved in the recycling process. On the other hand, it should be noted that the Education variable is positively related to the acceptance of the use of recycled water. People who are taking engineering or health sciences at university are more willing to use recycled water. Studying for these degrees provides students with a better understanding of how technology can be used to produce quality water through the treatment and purification of raw and recycled water. This finding is in line with the results of Price et al. (2015) and Fielding and Roiko (2014), showing that information and knowledge influence attitudinal responses to recycled water schemes.

In the set of variables reflecting environmental awareness and environmentally conscious behaviour, we also find some relationships to be significant. As reported by Hui and Cain (2018), people who claim to be more aware of environmental issues also show a greater willingness to use recycled water, provided it does not involve ingestion by people or pets. For uses involving ingestion, the psychological "disgust" factor has been identified in many previous studies and has proven to be the hardest to overcome (Dolnicar and Schafer 2009; Wester et al. 2016). Therefore, in the situation presented to respondents, people who self-identified as more environmentally aware would be more willing to use recycled water in order to help reduce water stress in the region and avoid putting more pressure on natural resources, as reported in the studies by Hurlimann (2007) and Ross et al. (2014). Although the variable representing environmental awareness shows the expected sign, no relationship is found to be statistically significant.

In the trust block, the risk perceived by the respondent is the most significant determinant explaining the lower acceptance of recycled water use. Different studies agree that the higher the perceived risk, the lower the acceptance of recycled water (see Dolnicar and Hurlimann, 2010; Gibson and Burton, 2014; Ross et al, 2014; Hurlimann and Dolnicar,

2016). The lack of significance for Level 5 may be due precisely to the fact that the absence of bodily contact reduces the perceived risk. In this vein, Hurlimann and Dolnicar (2010) show that providing information counteracts the perceived risk for moderate contact uses, but the effect is very limited for ingestion. The non-significance of other variables in this block may well be due to the fact that the perceived risk variable is capturing the effect of all these variables. In tests carried out to check for imperfect collinearity some correlations were high but they did not exceed the limit of 0.7. In addition, the variance inflation factor (VIF) test was implemented, yielding a maximum value below 2.82. Both tests indicate that there are no serious collinearity problems among the variables. The lack of previous experience with water recycling schemes may also have a limiting effect on the other variables. Moreover, it can be seen that the perceived risk variable has greater explanatory power when the water is intended for drinking and cooking and when there is direct contact, such as brushing teeth or showering. The variable indicating frequent purchases of bottled water for drinking at home, a proxy for respondents' degree of distrust of the safety and quality of water supplied to the home, is also negatively related to the use of recycled water. In this case, it is only significant for ingestion, both for people (Level 1) and for pets (Level 4). Therefore, those who already distrust the current source of water and opt instead to buy bottled water make up the group of people who are most averse to ingesting recycled water.

As for the variables that capture the yuck factor through the organoleptic properties of the water, odour is significant with the expected sign. As in Dolnicar and Hurlimann (2010), respondents who expect recycled water to smell show less acceptance for uses involving ingestion and direct or indirect personal contact. In line with what Hurlimann and McKay (2007) and Amaris et al. (2020) report, the importance assigned to this characteristic becomes greater the closer the personal contact. The reason for this could be a distrust of water quality and a greater perceived health risk. As noted in point 2.1.4, the sense of disgust arises from a defence mechanism against risks of contagion. This may explain why it becomes more intense the closer the personal contact. We note that the correlation between Smell and Taste was 0.893 and the VIF value was above 5 (max. 5.734), indicating that there may be a multicollinearity problem. That is why Taste does not appear in the estimates presented. The estimates with Taste instead of Smell are available in the Supplementary Information.

Ideology is also a predictor of the acceptance of recycled water use. People who claim to have a more right-leaning ideology show less acceptance of the use of recycled water. However, significant differences are only found when the intended use is something other than ingestion, whether by people or by pets. The result aligns with the hypothesis that people with a right-wing ideology are less environmentally aware (Liu et al., 2014). Finally, people who have a greater sense of social injustice are also less inclined to use recycled water. The rejection is greater when it involves ingestion by people or pets.

When we review the results considering the degree of proximity, we see similarities between Level 1 and Level 4, and between Level 2 and Level 3, while Level 5 seems to be an independent case. In situations where the ingestion of recycled water is intended, either by people or by pets, the variables representing the Health Hazard, the Yuck Factor and Social Justice are the most significant. So for ingestion, people who anticipate a greater health risk show more aversion to the use of recycled water, and those who have a greater sense that they are living in a situation of social injustice have a lower acceptance of using recycled water. In Levels 2 and 3, although Health Hazard and the Yuck Factor are determinants of the acceptance of recycled water use, other factors play a comparatively greater role in this regard, such as environmental awareness, political ideology and education.

The importance and impact of the results obtained extend beyond the area on which this research is focused. Like the area under analysis, there are currently many regions of the world that are in a situation of severe water stress (World Resources Institute, 2019; Munia et al., 2020). Moreover, this situation is expected to worsen as a result of climate change, so it is increasingly necessary to plan for the use of unconventional sources, such as reclaimed water (United Nations, 2020). Previous research warns of the low level of acceptance of recycled water for residential uses and, consequently, the need to implement strategies to reduce resistance to using reused water (see recent review by Fielding et al., 2019). While our findings are in line of those of previous research, we obtain more detailed results, which offer valuable information for the design of public policies. The determining factors of the degree of acceptance of reclaimed water differ according to the intended end use. Therefore, the design of public policies aimed at promoting reclaimed water will be shaped by the different residential uses, an issue that we address in the next section, where we set out the conclusions and recommendations of the research.

Study limitations and future research directions

Concerning limitations, it should be highlighted that the fieldwork was limited to university students aged between 18 and 30 years old. Ideally, the study would have been conducted with a representative sample covering different strata of society and water stress realities. The focus on a particular age cohort does not provide a full picture of society, as previous studies have found mixed evidence on the relationship between acceptance of recycled water and age (Fielding et al., 2019). In addition to the limitation regarding age, the study does not analyse all the areas facing water stress. Therefore, our research can be taken as a case study.

These limitations are important, but should be considered in tandem with the strengths of the research. Looking at the added value of the research points to avenues for future research. Having found that the determinants of acceptance differ according to the use made of recycled water in the home, it is our view that future research on the use of recycled water in the home in other regions of the world should take this fact into account. Moreover, it should be incorporated into feasibility studies for new investments and awareness-raising campaigns on the use of recycled water in the home. The situation under study here, focused on a water basin facing high levels of water stress, may serve as inspiration for other regions experiencing similar problems with water or anticipating such problems in the future (see World Resources Institute 2019; Munia et al., 2020). Finally, the age range of the sample reflects the calls made in United Nations General Assembly Resolution 70/1 for this age group to contribute to the implementation of the Sustainable Development Goals. Nevertheless, the fact that the results of this study refer to a certain age range in a particular area opens the door to future research. Subsequent research efforts should thus be aimed at exploring different situations of water stress in order to gain a fuller picture of how policy can be designed to tackle this issue.

CONCLUSION

As in other sectors, the circular economy model puts forward viable solutions for the water sector to relieve the pressure on the available resources and guarantee supply. These proposals are of particular interest in regions of the world facing ever more severe problems of water stress. Among other water policy measures, one possibility is direct potable reuse for the domestic water supply. However, while current technology makes this option possible, few countries have implemented it to date. The biggest obstacle to

this measure is the low level of user acceptance. As with any circular economy proposal, consumer acceptance is needed for the measure to be successful.

In this research, we analyse the degree of acceptance of the use of recycled water in households in southern Spain, as well as the determinants of said acceptance. This is a hypothetical scenario as under Spanish law the use of recycled water in the home is currently only allowed in case of a disaster declaration, but it could become a reality in the coming years. The main contribution this paper makes to the literature is that it distinguishes between different uses when analysing the determinants of acceptance of recycled water use.

In line with previous research, we found a low level of acceptance of recycled water use. In general, the level of acceptance decreases as the proximity of people's contact with recycled water increases, and the use of the water becomes more vital for people's lives. Another key contribution is the finding that the determinants of the acceptance of recycled water differ according to the intended use. With respect to ingestion by people and domestic animals, the main determining factors are the perceived risk to health and the yuck factor. For other uses that entail direct or indirect contact with water, environmental awareness, political ideology and education are more important.

A first conclusion is that, if permitted by law, investments in this area would not be very successful in ensuring the use of recycled water in the home. In light of the low level of acceptance reported here, the public may well protest if there were no prior awareness-raising and educational initiatives. We could also expect to see the adoption of defensive measures, such as the purchase of bottled water for drinking and cooking. A second conclusion is that if authorities were to opt for measures to promote the use of recycled water, they should take into account the fact that the reluctance to use recycled water and the determinants of acceptance differ according to the intended use. Two recommendations emerge that can be applied to contexts other than the one under study here. First, before investing in water recycling infrastructure, the degree of consumer acceptance of recycled water use must be assessed. This is not new; it has already been done in other parts of the world. Secondly, the main finding points to the advisability of measures to promote recycled water use that account for the different uses and determinants of acceptance of recycled water. General measures will not be enough. As an example of the importance of our takeaway message, note that the results obtained

suggest that environmental awareness campaigns warning of the scarcity of water resources would have no effect on the level of acceptance of the use of recycled water for drinking or cooking.

At least for the case analysed here, in order to help overcome people's aversion to consuming recycled water for essential uses, such as drinking and cooking, measures should first be taken to mitigate the perceived risk to health and also the yuck factor. In these cases, a mix of information campaigns accompanied by practical demonstrations could be useful. The message should be conveyed to the public that there is no risk involved in consuming recycled water, as we have the necessary means and know-how to obtain quality water from recycling. Therefore, the fact that there is a reluctance to consume recycled water and that some people decide to pay for bottled water is illogical. In addition, programmes could be proposed to allow people to gain first-hand experience of the organoleptic qualities of recycled water; that is, activities in which people can see, smell and taste recycled water. Such measures could prevent people from taking the defensive measure of buying bottled water for drinking and cooking.

Second, to reduce resistance to using recycled water for uses not involving ingestion, such as personal hygiene or household cleaning, there should be an appeal to environmental values with educational programmes for non-expert audiences. Shining a light on the issue of water stress and the environmental problems associated with the overexploitation of aquifers or the failure to respect the ecological flow of rivers could foster a greater sense of the need for sustainable water use. In turn, it could reduce the resistance to consuming recycled water for uses where the yuck factor and perceived health risk are less relevant determinants. Educational programmes should seek to explain as simply as possible the technology that can be used to produce recycled water and share experiences from other places in the world where recycled water is used in the home.

Further research on the subject is called for. First, there is a need for research similar to this proposal focusing on other areas of the world suffering from high levels of water stress. Cultural differences can lead to divergent results and conclusions. Second, research based on in-depth interviews could be conducted. While quantitative analyses provide a broad overview of the subject, qualitative studies would allow a deeper exploration of particular aspects that could help in the design of specific measures to reduce resistance to the use of recycled water in the home. Finally, it is necessary to test in different contexts

the effectiveness of measures aimed at promoting the consumption of recycled water for domestic uses.

SUPPLEMENTARY MATERIAL

Table 6.S1. Ordinary least squares estimations proposed for the analysis of determinants of acceptance of recycled water use for each proximity level.

Variables	Levels +				
	1	**2**	**3**	**4**	**5**
(Intercept)	5.8302*** (0.0000)	4.5205*** (0.0000)	4.5211*** (0.0000)	4.7872*** (0.0000)	4.0778*** (0.0000)
Sociodemographic variables					
Gender	0.2212. (0.0757)	0.2057 (0.1058)	0.3310* (0.0188)	0.3949** (0.0054)	0.2180 (0.1151)
Age	0.0078 (0.7095)	0.0585** (0.0064)	0.0521* (0.0283)	0.046. (0.0545)	0.074** (0.0016)
Residents	0.0034 (0.9537)	0.027 (0.6549)	0.0652 (0.3295)	0.0316 (0.6387)	0.1585* (0.016)
Job	-0.0132 (0.916)	0.0357 (0.7807)	0.1136 (0.4237)	0.124 (0.3862)	0.1002 (0.4729)
Formation	0.0579 (0.7055)	0.4234** (0.0069)	0.4382* (0.0116)	0.2527 (0.1478)	0.7444*** (0.0000)
Environmental awareness and perception					
Environmental_ awareness	0.1069. (0.098)	0.1909** (0.0039)	0.2313** (0.0016)	0.1026 (0.1632)	0.1374. (0.0559)
Environmental_ Perception	-0.0155 (0.6286)	-0.0156 (0.6335)	-0.0352 (0.3295)	-0.0153 (0.6735)	-0.0452 (0.2029)
NGO	0.2376 (0.2867)	0.0465 (0.8384)	0.1069 (0.6715)	-0.0875 (0.7303)	-0.0242 (0.9221)
Trust in institutions and perception of risk					
Health_Hazard	-0.2457*** (0.0000)	-0.2217*** (0.0001)	-0.1766** (0.0048)	-0.1403* (0.0259)	-0.0766 (0.2124)
Control	-0.0151 (0.7551)	-0.0744 (0.1325)	-0.0533 (0.3305)	0.0063 (0.9093)	0.0120 (0.8234)
Technology	-0.0018 (0.9695)	0.041 (0.406)	0.0291 (0.5936)	-0.0208 (0.7048)	-0.0369 (0.4918)
Inst_Credibility	-0.0556	-0.0748	-0.0189	-0.0590	-0.0358

	(0.3813)	(0.249)	(0.7927)	(0.4148)	(0.6118)
Researchers	-0.0296	-0.0473	-0.0652	0.0612	-0.0561
	(0.6179)	(0.4345)	(0.3307)	(0.3642)	(0.3946)
Bottled_water	-0.346**	-0.1317	-0.0367	-0.3432*	-0.1771
	(0.0093)	(0.3314)	(0.8066)	(0.0233)	(0.2301)
Beliefs about organoleptic properties (Yuck factor)					
Turbidity	-0.0125	-0.0253	-0.0525	-0.0806	-0.0909
	(0.8047)	(0.6235)	(0.3573)	(0.1607)	(0.1052)
Taste	-0.3174***	-0.2431***	-0.1411*	-0.2527***	-0.0306
	(0.0000)	(0.0000)	(0.0222)	(0.0001)	(0.6135)
Social justice and ideology					
Politics	-0.0343	-0.0907.	-0.1797***	-0.0632	-0.1632**
	(0.4574)	(0.0544)	(0.0006)	(0.2289)	(0.0015)
Inequality	-0.148**	-0.1268*	-0.0883	-0.2016***	-0.038
	(0.0028)	(0.012)	(0.1137)	(0.0004)	(0.4883)
F-test (p-value)	16.87 (0.000)	14.65 (0.000)	9.23 (0.000)	10.66 (0.000)	6.71 (0.000)
Adj. R2	0.2531	0.2257	0.1495	0.171	0.1276
RMSE	1.746	1.783	1.973	1.988	1.940
N	844	844	844	844	844

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, . $p<0.1$

[+]Level 1: Ingestion; Level 2: Personal contact; Level 3: House cleaning; Level 4: Pets; Level 5: Uses outside the house.

PART III.

Driving conservation: How water utilities shape sustainable water use

SDG 6.4. Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

INTRODUCTION

Water scarcity is an escalating global issue with profound implications for sustainable development, public health, and economic stability (Distefano & Kelly, 2017). The impacts of this scarcity are extensive, leading to severe water shortages, compromising food security, degrading riparian ecosystems, complicating the maintenance of diverse water supplies, and increasing social stress (Postel et al., 1996). Recognizing the critical importance of safeguarding and enhancing water security, the United Nations has established SDG 6.4, which aims to "substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater" by 2030.

Achieving this target is essential not only to meet the growing demand for water resources driven by urbanization, climate change, and population growth but also to address the significant challenges posed by water crises. These challenges include reducing carbon footprints and maintaining the affordability and reliability of municipal water supply and treatment systems (Hoekstra & Chapagain, 2007; Richter, 2014). Traditionally, research on water-use efficiency has predominantly focused on agriculture, given its status as the largest consumer of water (Evans & Sadler, 2008; Freire-González, 2019; UN-Water, 2021). However, the domestic sector also presents significant opportunities for improvement. While municipal water use constitutes a smaller portion of total consumption, the increasing competition for water resources will intensify the need for efficient management. Since drinking water is legally prioritized over other uses, water providers are well-positioned to influence decisions regarding water resource management. Therefore, this chapter explores how water utilities promote water conservation practices within the domestic sector, emphasizing their potential to contribute significantly to overall water sustainability.

Efforts to improve water-use efficiency, whether in agriculture or domestic settings, can be broadly categorized into supply-side and demand-side strategies (OECD, 2011). Supply-side measures focus on optimizing water availability and distribution through methods such as enhancing infrastructure, developing desalination techniques, and implementing water reuse systems—explored in Chapter 2. In contrast, demand-side strategies, which currently dominate water conservation efforts, aim to reduce water consumption by encouraging conservation behaviors, adopting efficient technologies, and enforcing regulatory measures to curb excessive use (Abu-Bakar et al., 2021).

The increasing frequency of water crises underscores the urgency of adopting strategies that address water demand through effective management and planning (Gober, 2013; Fielding et al., 2012; Addo et al., 2019). Consequently, this chapter specifically focuses on demand-side strategies developed by water utilities within the domestic sector. Examining whether and how water companies promote water conservation practices for domestic purposes is a crucial approach to understanding the challenges countries face in meeting SDG 6.4. Educational campaigns, which tailor their awareness and conservation messages to prevailing water usage behaviors (March et al., 2015), are fundamental to water conservation policies in urban environments (Woltemade & Fuellhart, 2013). Water utilities recognize that such campaigns are among the most effective means of reducing per capita water consumption (Tortajada et al., 2019), generating not only economic benefits but also social and environmental advantages (Dworak et al., 2007).

Water utilities, whether public or private, play a critical role in promoting sustainable water use among consumers. These organizations are responsible not only for the supply and management of water resources but also for influencing consumer behavior through the promotion of water-saving technologies and conservation practices. For example, Beal et al. (2016) suggest that applying behavioral interventions in the form of social marketing strategies to educate households on specific water-saving measures can result in substantial reductions from baseline consumption, in some cases reducing peak hour demand by over one-third. By analyzing the strategies employed by water companies, this study contributes to the broader body of literature that assesses the role of water utilities in shaping consumer behavior and promoting water-efficient technologies.

The existing literature on water scarcity and efficiency, particularly in relation to demand-side strategies, extensively addresses the challenges faced by countries. Research on developed nations has emphasized the role of technological innovations and public awareness campaigns in reducing domestic water consumption (Stavenhagen et al., 2018; García-Valiñas et al., 2015). However, these studies primarily focus on the effectiveness of specific strategies, leaving a gap in research that explores the broader range of services and solutions offered by utilities to their customers and the differences between them.

Despite these contributions, there is a lack of empirical research, particularly in examining how water utilities in Spain promote sustainable water use and pro-environmental behaviors among consumers. Furthermore, while existing literature

addresses the impact of utility ownership—whether public or private—on service delivery and efficiency, few studies have explored how these ownership structures influence the promotion of conservation practices at the household level (Kallis et al., 2010; Romano et al., 2014). This chapter seeks to address these gaps by analyzing the actions taken by water utilities to promote water conservation and by investigating the impact of different ownership structures on the effectiveness of these efforts.

Spain's combination of climatic challenges and varied water management frameworks makes it an intriguing case for investigating the implementation of SDG 6.4 and the broader implications for water sustainability. Its irregular rainfall and frequent droughts, compounded by population growth, high tourism demand, and the need to balance water resources between agricultural and urban needs, make the management of domestic water consumption particularly complex and significant (MITECO, 2024). Moreover, Spain's diverse water utility management structures—ranging from private entities to public authorities and public-private partnerships (PPPs) across different municipalities—provide a unique opportunity to study how varying governance models influence the design of demand-side strategies.

The central research questions guiding this chapter are: What actions do water supply companies take to promote pro-environmental behaviors and habits among users? Are there differences in the strategies for implementing sustainable water use practices based on the ownership structure of the utility? To address these questions, the chapter covers two specific research objectives:

Examine whether water supply companies actively promote pro-environmental behaviors and habits among users.

Investigate the effect of utility ownership on the promotion of sustainable water use in households.

These objectives are explored through two key papers that comprise this chapter, collectively addressing the challenges related to promoting sustainable water use practices. The first paper provides an analysis within the context of OECD countries, focusing on the effectiveness of water conservation efforts in domestic settings, specifically examining water use in activities representing the highest indoor demand, such as showers (Moslehi et al., 2020). Methodologically, this study involves analyzing the types of advice and tips provided to consumers and estimating the potential water

savings that could result from implementing these recommendations. The study is crucial for understanding broader international practices and the effectiveness of different strategies aimed at reducing water consumption in a critical area of daily life.

Building on the insights from the first paper, the second paper shifts its focus to the Spanish context, examining how the ownership structure of water utilities—whether public or private—affects the promotion and implementation of sustainable water use practices in households. Methodologically, statistical methods are used to compare the different types of water-saving advice offered by these utilities and how factors like water stress and population size influence their strategies. This analysis provides a detailed exploration of the impact of governance models on the effectiveness of these pro-environmental initiatives, offering a localized perspective that complements the broader international analysis from the first paper. Furthermore, it is the first study to explore the relationship between ownership and the content awareness campaigns, analyzing the two dimensions of conservation messaging identified in the literature on the effectiveness of educational campaigns (Nauges & Wheeler, 2017).

Together, these studies offer a comprehensive view of water conservation strategies by integrating international comparisons with in-depth local analysis. This research enhances our understanding of urban water management and contributes to the achievement of SDG 6.4 by providing insights into international practices and the specific challenges faced in Spain. The findings are intended to inform policymakers and water utilities, offering practical recommendations for improving water awareness campaigns, enhancing efficiency, and encouraging sustainable daily practices. Ultimately, this research contributes significantly to academic scholarship and policy-making, highlighting new areas for investigation and advancing the debate on the influence of ownership on water utility performance.

Chapter 7.

PROMOTING WATER CONSERVATION HABITS IN SHOWER USE: REVIEW OF WATER UTILITY WEBSITES IN OECD CITIES

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Abstract

Personal hygiene accounts for 30–45% of water use in households in Organisation for Economic Co-operation and Development (OECD) countries, and of this water, the greatest proportion is used for showering. More efficient showers can be achieved by using efficient technologies – mainly efficient showerheads – as well as through the adoption of sustainable habits, such as reducing shower frequency and duration. A review of the websites of water utilities in cities of OECD countries shows little effort to promote water-saving shower habits. Addressing this shortcoming would improve the sustainability of water use, compared with the current focus on efficient technologies.

Keywords: water-saving tips · water utilities · water conservation · OECD countries · saving shower habits

INTRODUCTION

Water conservation, an essential objective within the broader aim of overall water resource protection, continues to be crucial all over the world due to increasing water scarcity and deterioration, and the growing number of uses and users.

Looking at the different end uses of residential water, showering or bathing often represents the highest indoor demand, accounting for 30–45% of total residential use (Energy Saving Trust, 2015; Moslehi et al., 2020; Water Research Foundation, 2016). There is also evidence that, among personal hygiene options, showering is preferred over bathing in developed countries. For example, in a survey of approximately 10,000 households in 10 Organisation for Economic Co-operation and Development (OECD) countries, 85% of the interviewees said they prefer showers over baths (Grafton et al., 2011).

Thus, any strategy for encouraging water conservation in homes should include guidance on showering. Regarding water conservation in the shower, two determinants have been identified: technology and human behaviour. The main water-saving shower technologies are efficient showerheads (Watson, 2017; Willis et al., 2013); alarm and time control devices (Beal et al., 2013; Stewart et al., 2013), which also support the greatest energy saving (Lam et al., 2017); and digital feedback-based interventions (Hartley et al., 2021). However, efficient technology does not guarantee a more sustainable use of water and can lead to a rebound effect (Lindsay & Supski, 2017; Shove, 2003). The disconnect between the use of efficient technologies and the sustainable use of water can be explained in terms of individual resistance to the sacrifice associated with putting into practice pro-environmental attitudes (Ananga et al., 2019), or just because behaviour is not always rational and can be guided by habits or automatic routines (Steg & Vlek, 2009).

Therefore, the pro-environmental use of the shower also requires the development of good habits. Among these good habits, the most significant is to limit shower frequency and duration. Although personal hygiene is necessary, showering includes an important discretionary component. Showering too often or taking overly long showers can be considered a discretionary activity (Russell & Knoeri, 2020). Thus, hygiene habits are a relevant, but often ignored, factor in sustainability (Gram-Hanssen, 2007). Two other

habits can contribute to water saving in the shower: collecting cold water for other uses while waiting for the water to heat up, and turning off the tap while soaping up (Ananga et al., 2019).

Water utilities recognize that awareness campaigns are some of the most effective means to reduce per capita water consumption (Tortajada et al., 2019). However, we question whether they promote pro-environmental shower habits as much as they should. This viewpoint reviews the tips for pro-environmental and efficient shower use provided by water utilities (through their websites) in a sample of OECD cities. Overall, the amount of guidance provided in this way is quite small. We discuss whether water utilities should make greater efforts to promote water-conservation habits while using the shower. After all, many people may see the adoption of such habits as a sacrifice, making it an unpopular initiative.

This viewpoint is structured as follows. We next show that there is scope for saving water by changing shower habits. We highlight the importance of awareness campaigns for water saving, review the tips for pro-environmental shower use on water utilities' websites, and estimated water use depending on the duration and frequency of showers, as well as showerhead design. We complement our findings with a discussion of people's willingness to change their habits, even when it is not easy, and conclude with reflections on future research.

BACKGROUND

Shower habits conditioning water use

Shove and Walker (2010) argue that daily showering has gone from the routine of a few to the norm. Shower frequency can be surprisingly high. Households in Melbourne and Brisbane, Australia, reported taking between 0.9 and 1.8 showers per day (Binks et al., 2016). In the United States, the reported average is once per day, but up to 18% of the population takes multiple showers per day (Wilkes et al., 2005). Marzano et al. (2020) administered an online questionnaire in both the United States and Canada, focusing on a website (Microworkers, www.microworkers.com) for its popularity and ease of use.

They found an average weekly shower frequency of 5.7, but some people reported showering up to 11 times a week. Regarding shower duration, most studies estimate it at between 5 and 10 min, but again, some people take far longer. In the United States, the Water Research Foundation (2016) reports an average of 7.8 min, but according to

Marzano et al. (2020), the average is a bit more than 11 min – and some of their interviewees reported spending up to 1 h. Adeyeye et al. (2020) discussed that, in a two-week study with 12 volunteers, women spent more time in the shower compared with men. The average time for women was 11 min, and 9.5 min for men. Men spent more than 10 min in the shower in 50% of the cases, and women did so 70% of the times.

Across the UK, showers also represent the largest use of water in the home. Around 840 billion litres of water are used for showers each year, and people spend around £2.3 billion on heating water for these showers (EST, 2015). In a UK-led national study, 32% of a sample of nearly 160,000 persons using EST's water energy calculator reported an average shower length of 7.8 min (the calculator is an online tool that helps households in the UK to understand the energy associated with water use in their homes, and it identify opportunities to manage their consumption and bills). In Simpson et al. (2019), university students in campus accommodations in Bristol, UK, reported an average shower duration of 10–12 min, higher than reported UK norms.

While there is no universal agreement on the ideal frequency or duration of showers, some references are worth noting. Regarding duration, the United Nations recommend short showers to improve progress towards SDG 6. A total of 5 min was set as the sustainable shower duration for the World Water Day water-conservation campaign in 2020 (United Nations, 2020a, 2020b). The objective is to balance good personal hygiene with pro-environmental habits. Shorter showers are also suggested by the US Environmental Protection Agency (EPA, n.d.) as a part of 'showering better' (which refers to saving both water and electricity). Some researchers suggest that less frequent showering is still fine for personal hygiene (Shmerling, 2021), and furthermore that too much soap and water can strip the skin of its protective barrier, damaging it. A few people have taken the notion even further and have decided not to shower at all (Hamblin, 2016, 2020). While this is probably too drastic a response, many showers could be replaced by sponge baths. People who shower to relax might consider alternative (more environmentally friendly) relaxation techniques. In any case, a significant amount of water could be saved if people took shorter and/or fewer showers.

There are other ways to improve water-use efficiency in showering, such as turning the tap off while soaping up or collecting cold water for other uses, but such practices are not common. Most of the people Kappel and Grechenig (2009) interviewed did not turn off

the tap while soaping up. In a study in Ada in Oklahoma, United States, only 15% of respondents collected cold water for other uses while waiting for the shower water to heat up (Ananga et al., 2019).

Awareness campaigns for water savings

Traditionally, the instruments for changing behaviour in water use can be grouped into pricing and non-pricing (Garcia-Valiñas et al., 2015). Pricing instruments have only a small impact on water use. This is because the demand for water is relatively inelastic (Sebri, 2016; Worthington & Hoffman, 2008) and because water bills normally represent a small percentage of household incomes (Leflaive & Hjort, 2020).

Awareness campaigns are the main non-pricing instrument used to influence household water-use habits. They can significantly influence conservation behaviour and reduce water use (Kenney et al., 2008; March et al., 2015; Moglia et al., 2018). In a study in Queensland, Australia, Fielding et al. (2013) found that giving families practical advice on how to save water could reduce their water use by up to 16%.

However, to have long-term impacts, campaigns must be sustained. Studies have seen significant impacts at the beginning, say the first 1–3 months; but after this, water use returns to the baseline (Koop et al., 2019). Even campaigns maintained for years may gradually lose their effect. For example, in a four-year study by Lee et al. (2011), less impact was observed in the last two years.

On the precise impacts of water-saving campaigns, evidence is ambivalent. For example, an awareness campaign by Thames Water and the UK Environment Agency that directed mailings, posters, and newspaper and radio advertisements at 8000 households in Swindon had only minor effects. Only 5% of the population reported being aware of the campaign (Howarth & Butler, 2004). According to the authors, this lack of success could be due to a lack of public awareness of any problem of water scarcity. On the other hand, Brick et al. (2017) saw reductions in water use of between 0.6% and 1.3% from a tips and social norm campaign in Cape Town, South Africa.

Many water utilities offer talks in schools. It is easier to introduce good habits to children and teenagers – who can also influence their parents (Çoban et al., 2011; Damerell et al., 2013). In this regard, educational materials are normally aimed at children, such as animated cartoons, stories and theatre plays (Sauri, 2020).

More recently, information technologies have enabled low-cost campaigns that aspire to global impacts. Websites and social networks have been used to raise public awareness (Kuppuswamy, 2020; Tate et al., 2014). The advantage of social networks over the web is that they reach the younger populations, who are their main users (Elena-Bucea et al., 2021). The downside could be a briefer impact because the world of social media changes so rapidly.

Overall, it can be concluded that there is scope for making use of the shower more sustainable and that water utilities could promote such sustainable use through awareness campaigns.

METHOD

Water utilities' websites are a means of promoting the sustainable and efficient use of water. When people need information, many of them consult their water company's website. Given that information usually remains on a website for some time, we can assess how important shower water saving is in water utilities' conservation campaigns. If it is not mentioned on the website, it will probably not be included in social media. Messages on social media may have only a brief effect since they are quickly replaced by new information. Social media are perhaps best used for timely (or even emergency) information, such as notice of upcoming water supply cuts or a warning of health risks following water tests.

This study drew on information extracted from the websites of 38 water utilities, mostly in the capital cities of OECD countries. Only a few were not capital cities. Washington's, DC, website was not working, and Sacramento was chosen because it is the capital of the State of California and an area with high water stress. Within the UK, only England was selected. Thames Water serves customers across London and the Thames Valley; Affinity Water provides water to the London boroughs of Harrow and Hillingdon and parts of Barnet, Brent, Ealing and Enfield.

We focus on country capitals because, generally, they include a large part of the country's population and can be considered as exemplars for the rest of its water utilities. On each website, we searched for water-saving tips for the specific case of showers: (1) tips on shower frequency; (2) tips on shower duration (or time control); (3) a recommendation to turn off the water while soaping; and (4) a recommendation to collect cold water in a bucket for other uses while waiting for warm water.

We also estimated both the water use and the potential for water saving per person, considering both shower duration and frequency. For these estimates, we assumed three values: one to take as moderate, one to take as a goal and one to take as unsustainable:

- For shower time, 10 min is moderate, 5 min is a reasonable goal (United Nations, 2020a, 2020b) and 20 min is unsustainable (though it is widely reported, as mentioned above).
- For shower frequency, seven times per week is moderate, four times per week (complemented by sponge baths) is a decent goal and 14 times per week (twice a day) is unsustainable.
- For shower heads, 10 L/min (AA head) is standard, 7 L/min (AAA head) is widely available and 20 L/min (A head) is unsustainable (Willis et al., 2013).

SHOWER ADVICE ON WATER UTILITY WEBSITES

Here we document the advice related to showering given by 38 water utility websites (Table 7.1).

In general, these websites emphasize the good quality of tap water provided by the utility, along with monitoring and strict regulations. Most also explain that water is energy intensive, and that managing water consumption will reduce a household's electricity bill, along with its water bill.

Showering is usually seen as a more efficient and sustainable use of water than running a bath, but there also seems to be some agreement that this depends on its length. Some utilities explicitly suggest showers rather than baths (Belgium; Dublin, Ireland; Lisbon; Ljubljana; Madrid; Paris; Rome; Slovenia; and Tallinn, Estonia). But others think differently, including Reykjavík, Ottawa, Canberra, Wellington and Affinity Water in London. Reykjavík mentions that hot water is used more efficiently in showers rather than in full bathtubs. However, the difference is estimated at 30 litres of hot water, suggesting that a bath is a comparatively inexpensive luxury. Ottawa suggests filling the tub only onequarter full. Canberra and Wellington say that although many people believe that baths waste water, they use less water than a very long shower; it is enough to use a partially filled tub, or to reuse the bathwater to wash a car, for example.

Regarding showers, the most common conservation advice on these websites is related to shower duration – that is, taking shorter showers; 17 of the 38 water utilities mentioned

this (but note that this is still less than half of them). Affinity Water (in London) challenged customers to take a 4-min shower, while the Lisbon utility suggested 5 min.

The Copenhagen utility reports the litres saved for every 1 min a shower is shortened; Helsinki and London use economic language, focusing on water and electricity bill savings, to influence user behaviour. The Canberra utility has some of the most detailed suggestions, including purchasing a timer that will ring after 4 min of showering. Another is to shave before showering, and then rinse off in the shower.

While most of the utility websites recommend turning the water off while brushing one's teeth and shaving, turning the water off while soaping up is recommended by only a few of them. The Paris utility recommends using less soap, so that less time (and water) is needed for rinsing. Lisbon's utility says that turning off the tap during a 5-min shower (e.g., while soaping up) can save 36 litres of water. Only four utilities recommend using a bucket in the shower to collect the water before it is hot. The suggested uses of this water vary, and include flushing the toilet (Mexico), and watering plants (Madrid and Wellington). Madrid's utility says that 2–8 litres of cold water can be collected in every shower this way.

Remarkably, most of the utilities do not provide water-saving tips regarding shower frequency. In fact, there are hardly any references to this issue on their websites. Copenhagen's utility suggests that customers do not shower more than necessary; Amsterdam's gently suggests that a daily shower is all you need.

It should be noted that eight of the 37 cities in our sample have high water stress (the capitals of Israel, Greece, Spain, Mexico, Italy, Belgium, Turkey and Chile). Water utilities in these cities would be expected to have strong incentives to promote water conservation. However, four of them (Chile, Greece, Israel and Turkey) do not offer any such advice on their websites.

Table 7.1. Advice promoting pro-environmental behaviours in shower use on water utilities websites of capital cities of OECD countries (2020)

Country	*City*	*(1)*	*(2)*	*(3)*	*(4)*	*Observations*
Australia	Canberra		X	X	X	https://www.iconwater.com.au/my-home/saving-water/for-your-home/bathroom.aspx
Austria	Vienna		X			https://www.wien.gv.at/english/environment/klip/pdf/climate-tips.pdf
Belgium	Brussels					https://customers.vivaqua.be/conseils/comment-economiser-leau/; https://www.vivaqua.be/fr/qualite-de-leau/
Canada	Ottawa		X			https://ottawa.ca/en/living-ottawa/drinking-water-stormwater-and-wastewater/drinking-water/water-conservation#water-conservation-tips https://ottawa.ca/en/living-ottawa/water-utility-bills
Chile	Santiago de Chile					https://www.aguasandinasinversionistas.cl/es, https://www.aguasandinasinversionistas.cl/es/quienes-somos/sustentabilidad, https://www.aguasandinasinversionistas.cl/es/quienes-somos/sustentabilidad/reportes
Colombia	Bogotá		X		X	https://bit.ly/3t2fl5U; https://bit.ly/3ayXkEd
Czech Republic	Prague		X			https://www.pvk.cz/vse-o-vode/pitna-voda/spotreba-vody/jak-a-proc-setrit-vodou/
Denmark	Copenhagen	X	X	X		https://www.hofor.dk/privat/spar-penge/spareraad-til-vand/spar-vand-paa-badevaerelset/

Estonia	Tallinn	X		https://vesi.evg.ee/firmast-1/; http://www.kvd.ee/index.htm; https://tallinnavesi.ee/en/corporate-social-responsibility/soovitused-vee-saastmiseks/
Finland	Helsinki	X		https://www.hsy.fi/en/water-and-sewers/tips-for-water-use/
France	Paris		X	http://www.eaudeparis.fr/leau-au-quotidien/une-consommation-maitrisee/#conso_moyenne
Germany	Berlin			https://www.bwb.de/content/en/html/2266.php
Greece	Athens			https://www.eydap.gr/en/LearnAboutWater/enviromental-programms/
Hungary	Budapest			https://www.vizmuvek.hu/en/
Iceland	Reykjavik			https://www.veitur.is/en/bathroom
Ireland	Dublin	X		https://www.water.ie/conserve/; https://www.water.ie/conservation/business-water-conservation/business-conservation-tip/
Israel	Jerusalem			https://www.hagihon.co.il/water/?lang=en
Italy	Rome			https://www.gruppo.acea.it/en/serving-people/water/acea-ato-5/acea-ato-5-reports/2020/05/water-is-precious-here-are-some-tips-on-how-to-save-it; https://www.gruppo.acea.it/en/serving-people/water/acea-ato-5/acea-ato-5-reports/2020/07/saving-water-shared-commitment; https://www.gruppo.acea.it/en/serving-people/water/acea-ato-5/acea-ato-5-reports/2019/09/ten-invaluable-rules-for-saving-water-home

Japan	Tokyo			X		http://www.waterworks.metro.tokyo.jp/eng/topics/20160614.html
Korea	Seoul					http://english.kwater.or.kr/eng/about/sub02/orgnPage.do?s_mid=1102
Latvia	Riga					https://www.rigasudens.lv/
Lithuania	Vilnius					https://www.vv.lt/en/about/
Luxembourg	Luxembourg					https://www.vdl.lu/fr/la-ville/participez-vous-aussi/economisez-leau
Mexico	Mexico City				X	https://www.sacmex.cdmx.gob.mx/cultura-del-agua; https://www.sacmex.cdmx.gob.mx/atencion-usuarios/camp/derecho-al-agua
Netherlands	Amsterdam	X	X			https://www.waternet.nl/en/service-and-contact/tap-water/average-water-use/; https://www.waternet.nl/en/service-and-contact/tap-water/
New Zealand	Wellington		X		X	https://www.wellingtonwater.co.nz/your-water/drinking-water/looking-after-your-water/water-conservation/water-conservation-inside/
Norway	Oslo					https://www.oslo.kommune.no/vann-og-avlop/tilknytningsgebyr-arsgebyr-og-vannmaler/vann-og-avlopsgebyrer/
Poland[*]	Krakow	X				https://wodociagi.krakow.pl/jakosc-wody/ciekawostki/jak-oszczedzac-wode-w-domu.html; https://wodociagi.krakow.pl/jakosc-wody/ciekawostki/ile-wody-zuzywamy.html; http://www.mpwik.com.pl/

Portugal	Lisbon	X	X		https://www.epal.pt/EPAL/en/menu/our-water/campaigns/efficient-use
Slovak Republic	Bratislava				https://www.bvsas.sk/
Slovenia	Ljubljana	X			https://www.vo-ka-celje.si/sl/uporabniski-center-63
Spain	Madrid		X	X	https://www.canaldeisabelsegunda.es/documents/20143/616729/Consejos+de+ahorro+de+agua_En+tu+hogar_010419_vpdf.pdf
Sweden	Stockholm	X	X		http://www.stockholmvattenochavfall.se/en/
Switzerland	Bern				https://www.ewb.ch/wissen/faq/faq-wasser-wasser-sparen
Turkey	Ankara				https://www.aski.gov.tr/tr/Anasayfa
*England***	London (Thames Water)***	X	X		https://www.thameswater.co.uk/help/water-saving/water-saving-tips
*England***	London (Affinity Water)****	X			https://www.affinitywater.co.uk/save-water
United States+	Sacramento	X			https://www.dcwater.com/savewater

Note: (1) Tips on shower frequency (2) Tips on the duration of the shower (or time control); (3) Recommendation to turn off the water while soaping; (4) Recommendation to collect cold water in a bucket while waiting for warm water for other uses.

* Warsaw's website is disabled; Krakow has been selected due to its population size.

**Within UK, only England was selected. ***Thames Water serves customers across London and the Thames Valley. ****Affinity Water, provides water to the boroughs of Harrow and Hillingdon and parts of the boroughs of Barnet, Brent, Ealing, and Enfield

+ Washington's website is disabled. Sacramento has been chosen because it is the capital of the State of California, an area with high water stress.

WATER-CONSERVATION ESTIMATES

To support our arguments regarding sustainable and unsustainable habits in the use of the shower, we estimate the volumes of water used during a shower under the assumptions (previously described) of shower duration and types of showerheads (Table 7.2).

Shortening the shower from 20 to 10 min can save 70–200 litres of water each time, depending on the type of showerhead. Shortening it from 10 to 5 min can save between 35 and 100 litres of water each time.

We also estimated the quantity of shower water used per person per year (Table 7.3). A 10-min shower (the average reported length) uses 70, 100 or 200 litres, depending on the showerhead. This can be multiplied by the three frequencies mentioned above: four, seven or 14 showers per week. We also include estimates of water saved if people decide to adjust their habit – that is, taking one less shower per week than before. This can reduce annual water use by 3640 litres with a 7 L/min showerhead, by 5200 litres for a 10 L/min showerhead and by 10,400 litres for a 20 L/min showerhead.

Table 7.2. Estimates of water consumption (litres) per person based on the duration of showers and types of showerheads.

	Duration of the shower			*Potential savings*	
Showerhead	5 min.	10 min.	20 min.	From 10 to 5 min.	From 20 to 10 min.
7 L/min.	35	70	140	35	70
10 L/min.	50	100	200	50	100
20 L/min.	100	200	400	100	200

Table 7.3. Estimates of annual water use (litres) during showers per person based on different assumptions of shower frequency per week

	Showers per week			*One shower less per week*		
*Liters per shower**	4	7	14	From 4 to 3	From 7 to 6	From 14 to 13
70 L / shower	14,56	25,55	51,10	10,92	21,91	47,46
100 L / shower	20,80	36,50	73,00	15,60	31,30	67,80
200 L / shower	41,60	73,00	146,00	31,20	62,60	135,60

DISCUSSION AND CONCLUSIONS

SDG target 6.4 calls for a significant increase in the efficient use of water in all sectors by 2030. It is true that the greatest margin for saving water is in agriculture, the main user of water. However, people can also contribute to the conservation of water in their household, specifically in the use of the shower. This can be aided by smart devices, but the most important change is more sustainable habits.

For people to make such changes, they need information. They need to know what sustainable and unsustainable habits look like and what their impacts are. And water utilities' websites are an excellent platform from which to educate their many customers on sustainable habits.

In previous sections we discussed sustainable and non-sustainable habits in the use of the shower. To support our arguments, we estimated the volumes of water used during a shower under plausible assumptions of shower duration and types of showerheads.

These estimates show the potential for saving water through shorter and/or less frequent showers. They also show that technology alone is not enough to make showers efficient and sustainable. Efficient showerheads (7 L/min) can result in higher water use compared with less efficient showerheads if people use them to justify taking longer showers or showering more frequently. In fact, Grafton et al. (2011) did not find significant water savings due to the use of efficient showerheads. Therefore, to save water and avoid a possible rebound effect, sustainable habits are essential. Requiring the installation of efficient showerheads in new housing, or promotional campaigns and subsidies for the installation of efficient devices in the shower, may not be effective if they are not accompanied by the promotion of better habits.

On the websites of the water utilities we studied, suggestions on water-conservation and sustainable habits related to personal hygiene focus on tooth-brushing and shower use. In terms of showering (Table 7.1), the water utilities suggest taking shorter showers (17), turning off the water while soaping up (eight), collecting cold water for other uses while waiting for warm water (four) and showering less often (two). Some suggest how to use baths more effectively (using less water). In any case, shower use is more widespread in OECD countries (Grafton, 2014). This means that more water can be saved through changes in showering habits.

Given the scant information on water utility websites, one wonders whether the utilities are aware that communication is crucial to engage users in water-conservation habits. One also wonders why they are not motivated to provide more information on water conservation. Is it because they do not have this information, or because they do not consider it important? Or could there be a disconnect between realities and policies? For example, since most of the population in OECD countries shower at present, water utilities seem to be out of touch when they suggest that people should take showers rather than baths, and when they do not to provide more recommendations on how to follow a pro-environmental behaviour. This is the case in Berlin, Brussels, Rome, Luxembourg and Warsaw.

Bringing about a change in shower habits is a challenge, especially when showering is associated with multiple functions and not simply personal hygiene (Kurz et al., 2015). In terms of personal hygiene, should there be more discussion of freshness and bodily hygiene (Shove & Walker, 2010), opening the door for water utilities to suggest showering less often? How would people in middle- and high-income OECD countries respond to such a suggestion? Socially speaking, would skipping daily showers result in social rejection, reinforcing biases due to culture and race? Or are cultural expectations around body care, beauty and hair-washing mainly the result of media messages, as suggested by Robbie (2009)? It is known that social networks influence people's views on body care and personal image, mainly in the case of young people (Cohen et al., 2021; Henriques & Patnaik, 2020).

Returning to new habits, the resistance to forming them is likely to be greater if people associate them with less comfort as well as making a sacrifice (Poortinga et al., 2003). Although people in general are aware of the importance of saving water, households are

more likely to engage in behaviours that require little effort or financial investment. In fact, these behaviours are encouraged by some public water services. For example, Sacramento's Water Wise Rebates subsidize the installation of highly water-efficient technology. This reduces the time and money that need to be spent on water-conservation upgrades to dwellings. On the one hand, this will probably save a certain amount of water, which is why water utilities in the OECD cities we checked suggest that more efficient showerheads be installed. On the other hand, this progress could be prevented if people take too long or too frequent showers – that is, if they do not change their habits. In this regard, it is important to document whether people are aware of the water they use in the shower and the water they could save by changing their habits. Another equally important issue is whether people would be willing to change their habits if they were aware of the water savings and the resulting drop in their water and electricity bills. These are promising lines of research.

Overall, water utilities should make greater efforts to promote more efficient shower use by encouraging behavioural changes. These attempts may not work if they use messages that are likely to be rejected by most people, and such rejection can be an important hurdle in the battle for water conservation in personal hygiene habits. In this regard, a question remains. With showering having prevailed over bathing, should not the efficient use of water be promoted much more strongly, even if it entails sacrifices by the public? Policymakers and water utilities will have to start this discussion at some point, even if it is likely to be unpopular.

Chapter 8.

DOES THE OWNERSHIP OF WATER UTILITIES INFLUENCE WATER-SAVING ADVICE PROVIDED TO SERVICE USERS? AN ANALYSIS OF THE SPANISH WATER SECTOR[40]

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Abstract

This paper addresses the need to ensure the sustainable use of water, in line with the United Nations' Sustainable Development Goals. Using statistical methods, this paper analyses whether the ownership of the water utility is an explanatory factor for (1) the provision of water conservation advice on utilities' websites; and (2) how comprehensive this advice is in terms of tips on (i) installing efficient technology and (ii) adopting sustainable habits and behaviours. The paper focuses on the Spanish water industry, which is considered particularly appropriate for the analysis due to the coexistence of utilities with different ownership structures. The results reveal statistically significant differences according to the ownership of the operator and the size of the population served. For example, more private companies provide some advice on their websites, while public companies offer more tips per online advice section. The evidence should encourage national governments and regulatory authorities to pass a regulation that establishes guidelines on how these companies, both public and private, should provide water conservation advice on their websites.

Keywords: Public companies · Private companies · Information campaigns · Sustainability · Water saving · Corporate Social Responsibility

[40]The previously published version of the manuscript included tables and figures in the supplementary material due to word limitations. However, in this revised manuscript, the decision has been made to incorporate that material into the main text to enhance readability while preserving the original wording.

INTRODUCTION

Motivation

Promoting efficient use of water resources is crucial due to the worsening water scarcity worldwide, and the growing number of uses and users (Addo et al. 2019). In its 2030 Agenda, the UN dedicates Sustainable Development Goals (SDGs) 6 and 12 to finding a balance between providing universal access to water and ensuring its sustainable use (UN 2015). The responsibility for achieving this goal lies with all stakeholders, including utilities, regardless of the ownership of the operator. However, there is an ongoing debate on the desirability of private participation in the industry. The main argument against private ownership is that these companies prioritise a cost and market orientation over a customer/user orientation (Lobina 2013; Shen et al. 2016).

Previous research has applied different approaches to demonstrate the effect of ownership on water service provision. For example, studies have examined the relationship between ownership and prices (Wait and Petrie 2017), the perceived quality of the service (Romano and Masserini 2020), or the loss of water through networks (Martínez-Espiñeira et al. 2017). Yet, there is little evidence on the relationship between ownership and the promotion of sustainable behaviour by service users; some of the few studies in this vein include those by Barrett and Wallace (2011) and Romano et al. (2014).

Educational campaigns constitute a key pillar of water conservation policies in urban environments (Addo et al. 2019). Water utilities recognise that such campaigns are one of the most effective means of reducing per capita water consumption (Tortajada et al. 2019), generating not only cost savings for users but also social and environmental benefits. Moreover, EU Directive 2020/2184 stipulates that water utilities must provide online advice to consumers, including tips on how to reduce water consumption. Consequently, any assessment of their performance must go beyond questions of profitability and financial solvency. However, in the absence of regulatory agencies, the question arises as to whether ownership has a bearing on the design and implementation of information campaigns for service users. This is an important issue because the SDGs are not built on economic logic, but rather are guided by a clear social and environmental purpose. Water utilities are not only central to improving the efficient use of water (SDG 6.4), but can also play a role in achieving SDG 12.8, which is aimed at ensuring that

people everywhere have the relevant information and awareness for sustainable development.

Spain is selected as a case study because it has a Mediterranean climate, and the conservation of its inland ecosystems requires changes to the way people use water (Latinopoulos et al. 2016). Moreover, Spanish water utilities are not obligated to promote the efficient use of water to their customersFootnote1 and, although municipalities are responsible for ensuring service provision, they can choose to delegate water supply management to public, private and mixed-capital companies.

Objective and Hypotheses

This paper aims to contribute to the existing literature on the sustainable use of water and reduction of household water consumption by analysing whether Spanish water utilities seek to encourage efficient water consumption through online information campaigns, and by identifying the extent to which this can be explained by the ownership of the utility. Specifically, it examines whether ownership is an explanatory factor for (1) the provision of water conservation advice on utilities' websites; and (2) how comprehensive these sites are in terms of disseminating advice on (i) installing efficient technology and (ii) adopting sustainable habits and behaviours. To this end, a logistic regression, a one-way analysis of variance (ANOVA), and an ordinary least squares (OLS) regression analysis are applied to a sample of 341 Spanish service areas.

Considering the inherent contradiction between the pursuit of profit and the promotion of efficient consumption behaviour (Howarth 2011), the main hypothesis to be tested is whether the private company provides less water-saving advice to service users than the public operator. As a counterpoint to this rationale, it could be the case that Corporate Social Responsibility (CSR) overrides the differences between public and private management when it comes to offering water-saving advice.

Contribution of the Research and Structure

The main contribution of this paper is that it is the first study on the relationship between ownership and the content of online information campaigns to analyse the two dimensions of conservation messaging identified by the literature on the effectiveness of educational campaigns (Nauges and Wheeler 2017). The research therefore adds to the ongoing debate about the influence of ownership on the performance of water utilities.

This paper is structured as follows. Section 2 offers a review of the literature. Section 3 describes the methodology. The results and discussion are presented in Section 4. Finally, Section 5 reports the conclusions and provides some recommendations.

LITERATURE REVIEW

Ownership and CSR

The behaviour of public enterprises is considered to be driven by criteria that go beyond the economic logic of profit-maximisation (Megginson and Netter 2001). Guided by the general interest, the ultimate goal of a public shareholder is to maximise profits while meeting the needs and expectations of citizens. In terms of water services, the general interest from the point of view of environmental sustainability would be the preservation of water resources, avoiding waste and over-consumption. As such, public utilities are expected to pursue cost recovery but not profits (Lauesen 2011), and are likely to be more driven by the goals of raising environmental awareness and conservation (Shen et al. 2016). In order to legitimise their actions and existence, public utilities have strong incentives to disclose more social and environmental information than private firms do (Cormier and Gordon 2001). Therefore, they are expected to share more water-saving advice.

On the other hand, the role of private operators in the water sector can be paradoxical. According to various perspectives, such as the neoclassical view, the objective of operating a business should be profit-maximisation. Indeed, Friedman (2007) argues that this is a firm's sole responsibility. Some authors claim that incorporating objectives beyond profit-maximisation runs counter to the principles of the market economy (Henderson 2004). When it comes to the private provision of water services, this creates the challenge of reconciling profit-maximisation with social and environmental demands (Rahman et al. 2022), because private companies should not neglect their social and environmental responsibilities when managing public services such the water supply (Lobina 2013; Cabrera et al. 2022).

Contrary to neoclassical approaches, Elkington (1998) claims environmental and social issues should be as important as economic ones. In this context, CSR emerges as an integrative model for business ethics, combining economic, social and environmental objectives (Diop and Bah 2018). According to Lantos (2001), CSR should focus on two

aspects: (1) preventing any harm that could result from business activities; and (2) achieving strategic business objectives.

Implementing CSR implies that companies have decided to go beyond the minimum legal requirements and collective bargaining obligations, striving to address the needs of society (The British Academy 2021). The motivation behind this behaviour can be interpreted in two ways. First, according to the resource-based view, companies may believe that being seen as socially responsible will give them a competitive advantage, enabling them to achieve better economic performance because good relationships with stakeholders can led to higher financial returns (Li et al. 2020). Second, legitimacy and stakeholder theories focus on external pressures to explain engagement in CSR activities. For private companies, CSR could be a way to reconcile their economic objectives and their social obligations, because companies use the disclosure of CSR activities to demonstrate their commitment to socially desirable behaviour (Branco and Rodrigues 2008).

However, private water utilities may not have good incentives to disseminate conservation advice. Educational campaigns seek to achieve considerable water savings by changing people's water-use habits (García-Valiñas et al. 2015), thereby lowering their profits in the short term (Argento et al. 2019). Instead, they may well turn to CSR strategies that do not come into conflict with their economic objectives, such as sustainability reports (Lauesen 2016), which can bolster their financial rather than social prestige (Markopoulos et al. 2020).

CSR can also be applied by public companies, although the specific nature of their stakeholders must be considered. Unlike in the for-profit sector, public enterprises show an interdependence of stakeholders (Lauesen 2011), with citizens being their ultimate stakeholders (Greiling et al. 2015). Consumers are of paramount importance in modern water and sanitation services; especially because they are simultaneously customers and potential voters with the power to elect politicians (Lauesen 2011). Thus, the use of pricing instruments, although effective in reducing consumption, may be less commonly used by public companies due to the negative effect on the political prospects of those who govern (Klien 2014), motivating them to implement alternative demand management strategies. Conversely, in private organisations, there is a natural gap between stakeholders' interests (Crane et al. 2008), usually in terms of profits, which discourages

the promotion of consumption efficiency and encourages the use of pricing instruments. Finally, information campaigns that motivate households to implement efficient water-use behaviour and that disseminate conservation advice can be understood as social marketing products (Romano et al. 2014). As such, they can be analysed as a CSR instrument, given that they aim to influence social behaviour to benefit users and society as a whole, including the environment, rather than directly benefitting the company itself (Zainuddin and Gordon 2020). However, the relationship between ownership and these types of CSR initiatives remains understudied.

Ownership and Promotion of Sustainable Behaviours

The literature shows that, regardless of ownership, the promotion of sustainable water behaviour is most common in periods of drought and water scarcity (Syme et al. 2000). Therefore, companies in areas with higher levels of water stress are expected to have greater incentives to disseminate water conservation advice. During the early stages of droughts, Kallis et al. (2010) note that public systems are more proactive than their private counterparts in requesting sustainable behaviours from their users. Moreover, Howarth (2011) shows that there is no financial incentive for private water companies to actively reduce demand.

In general, there is evidence that public sector involvement in the water supply is positively associated with promoting sustainable water use. For example, in England, privatised utilities were found to be the only ones that did not offer support for installing efficient showerheads (Barrett and Wallace 2011).

Website Information and Promotion of Efficient Use of Water

Finding solutions to alleviate water stress requires citizens to become knowledgeable about what they can do to reduce their demand (Walker et al. 2015). The literature points to the importance of company websites in the dissemination of sustainability information (Adams and Frost 2006; Rahim and Omar 2017). They offer the advantage of easily accessible, up-to-date, low-cost information dissemination, and wider coverage (Adams and Frost 2006). Moreover, Delorme et al. (2003) show how consumers react favourably to website campaigns designed to educate the population on better water management practices. In this vein, Directive 2020/2184 stipulates that consumers must be provided with a link to a website containing advice on how to reduce water consumption. As such

campaigns are especially cost-effective for larger target populations, we would expect to find a positive relationship between the size of the population served and the online provision of conservation tips.

However, the literature to date has not explored whether water utilities seek to encourage a reduction in household water consumption through website information campaigns. The scarce empirical evidence on this issue—from California (Kallis et al. 2010) and Italy (Romano et al. 2014)—suggests that public companies make greater efforts to promote water conservation measures on their websites, but there are no studies on the type of messages disseminated, which is the subject of this research.

METHODOLOGY

Fieldwork

The study covers 341 service areas in Spain, which together account for 67.27% of the country's population. All service areas with more than 20,000 inhabitants were included in the sample.

Websites are representative of water utilities' broader promotion of water conservation and the online information they provide is thus an appropriate measure of their efforts in this area (González-Gómez et al., 2022). Consequently, the websites of the relevant water companies were searched for information on conservation and water-saving tips. Content analysis was applied to web-based documents, which is a well-established research technique (McMillan, 2000). First, a search was conducted to determine whether companies had a specific section on their website dedicated to water-saving tips, followed by a broader search across the website. In cases where no such information was found, companies were contacted through different channels—telephone, social media and email—to confirm whether this information did in fact exist. Note that the choice was made to group municipalities into service areas, because the unit of analysis is not the individual municipality, but the website of the water service provider. Table 8.S1, available in the supplementary material (online), lists all the municipalities/service areas and their characteristics included in the analysis.

Data on the population supplied were obtained from the Spanish National Institute of Statistics (INE, 2021). Data on levels of water stress were collected from the Water Exploitation Index Plus for river basin districts (EEA, 2021).

Variables Included in the Study

The variables used in the study are shown in Table 8.1, noting the stage in which they are incorporated into the analysis. Table 8.1 also states the hypotheses indicating the expected direction of the relationship, and provides the descriptive statistics for both stages of analysis.

Dependent Variables

To achieve the overall research objective, a two-stage analysis is carried out. Four dependent variables are investigated, depending on the stage of analysis.

First stage

tips_presence (explanation in Table 8.1).

Second Stage

- efficient_tech: an ordinal index that accounts for the presence of tips related to four water-efficient household appliances.
- sust_habits: an index that includes 17 pro-environmental behaviours and habits related to water use.
- water_saving_tips: a habits index constructed by summing the individual scores of efficient_tech and sust_habits.

The list of tips and the source chosen to build each variable can be found in Table 8.2.

Table 8.1. Description of the variables used in the study

Variable		Description	Hypotheses		Descriptive statistics of the variables			
			1st stage	2nd stage	1st stage (N=341) · 2nd stage (N=277)			
					Mean/%	Std. Dev.	Min	Max
Independent								
ownership	municipal_service	Dummy variable equal to 1 if the service is managed directly by the local council, and 0 otherwise	+	Not used	5.57·Not used		0	1
	public_enterprise	Dummy variable equal to 1 if the service is managed by a 100% public enterprise, and 0 otherwise	+	Not used	17.89 · Not used		0	1
	public	Dummy variable equal to 1 if the service is managed by either a municipal service or a public enterprise, and 0 otherwise	Not used	+	62.46 · 69.67		0	1
	private	Dummy variable equal to 1 if the service is managed by a 100% private enterprise, and 0 otherwise	-	-	14.08 · 15.52		0	1
	PPP	Dummy variable equal to 1 if the service is managed by a public-private partnership, and 0 otherwise	-	-				
water stress	low	Dummy variable equal to 1 if the region served suffers from low-medium water stress, and 0 otherwise	-	-	6.45 · 3.97		0	1
	medium	Dummy variable equal to 1 if the region served suffers from medium-high water stress, and 0 otherwise	+	+	7.04 · 5.41		0	1

	high	Dummy variable equal to 1 if the region served suffers from high water stress, and 0 otherwise	+	+	50.44 · 54.87		0	1
	extreme	Dummy variable equal to 1 if the region served suffers from extremely high water stress, and 0 otherwise	+	+	36.07 · 35.74		0	1
population	*Population*	Population variable expressed quantitatively			93,371.23 · 102,942.4	374,424.4 · 414,177	19,974	6,545,725
	>50M	Dummy variable equal to 1 if the population served is larger than 50,000 people, and 0 otherwise	+	+	31.96 · 33.94		0	1
	<50M	Dummy variable equal to 1 if the population served is smaller than 50,000 people, and 0 otherwise	-	-	68.03 · 66.06		0	1
Dependent								
Presence of tips web page	tips_presence	Dummy variable equal to 1 if the company website provides water-saving tips, and 0 otherwise	Used	Not used	81.23	0.3910	0	1
web page content	water_saving_tips	Indicator of water conservation tips (explanation in the text)	Not used	Used	0.3604	0.2143	0	0.8235
	efficient_tech	Index capturing tips related to efficient technology (explanation in the text)	Not used	Used	0.25	0.3451	0	1
	sust_habits	Index capturing tips on sustainable habits (explanation in the text)	Not used	Used	0.3943	0.2157	0	0.8462

Table 8.2. Tips considered to build the indicators

Variable		Description
Water_saving_tips	*efficient_tech*	Water-saving devices in taps [a] Single-lever/ thermostatic taps [a] Water-saving devices in toilets [a] Water-efficient household appliances (Triple A) [a]
	sust_habits	Repair and control leaks [a] Reuse cooking water for other uses (e.g. watering the plants) [a] Collect cold water in a bucket for other uses while waiting for water to warm up [a] Have a bottle with cold water in the fridge so as not to let the water run [a] Defrost food in advance to avoid doing so under the tap [a] Fill the sink before washing the dishes [a] Use the washing machine and dishwasher with a full load [a] Close the stopcock a little to reduce the flow of the taps [a] Keep a wastepaper basket in the bathroom to avoid using toilet as a bin [a] Turn off the water while brushing teeth [b] Turn off the water while soaping [b] Tips on shower frequency [b] Tips on shower duration (or time control) [b]

[a] Habits and technology investments adopted from the 2008 Households and Environment survey (INE 2008); [b] Habits adopted from González-Gómez et al. (2022)

Independent Variables

The independent variables considered in the study are ownership, water stress and population.

Ownership is categorised in two different ways, depending on the stage of the analysis. In the first stage, four dummy variables are included. Within the public ownership category, we distinguish between areas managed directly by the local town council–municipal_service–and those managed by a public company–public_enterprise. However, in the second stage, these two variables are grouped together into public. Considering the management of private companies, the variables private and PPP (public private partnership) are introduced. These two variables, used in both stages, capture the areas managed by wholly private companies and public-private partnerships, respectively.

Water stress is included because it can be considered a proxy for the need to promote sustainable water use to ensure reserve flows and water security (Carvalho and Marques 2011). It is disaggregated into four categories, as indicated by the EEA (2021). Lastly, population is used as a proxy variable for the size of the operator and the degree of professionalisation in the management of the company. Following the UN's (2017) recommended classification of localities by size class, we differentiate between areas with more than 50,000 inhabitants and smaller areas.

Analytical Strategy and Data Analysis

First Stage

In the first stage, we checked whether each service area had water conservation sections on their websites. The objective of this stage is to determine whether ownership is an explanatory factor for the presence/absence of these sections. To that end, a logistic regression is applied to the set of 341 observations. The general specification of the estimated equation is as follows:

Second Stage

The second stage focuses on the content of the sections dedicated to promoting sustainable water use. Operators that do not provide advice are eliminated from this stage of the analysis. As a result, 277 service areas serving 60.24% of the Spanish population are analysed.

The objective of this stage is to determine whether ownership influences the type of content offered. According to the literature on the effects of educational campaigns, water savings can be achieved through the adoption of sustainable habits and behaviours and/or the installation of water-saving technologies (Nauges and Wheeler 2017). We thus examine the effect of the ownership on the dissemination of tips differentiating between tips on sustainable behaviour and habits—sust_habits; tips on the use of efficient technology—efficient_tech; and all tips in general—water_saving_tips, which is the sum of the two previous variables.

We perform an ANOVA, using the Bonferroni test for the post hoc analysis to compare the mean number of tips provided by the three ownership categories (public, private and PPP). The influence of ownership on the promotion of water-saving measures is analysed

with an OLS regression analysis. The estimations were performed heteroskedasticity-robust standard errors. The general specification of the estimated equation is as follows:

All analyses were conducted first for the whole set of tips, and then again distinguishing between technology-based water conservation measures and those based on behavioural change. Figure 8.1 presents a flowchart summarising the methodology.

RESULTS AND DISCUSSION

Influence of Ownership on the Presence of Water Conservation Advice on Websites (Stage 1 of the Analysis)

Table 8.1 contains summary statistics on all variables used in both stages. The values of the population variable indicate that the size of the population served differs markedly between service areas, illustrating an industry in which small local units coexist with very large service areas. Concerning ownership, the most frequent type is private, accounting for more than half of the sample. At the other extreme, the least common is municipal_service, with less than 6% of the sample.

Despite not being obligated to promote the efficient use of water to their customers, water utilities' websites seems to be a widely-used instrument to inform users on how to reduce their water consumption in Spain. Only 19% of our sample do not provide any water-saving tips, compared to 57% of Italian water utilities (Romano et al. 2014). Of the service areas in our sample that provide no information, 23.4% are managed by municipal_service and 7.8% by PPP companies, while the most represented management types in this regard are private (31.3%) and public_enterprise (37.5%).

Table S3, available in the supplementary material, shows that users served by wholly public entities are less likely to find tips on how to conserve water when visiting their water supplier's website. Indeed, about 80% of the municipal_service websites in our sample lacked such information, while public_enterprise shared conservation tips in just over 60% of the corresponding service areas. In comparison, PPP and private dedicate space on their websites to water conservation information in 90% of the corresponding service areas. This could indicate that private management is not setting its sights purely on profit-maximisation for shareholders, but is also seeking to provide environmental and social benefits (Elkington 1998).

Figure 8.1. Flowchart Methodology

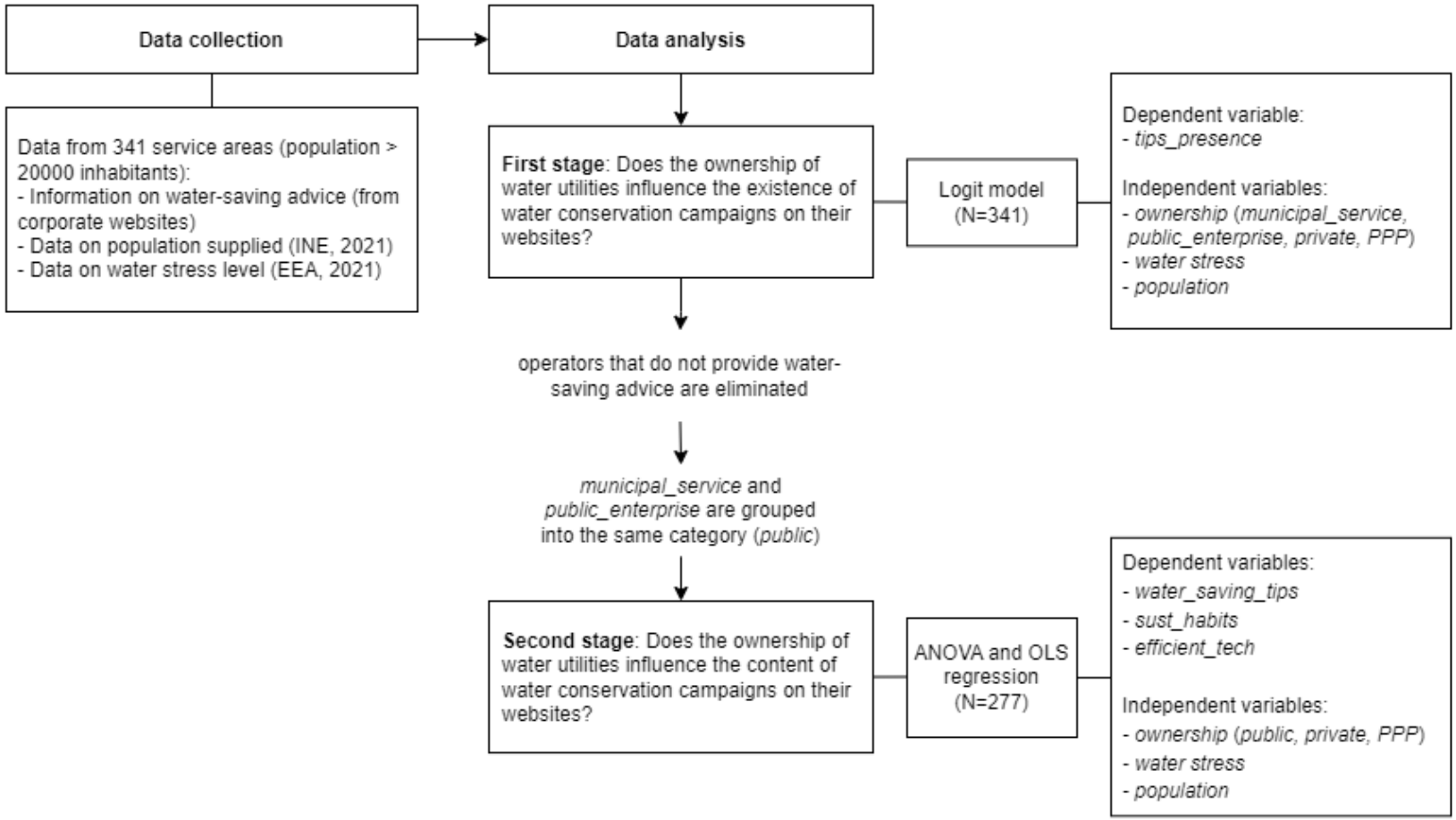

Table 8.S3. Presence of water conservation advice by ownership

Ownership	**Freq.**	**Percent**	***tips_presence***
municipal_service	19	5.57	21.1%
public_enterprise	61	17.89	60.7%
private	213	62.46	90.6%
PPP	48	14.08	89.6%
Total	341	100	81.2%

Table 8.3 indicates that ownership is a significant variable in explaining the provision of online water-saving advice ($p < 0.01$). Private users are about four times more likely to find water conservation advice on their supplier's website than municipal_service users. Our results, in line with Giacomini et al. (2020) and Argento et al. (2019), who note that municipal_service had a lower percentage of posts disclosing environmental issues, show that public management is less likely to provide online advice than privately owned utilities are.

Table 8.3. Logit analysis for *tips_presence*

		tips_presence
Ownership	*public*	1.571***
		(0.588)
	private	3.816***
		(0.586)
	PPP	3.138***
		(0.775)
Water stress	*medium*	1.045
		(0.683)
	high	2.372***
		(0.552)
	extreme	2.082***
Population	*<50M*	-1.348***
		(0.441)
	Constant	-2.274***
		(0.732)
	N	341
	Pseudo-R^2	0.2738
	χ^2	65.59

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Despite expecting a negative relationship for private and PPP, all categories of ownership are found to have a positive and significant influence, providing evidence of the effect of CSR. Another possible explanation can be found in the distribution of ownership by population density of the service areas. Additional calculations reveal that 76.6% of the analysed websites without water conservation advice correspond to areas with fewer than 50,000 inhabitants, which happen to be less profitable (González-Gómez et al. 2013) and where municipal_service tends to be more common. However, these data contrast with evidence from California, where public companies are more likely to proactively ask their users to reduce consumption (Kallis et al. 2010).

Population is also significant. The analysis shows that populations of under 50,000 have a negative effect on tips_presence, as predicted in the hypothesis ((b=-1.348, $p < 0.01$). Small utilities are less predisposed to this and other voluntary commitments, presumably due to limited resources (Roeger and Tavares 2020), even though service managers in small populations perceive website campaigns as a cost-effective strategy (Romano et al. 2013). Our results are in line with García-Sánchez et al. (2013), who found a positive relationship between population size and the disclosure of sustainability information by local governments, due to the variety of stakeholders they have to deal with. This finding is consistent with previous literature that suggests that large organisations tend to report more environmental information (Romano et al. 2014) because they face more pressure from society to behave in a socially responsible way (Argento et al. 2019; Garde-Sánchez et al. 2018). In fact, additional calculations show that 12 of the 15 service areas without online advice managed by a municipal_service are located in towns with fewer than 50,000 inhabitants, and most private operators without information campaigns are located in less populated areas. Another explanation could be that companies have less interest in reducing water consumption, especially when they have fewer customers, as it would entail a drop in revenues and net profits (Howarth 2011).

The expected relationship for water stress is also confirmed, but only extreme and high are significant ($p < 0.01$). Although areas that have high water stress values seem to have a slightly more significant effect than those with extreme values, our findings show that suffering from water stress is related to the provision of advice, as reported by Lu et al. (2019).

Influence of ownership on the content of water conservation advice on websites (stage 2 of the analysis)

In terms of the kind of advice provided, sust_habits tips (0.3943) are more common than tips on efficient_tech (0.25). A possible explanation for this finding is that behavioural changes involve less monetary sacrifice for users (Hannibal et al. 2019). The focus on advice of a behavioural nature is in line with the aim of encouraging users to be more active in making sustainable use of water (Sharp 2006). In this vein, Kumar et al. (2017) show how attitude positively affects the purchase of sustainable products such as water-saving appliances. Conversely, water utilities officials in four European countries rated campaigns promoting water-saving technologies as the second most effective way of reducing water consumption, behind the renovation and maintenance of networks (Stavenhagen et al. 2018).

The results of the ANOVA and the Bonferroni multiple comparison test (Table 8.S4, supplementary material) reveal statistically significant differences between different ownership categories in terms of the mean values of the index of tips ($F = 10.17$, $p < 0.01$). The differences are between the recommendations provided by public and those provided by private ($p < 0.01$) and PPP ($p < 0.01$), with no significant differences observed between PPP and private. Consistent with the hypothesis, the data show that public utilities offer more water-saving advice on average than private and PPP. A reason for this could be that private companies' rates per cubic metre are more expensive on average (Martínez-Espiñeira et al. 2012). Consequently, if they were to achieve a reduction in consumption it would mean a more pronounced loss of profit for them than for public companies. Alternatively, public utilities are more vulnerable to external pressures because of the nature of their stakeholders (García-Sánchez et al. 2013).

Table 8.S4. Summary results of ANOVA and Bonferroni tests

		Mean	Analysis of Variance (difference between groups)		Multiple comparisons (Bonferroni)	
			F	Sig.		Sig.
water_saving_tips	*public*	0.495	10.17	0.0001	*private - public*	0.000
	private	0.335			*PPP - public*	0.007
	PPP	0.356			*PPP - private*	1.000
	Total	0.362				
efficient_tech	*public*	0.555				
	private	0.168				
	PPP	0.333				
	Total	0.251				
sustainable habits	*public*	0.477	3.68	0. 0266	*private - public*	0.041
	private	0.386			*PPP - public*	0.046
	PPP	0.363			*PPP - private*	1.000
	Total	0.396				

A second explanation could be that public objectives transcend the logic of economic profit (Megginson and Netter 2001), so instead of resorting to pricing instruments, public companies prefer to encourage more sustainable behaviour through the information they provide on their website (Romano et al. 2013, 2014). However, they may also be driven by the need to rely on strategies other than pricing, due to the negative political impacts on local government, as suggested by Suárez-Varela et al. (2015). Consequently, given the political strategy of offering low prices and the prevailing demand management approaches, providing information on how to reduce water consumption emerges as a win-win tool for the three stakeholders involved: politicians, users, and the environment. In the CSR framework defined by Lantos (2001), such an approach would allow politicians, who are the ultimate price-setters, to achieve their strategic objective of maintaining a good image, avoiding rate increases and contributing to the sustainable use of water resources.

The results are in line with those of Kallis et al. (2010) and Romano et al. (2014, 2013), who report that public companies show a greater tendency to promote the reduction of

household water consumption than private ones. It is remarkable that one of the largest business groups in the industry, covering 108 service areas, only offers a single piece of advice in 48.15% of the cases. Specifically, the advice is “do not use the toilet as a waste bin”. This advice has more of an environmental impact than a consumption reduction effect, which ultimately benefits the company by reducing water pollution. Consequently, it helps the company to prevent environmental damage resulting from its business activities, while allowing it to reduce costs (Lantos 2001). Their water conservation reporting is in line with the level of maturity in CSR found in Denmark (Lauesen 2016), where companies use sophisticated tailored measures in CSR reports following different incomparable standards, but do not promote sustainable behaviour in the way defined by the Brundtland Report. This finding might suggest that they recognise the social importance of providing such a section in their official communications, but do not have sufficient incentives to do so effectively. However, their behaviour is not consistent with recent evidence showing that the public want CRS messages from firms (Saxton et al. 2019).

On the other hand, when breaking down the variable water_saving_tips, the findings are similar for the variable sust_habits ($F = 3.68$, $p < 0.05$), in line with the hypothesis. Although public companies again offer significantly more tips than non-public companies do, the differences are slightly smaller. The reason for this may be that these activities involve a higher level of personal sacrifice (Ananga et al. 2019) and the general public is often less receptive to these messages when they are delivered by private companies (Kallis et al. 2010). In fact, the literature points out that greenwashing concerns negatively influence sustainable purchase intention (Rausch and Kopplin 2021), and therefore the adoption of sustainable behaviour.

ANOVA results for the variable efficient_tech are not presented because the assumption of homogeneity of variances is not met, but the Kruskal-Wallis test suggests that there are again significant differences between ownership groups (

$(2) = 32.993$, $p = 0.0001$). Similarly, for this set of variables, public offers substantially more tips.

Table 8.4 shows the results of the OLS estimations relating to the determinants of the content of the advice for each of the dimensions of the educational campaigns. Again, all categories of ownership are found to be significant and the hypotheses are confirmed.

Private is found to have negative effect on the online promotion of water conservation measures (b=-0.1691, $p < 0.01$); both for tips based on efficient technologies (b=-0.412, $p < 0.01$) and those related to sustainable habits (b=-0.094, $p < 0.01$). The results are very similar in the case of PPP, which is also negatively associated with the number of water-saving tips provided (b=-0.137, $p < 0.01$). Nonetheless, results reveal a more significant effect on tips related to efficient technologies (b=-0.247, $p < 0.01$) than on the promotion of sustainable habits (b=-0.103, $p < 0.5$).

Table 8.4. Regression models of water-saving tips.

		water_saving_tips	*efficient_tech*	*sust_habits*
Ownership	*private*	-0.169***	-0.412***	-0.0940**
		(0.0368)	(0.0642)	(0.0380)
	PPP	-0.137***	-0.247***	-0.103**
		(0.0518)	(0.0839)	(0.0506)
Water stress	*medium*	-0.179**	-0.240**	-0.161*
		(0.0850)	(0.113)	(0.0909)
	high	-0.163**	-0.123	-0.175**
		(0.0714)	(0.0937)	(0.0728)
	extreme	-0.134*	-0.163*	-0.125*
		(0.0720)	(0.0961)	(0.0738)
Population	*<50,000 habitants*	0.00934	-0.000683	0.0124
		(0.0271)	(0.0408)	(0.0282)
	Constant	0.641***	0.716***	0.618***
		(0.0788)	(0.114)	(0.0796)
	N	276	276	276
	F	5.01	8.27	2.89
	R^2	0.094	0.178	0.058

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, *p<0.1

Due to the effectiveness of water-saving devices in reducing water consumption (Stavenhagen et al. 2018), the results underline the idea that water companies are not interested in promoting such devices because a reduction in consumption would lead to a

decrease in revenues and profits. On the supply side, the adoption of conservation technologies is rendered unattractive by operators' interest in short-term profit (Friedman 2007). In addition, there is evidence that users are less receptive to conservation advice from private suppliers (Barrett and Wallace 2011). This may be another reason that partially explains why private and PPP provide less comprehensive advice, even though these types of operators have comparatively more websites with water-saving tips.

Although more populated areas are found to have more tips available on suppliers' websites, population is not found to significantly influence the content of information campaigns to promote the sustainable use of water.

Contrary to the Italian evidence (Romano et al. 2014), our results show that all water stress categories have a negative effect for each dependent variable. Although water conservation campaigns attract less public resistance in times of water shortages (Katz et al. 2016; Hannibal et al. 2019), the hypothesis that water stress has a positive effect on the provision of more comprehensive information campaigns is rejected. In fact, not all the categories are consistently significant: while medium and extreme are found to be significant in relation to all the dependent variables, high is not significant in relation to efficient_tech. This is especially noteworthy because water stress does have a significant positive effect on the presence of water-saving advice on websites (stage 1).

The evidence indicates that territorial characteristics are more important than water stress conditions, suggesting that companies use these sections on websites as a greenwashing tool (Lauesen 2016). Therefore, confirming the hypothesis, results suggest that public utilities provide better water-saving advice than their private counterparts do. Since these companies do not have to compete in the market, but rather for the market, it may not seem rational to consider the interests of the environment, users and the community when attempting to create competitive advantages that differentiate them from competitors (Branco and Rodrigues 2008).

CONCLUSIONS, POLICY RECOMMENDATIONS AND FUTURE RESEARCH DIRECTIONS

This paper studies whether ownership is a determinant of the presence of online information aimed at reducing household water consumption, and the type of content of that information. To do so, it uses data collected from the websites of 341 Spanish management areas. The results can be usefully applied to other contexts where a lack of

competition due to a monopoly held by operators might lead water utilities to neglect environmental issues, as may be the case in Italy, Portugal or the Netherlands.

Contrary to the initial hypothesis, results indicate that private companies do seem to recognise the importance of dedicating space on their websites to providing advice to their customers (Tortajada et al. 2019). Indeed, 90% of these companies provide this information on their website, which may be due to a willingness to adhere to CSR practices. On the other hand, fewer public companies have websites with advice, especially when they supply smaller populations, possibly indicating a lack of resources.

In the second stage of the analysis, the results confirm that when public companies do provide advice, their website is significantly more comprehensive than that of private companies. Companies with private ownership provide less thorough advice on water-saving behaviour and efficient technology. Taken together with the results from the first stage, this could suggest that such companies provide advice sections as a greenwashing tool (Lauesen 2016). Thus, while CSR incentivises private companies to create a space with at least one water conservation tip, they provide considerably fewer tips on their websites than public utilities do. This evidence calls into question their commitment to engage in environmental awareness-raising processes and actively contribute to SDG target 12.8, at least in the case of household water management.

The results suggest that public administrations should play a proactive role in raising awareness of efficient urban water use. An additional recommendation for policymakers would be to pass a regulation that establishes guidelines on how companies, both public and private, should provide water conservation advice on their websites. For example, in England, water utilities are obligated to promote the efficient use of water to their customers (Sharp 2006). Such a measure would help to override the economic-environmental conflict by decoupling profits from consumption.

Considering that Directive 2020/2184 promotes the use of websites to provide water-saving tips, the scope of this study is limited to information available on corporate websites. However, in further research, it would be interesting to explore utilities' communication via other media such as social networks, where 82% have accounts (AEAS 2021).

Chapter 9. Conclusions and future lines of research

Abstract

This doctoral thesis concludes that significant legal, social, and policy reforms are needed to address water inequality and ensure sustainable water management in Spain. One of the key recommendations is the creation of an independent regulatory agency (IRA) to address the fragmented water management systems across the country. The thesis argues that the current regional disparities in water pricing, access, and conservation efforts hinder Spain's progress towards achieving SDG 6. An IRA would harmonize legal frameworks, standardize water affordability measures, and oversee the equitable distribution of water resources, ensuring that vulnerable populations are protected from water poverty. This independent body would play a crucial role in enforcing water rights and fostering transparency in water management, free from political and corporate pressures.

The thesis recommends targeted reforms to address water affordability. Measures such as income-based tariffs and enhanced social support mechanisms are essential to protect low-income households from the economic barriers that restrict access to water services. Strengthening these legal and financial protections is vital for ensuring the human right to water for all citizens, particularly those at risk of poverty.

Another key recommendation is the implementation of comprehensive public education campaigns to improve public acceptance of water reuse technologies, especially recycled water for domestic use. The study shows that public skepticism remains a significant obstacle to the adoption of water reuse, with concerns about health risks and the "yuck factor" influencing resistance. Direct engagement, transparency, and trust-building initiatives are recommended to shift public perceptions and promote sustainable water practices.

Finally, the thesis emphasizes the need for stronger regulatory frameworks to ensure that both public and private water utilities actively promote water-saving behaviors. Public utilities are more likely to engage in comprehensive conservation efforts, revealing a gap that could be bridged through consistent regulatory oversight by the proposed IRA.

Keywords: Water affordability · Water reuse · Independent regulatory agency ·SDG 6

The water crisis in Spain is not merely an environmental challenge; it is also a social, economic, and political issue deeply intertwined with water resource management. The scarcity of water in certain regions, exacerbated by climate change and increasing urban demand, presents a set of problems that require coordinated interventions at the local, regional, and national levels. While Spain demonstrated significant progress toward meeting the SDG 6 targets (SDG6data, 2024), also those related to residential water use, this doctoral thesis identifies several critical gaps and challenges that hinders its full readiness if only assessing the improvement under predetermined indicators, particularly in the context of equitable water access, water reuse, and water-use efficiency. Substantial inequalities persist in terms of water affordability and the adoption of sustainable practices, highlighting the need for a more holistic approach.

The primary aim of this thesis is to contribute to the literature on sustainable water management and water justice by addressing both equity in access and the promotion of efficient water use, as well as the social feasibility of hypothetically using recycled water for domestic purposes.

One of the most notable findings of this research is the gap between available infrastructure and its economic accessibility (Part I; Chapters 2&3). Despite existing regulatory frameworks, there are low-income households facing exclusion from essential water services due to economic barriers. This highlights the need for broader legal reforms that ensure not only physical access to water but also affordability, with more consistent protection for vulnerable populations across different regions of the country.

Furthermore, the study examined key factors influencing the adoption of pro-environmental behaviors, particularly regarding domestic water use, and analyzed public perceptions of unconventional water sources, such as recycled water (Part II; Chapters 4, 5&6). Cities in Spain, particularly those facing high levels of water stress, are under significant pressure, and understanding public acceptance of alternative sources is crucial to ensuring a sustainable water supply. However, the results underscore that public perception of recycled water, particularly for potable use, remains largely negative, which limits the feasibility of its widespread adoption despite technological and regulatory advances.

Additionally, the study reveals that awareness campaigns focused on water scarcity, while necessary, would be insufficient on their own to change water consumption behaviors or increase acceptance of recycled water. More direct and participatory strategies are required, involving citizens not only through information but also through trust-building measures that demonstrate the environmental and health benefits of such practices.

Finally, examining how water utilities engage in promoting sustainable use of water among their users, the study reveals that cities of OECD countries shows little effort to promote water-saving shower habits (Part III; Chapter 7). Moreover, when analyzing the case of Spain in deep, the results reveals that the level in which this efforts are made varies significantly depending on the ownership structure of the utility (Part III; Chapter 8). Publicly owned utilities are more likely to implement comprehensive water-saving campaigns and provide meaningful conservation advice, while private utilities often focus on technological solutions with less emphasis on behavioral change. This disparity highlights the need for stronger regulatory frameworks and more consistent public education initiatives to ensure that all utilities, regardless of ownership, actively contribute to promoting sustainable water use practices.

The main general conclusions that can be drawn from the results of this thesis are as follows:

1. **Inequality in water access remains a critical issue in Spain**, particularly in terms of affordability. Legal and policy reforms are essential to ensure that the human right to water is protected for all individuals, regardless of their economic status. Spain enjoys nearly universal physical access to residential water services, in line with SDG 6.1, which aims to achieve universal and equitable access to safe and affordable drinking water by 2030. The country's well-developed infrastructure and water management systems have enabled widespread coverage, both in urban and rural areas, and ensured compliance with water quality standards. However, while physical access is nearly universal, the issue of affordability remains a pressing concern, particularly for low-income households. The results highlights that a significant portion of the population could faces water poverty due to high tariffs and insufficient social protection mechanisms. This affordability issue poses a direct challenge to the realization of equitable access to water for all, a core objective of SDG 6.1. Chapter 2 reveals that the legal frameworks governing water access in Spain are fragmented and insufficient to guarantee equitable protection for vulnerable groups. The absence of a coherent national

law ensuring the right to water leaves marginalized households, particularly in poorer regions, without consistent access to essential services. To address these issues, the thesis calls for significant legal reforms at both the national and municipal levels to ensure consistent protection of water as a basic human right, particularly for families at risk of poverty and social exclusion.

Chapter 3 reveals that despite Spain has nearly universal physical access to water, economic barriers—particularly for low-income households—pose a significant threat to equitable water access. For households with a single income equivalent to the national minimum wage, the water bill would represent more than 3% of that income in four cities of the sample, while in at least four cities the water bill represents more than 9% of the family income when the household depend on exceptional aid for people who is no longer entitled to standard unemployment benefits. Moreover, the research reveal that water tariffs, coupled with economic inequality, can legally result in water disconnections for families unable to pay, raising questions about the effectiveness of Spain's legal frameworks in ensuring the human right to water. The level of protection varies between regions and municipalities since some of them developed policies banning disconnections build subsidy schemes, while others do not provide with this kind of helping mechanisms or do it in varying levels.

2. **Public perception of the use of recycled water for domestic consumption is expected to be a significant barrier to the adoption of sustainable practices**. If permitted by law, investments in this area would not be very successful in ensuring the use of recycled water in the home. In light of the low level of acceptance reported here, the public may well protest if there were no prior awareness-raising and educational initiatives. Could be expected to see the adoption of defensive measures, such as the purchase of bottled water for drinking and cooking. Moreover, if authorities were to opt for measures to promote the use of recycled water, they should take into account the fact that the reluctance to use recycled water and the determinants of acceptance differ according to the intended use, avoiding general measures as main strategy. This underscores the need for more targeted public education campaigns and experiences that help citizens understand and accept the use of non-conventional water sources.

Chapter 4 point out that in terms of SDG 6.3, which focuses on improving water quality and substantially increasing the reuse of treated wastewater, Spain also has made

considerable strides, particularly in agricultural reuse. Nonetheless, the thesis specially focus on the social feasibility of expanding water reuse to domestic purposes if the law regulating it change. In this regard, Chapter 5 finds significant public reluctance to use recycled water, especially for certain uses, and thus suggests that implementing recycled water schemes for human consumption would be risky there. Given the public response, the recycled water option would seem to be contrary to the public interest: it would raise people's water bills for the treatment of unwanted water, and increase families' spending on bottled water, along with greater exploitation of sources of mineral water and greater production of plastic.

Chapters 5&6 reveals that the perception of health risks and negative attitudes toward the use of recycled water for domestic purposes could hinder the hypothetical expansion of water reuse practices. While regulatory frameworks exist to support water regeneration and reuse, public acceptance remains a critical barrier, necessitating enhanced educational campaigns and public engagement efforts to overcome societal resistance. Chapter 5 & 6 shows that even if legislation would allow it, a significant barrier to the broader implementation of water reuse strategies for domestic purposes in Spain is public skepticism and the "yuck factor" associated with recycled water, particularly when it comes to potable reuse. This reflects a gap in public education and engagement regarding non-conventional water sources. Moreover, both chapters underscore that those individuals who show greater concern for the conservation and protection of the environment and those who had an academic background on science report greater acceptance of the use of recycled water.

Additionally, Chapter 6 finds out that level of acceptance decreases as the proximity of people's contact with recycled water increases, and the use of the water becomes more vital for people's lives. Moreover, it shows the determinants of the acceptance of recycled water differ according to the intended use. With respect to ingestion by people and domestic animals, the main determining factors are the perceived risk to health and the yuck factor. For other uses that entail direct or indirect contact with water, environmental awareness, political ideology and education are more important.

3. **The ownership structure of water utilities influences the promotion of pro-environmental behaviors**. Public utilities are more likely to actively promote water-saving behaviors compared to private ones, highlighting an opportunity to improve conservation policies through stronger regulatory frameworks.

Regarding SDG 6.4, which aims to increase water-use efficiency, the document identifies a mixed performance across different regions and utility management structures. While certain public utilities actively promote water-saving behaviors through public campaigns, the study reveals that these efforts are often inconsistent and insufficiently comprehensive. Moreover, private utilities, in some cases, focus more on technological solutions than on fostering behavioral change among consumers. Given the growing pressures of climate change and water scarcity, particularly in Spain's southern regions, enhancing water-use efficiency across all sectors is crucial for long-term sustainability.

The study finds that the ownership structure of water utilities (public vs. private) affects the promotion of sustainable water-use practices. Publicly owned utilities are more likely to engage in comprehensive efforts to promote water conservation and efficiency compared to their private counterparts, who may prioritize profit over public interest.

Effective governance requires not only infrastructural investment but also the active promotion of water-saving behaviors among consumers, particularly through education and engagement initiatives, which are currently lacking in most regions.

4. Urgency of public engagement and education. One of the doctoral thesis key insights is the importance of public engagement in fostering sustainable water use and acceptance of new water management practices. Public resistance to recycled water is a critical challenge that can only be addressed through sustained educational campaigns and transparent communication from policymakers and water utilities. By engaging the public in the decision-making process, governments and utilities can not only increase the acceptance of alternative water sources but also empower citizens to take part in water conservation efforts, a necessity in a water-scarce country like Spain. Moreover, Spain's increasing water stress due to climate change and regional disparities calls for innovative solutions such as water reuse and the promotion of water-efficient behaviors. However, the study emphasizes that these solutions must be implemented with a focus on social equity to avoid deepening the divide between regions and socio-economic groups.

Achieving the SDG 6 in Spain will require a comprehensive approach that balances technological innovation with socio-political reforms, ensuring both the sustainable management of water resources and equitable access for all. Moreover, the need to improve education arise all over the essays of the thesis. Further research point out that some users do not benefit from tariff subsidies because they are not aware of their

existence of neither know how to apply. In the same line, Part III of the thesis shows that there is room to improve water utilities campaigns trying to promote a better use of water.

In this regard, this doctoral thesis makes several unique contributions to the existing body of knowledge on sustainable water management, particularly in the context of Spain's efforts to meet SDG 6. First, it goes beyond the conventional focus on physical access to water and provides an in-depth analysis of water affordability, a critical but often overlooked aspect of water access in developed countries. While much of the global research in this field has concentrated on developing nations, this thesis identifies the socio-economic barriers that persist in Spain, where affordability challenges could hinder the realization of universal access to water.

Second, this research uniquely explores the social feasibility of using recycled water for domestic purposes, an area that has not been widely examined in Spain. By integrating public perceptions and psychological factors such as the "yuck factor," the thesis offers a novel perspective on the barriers to implementing water reuse policies, providing insights into how public attitudes could shape future water management strategies.

Additionally, the comparative analysis of water utility ownership structures and their impact on promoting pro-environmental behaviors among consumers adds a political economy dimension to the field of water conservation. This study reveals for the first time how public vs. private ownership influences the effectiveness of water-saving campaigns, highlighting opportunities for reform in the governance of water utilities.

By addressing these unique aspects, this thesis contributes to a deeper understanding of how socio-economic, political, and psychological factors intersect in the management of water resources, offering both theoretical insights and practical recommendations for policy reform in Spain and beyond.

~~Table 9.1. Summary of~~ key conclusions by chapter.

Chapter	Objective	Key conclusions
Chapter 2: Human rights in Spain - protection of the right to water for families with affordability problems	Analyze the protection of the right to water in Spain for families facing affordability issues.	2.1. The existing legal frameworks in Spain do not sufficiently protect vulnerable populations from water disconnections, particularly for low-income households. 2.2. Municipal-level social measures vary greatly across regions, leading to unequal access to protection from water poverty. 2.3. Comprehensive reforms are needed to ensure the right to water for families at risk of poverty, including tariff reforms and social support mechanisms.
Chapter 3: Is the human right to water sufficiently protected in Spain?	Examine whether low-income families are at risk of water exclusion.	3.1. There are significant discrepancies in water affordability across various Spanish cities, with poorer households being disproportionately affected by high water tariffs. 3.2. The legal frameworks governing water services in Spain lack consistency, leading to governance challenges in ensuring equitable water access. 3.3. Vulnerable populations are at a higher risk of exclusion from essential water services due to these economic barriers, necessitating targeted policy interventions.
Chapter 4: Regenerate and reuse water in Spain - facts and politics	Investigate the evolution of water regeneration and reuse policies in Spain.	4.1. Political and legal frameworks have promoted water reuse, but household-level water reuse has yet to reach its full potential. 4.2. Regional disparities in the implementation of water reuse policies across Spain are significant, necessitating a unified approach. 4.3. A lack of public understanding and engagement with water reuse projects has hindered broader acceptance.
Chapter 5: Acceptance of direct potable water reuse for domestic purposes in Southern Spain	Investigate public acceptance of using	5.1. Public acceptance of recycled water for domestic use is influenced by the level of personal contact, with higher resistance for uses involving ingestion (e.g., drinking water).

	recycled water for domestic purposes.	5.2. Public perception of health risks and the "yuck factor" significantly impact the willingness to use recycled water for potable purposes.
		5.3. Information campaigns and direct experiences (e.g., water tasting events) can mitigate resistance and promote acceptance.
Chapter 6: Determinants of acceptance of recycled water for domestic use	Analyze the factors influencing the acceptance of recycled water based on use type.	6.1. Sociodemographic factors, such as age, education, and environmental awareness, influence acceptance levels, with younger and more environmentally aware individuals showing higher acceptance.
		6.2. Acceptance varies significantly depending on the proximity of water use to personal contact; uses like cleaning and irrigation are more acceptable than drinking or personal hygiene.
Chapter 7: Promoting water conservation habits in shower use in OECD cities	Examine how OECD water utilities promote water conservation habits for shower use.	7.1. OECD water utility websites do not sufficiently promote water-saving habits related to shower use, despite showers being the highest water-consuming household activity.
		7.2. Water conservation strategies focus more on promoting efficient technology (e.g., showerheads) than changing user behavior, revealing a gap in communication efforts.
Chapter 8: Ownership of water utilities and the promotion of water-saving advice	Assess whether the ownership of water utilities affects the promotion of water-saving behaviors.	8.1. Public utilities provide more comprehensive water-saving advice compared to private utilities, which may use water-saving messages primarily for greenwashing purposes.
		8.2. The ownership structure (public vs. private) influences the depth and quality of conservation messaging, with public companies showing greater commitment to promoting sustainable water use practices.

Building on these findings, it is clear that Spain must address socio-economic barriers to water access, promote public acceptance of innovative water reuse solutions, and enhance water-use efficiency through both technological and behavioral interventions. Fostering greater policy coherence across regions is essential to strengthening Spain's readiness to meet SDG 6 targets and ensure a more sustainable and equitable water future.

POLICY RECOMMENDATIONS

In this regard, based on the results, some recommendations are proposed to guide the formulations of measures aimed to Spain to meet the SDG 6 targets fully and respond to current and future challenges:

1. **Strengthening legal and policy frameworks**:

The thesis highlights the need for comprehensive legal reforms to ensure the human right to water, particularly for vulnerable populations at risk of poverty in some municipalities. Spain lacks a national law explicitly guaranteeing water as a human right, and regional disparities in social measures create unequal access to protections. Harmonizing legal frameworks across regions and introducing clearer regulations regarding water affordability and access will be essential to address these inequalities.

2. **Enhancing affordability and social support mechanisms**:

To address the growing issue of water poverty, Spain must implement targeted policies that ensure water remains affordable for low-income households. This could include the adoption of income-based water tariffs or enhanced subsidy programs for vulnerable populations. Affordability must be treated as a central component of the water access agenda, complementing efforts to expand or improve physical infrastructure when needed.

3. **Promoting public acceptance of water reuse**:

Public skepticism toward recycled water use remains a significant obstacle to achieving SDG 6.3. To address this challenge, policymakers should launch comprehensive public education campaigns that provide transparent information about the safety and environmental benefits of water reuse (Tortajada and Nambiar, 2019). Direct engagement with communities, including water reuse demonstration projects and public consultations,

will be crucial for building trust and encouraging broader adoption of recycled water for residential purposes (Tanner et al., 2024; Kemp et al., 2012).

Although the current legislation in Spain prohibits the use of recycled water for domestic purposes, it is recommended that efforts be made to change public perception, preparing the population for a potential future scenario where the legal framework may evolve. By proactively addressing concerns and building acceptance now, the transition to water reuse in residential contexts could be smoother if such measures become legally necessary.

The findings suggest that the timing may not yet be right for introducing water reuse for residential use, but a more practical strategy to address water scarcity could involve developing desalination schemes for residential demand while promoting reclaimed water for agricultural and environmental purposes, where acceptance is currently higher.

While water reuse is legally permitted in agriculture, there is still some reluctance among farmers to adopt this practice (Mesa-Pérez et al., 2020; Ballesteros-Olza et al., 2022). However, this hesitation diminishes significantly once reclaimed water used. In fact, over 70% of farmers surveyed by López-Serrano et al. (2022) expressed a willingness to use reclaimed water if provided with sufficient information regarding its safety and benefits.

4. **Improving water-use efficiency**:

While technological advancements, such as water-efficient appliances, play a role in reducing water consumption, more focus is needed on behavioral change. Water utilities, both public and private, should intensify efforts to promote sustainable water habits among consumers through targeted campaigns and educational programs. This is particularly important in regions experiencing high water stress due to climate change and increased urbanization.

5. **Creating an independent regulatory agency to address regional disparities**:

Spain’s decentralized water management system has led to significant regional disparities in both water pricing and conservation efforts. These disparities undermine the country's ability to meet SDG 6 targets uniformly, as different regions face varying levels of water scarcity, pricing inconsistencies, and service quality gaps. To ensure cohesive and

efficient water management, the creation of an independent regulatory agency is highly recommended.

An independent regulatory agency would help harmonize water management practices across the nation by standardizing the application of legal frameworks, particularly in the areas of water affordability, reuse, and sustainability. This agency would centralize oversight, ensuring compliance with both national and international policies, including European directives on water reuse and quality standards. Moreover, it would play a pivotal role in implementing equitable pricing models, ensuring that vulnerable populations are protected, and fostering greater public acceptance of innovative practices like water reuse. By promoting transparency and accountability, the agency would help mitigate inefficiencies in the current system and improve coordination between local, regional, and national governments, thus contributing to more sustainable and equitable water governance.

The establishment of such an independent regulatory body has been a long-standing demand from both public and private water utilities in Spain (AEAS, 2016; Tecnoaqua, 2017; Tecnoaqua, 2024). This aligns with a broader global trend that began in the 1990s, when regulatory functions were increasingly outsourced to independent agencies operating at arm's length from elected officials (Majone, 1997). Globally, independent regulatory agencies are widely implemented to correct market failures, especially in sectors like water, where privatization has been extensive (Majone, 1997). By separating regulation from service provision and policymaking, these agencies enhance transparency, boost stakeholder confidence, and ensure long-term policy stability by shielding regulation from short-term political pressures (Estache et al., 2009; Thatcher, 2002; Epstein & O'Halloran, 1999). Moreover, to avoid regulatory capture, it is essential that the agency remains independent not only from political actors but also from the water management entities themselves, ensuring that its oversight functions are not compromised by the interests of the regulated entities.

Therefore, the creation of an independent regulatory agency in Spain would align with global best practices, address long-standing demands from the water sector, and play a crucial role in overcoming governance challenges. Many of the previous recommendations outlined in this thesis, such as enhancing affordability and social support mechanisms, strengthening legal and policy frameworks, promoting efficient

water use, and increasing public acceptance of water reuse, could fall under the mandate of this regulator, allowing for more cohesive and consistent implementation of water management policies across the country.

LIMITATIONS AND FUTURE LINES OF RESEARCH

Before concluding, it is important to highlight some limitations of the research conducted. When interpreting the results, the cross-sectional nature of the data analyzed should be considered, as this limits the ability to make definitive causal interpretations. It should also be noted that the results were derived from different datasets, some of which are 3 to 4 years old, and certain updates have been made since the original publication of the essays. For instance, Part I of the thesis was written before the recent update to the minimum wage in Spain (Gobierno de España, 2023) and the latest call from the European Union to increase water tariffs to comply with the cost recovery principle. These changes may have altered the affordability landscape. In this regard, it would be valuable to conduct panel studies to track how affordability has evolved in Spain and to identify its key determinants.

Additionally, future research should explore the effect of ownership on affordability, not only by focusing on the cost of regular water services but also by examining the availability and level of subsidies. It would also be insightful to investigate qualitatively how water utilities and citizens deal with disconnections or the risk of disconnection, as well as the trends in disconnections over recent years.

Moreover, the results of Chapters 5 and 6 were obtained from a sample of university students, primarily young people from an area with high water stress. Future research should investigate whether these findings are applicable to other populations and geographical areas with different environmental and cultural contexts. Additionally, although the public is increasingly engaging with information about water reuse proposals through the Internet, there is little evidence examining public responses to online news regarding potable reuse (Godwing et al., 2018). Therefore, an interesting future line of research would be to study the extent to which online platforms and social media are effective in addressing diverse concerns related to water resource management and in increasing public acceptance of non-conventional water resources.

Finally, Part III of the thesis is limited to static campaigns available on websites. It would be valuable for future research to compare the information provided by various channels,

such as social media or school campaigns. Furthermore, future studies should focus on evaluating the effectiveness of such campaigns and analyzing the sustainable water use practices that users implement at home. In this regard, the author collaborated on a study that quantitatively examined shower habits (Ibáñez-Rueda et al., 2023). However, there are plans to expand this line of research by further exploring the issue from a qualitative perspective. This is expected to enhance the knowledge necessary to develop more effective awareness campaigns.

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Part 1.

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Q1	Q1	24

[41] This paper was accepted on 14 Jul 2020 and published online on 12 Aug 2020. For that reason, we use the journal indexation of 2020 instead of 2021.

Chapter 6

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Q1	Q1	34

Chapter 7

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Q2	Q2	4

Chapter 8

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Q1	Q1	4

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