

## Exploring the role of inter-municipal cooperation for promoting water circular economy: Insights from a Southern European country

Fayaz Riazi <sup>a,\*</sup>, Teresa Fidélis <sup>a</sup> and Filipe Teles <sup>b</sup>

<sup>a</sup> GOVCOPP and Department of Environment and Planning, University of Aveiro, Aveiro 3810-193, Portugal

<sup>b</sup> Rectory, GOVCOPP and Department of Social, Political and Territorial Sciences, University of Aveiro, Aveiro 3810-193, Portugal

\*Corresponding author. E-mail: fayaz.riazi@ua.pt

 FR, 0000-0001-5935-4485; TF, 0000-0002-6594-2571; FT, 0000-0002-5059-368X

### ABSTRACT

This article analyses the role of inter-municipal cooperation (IMC) as a governance model in promoting water circular economy (WCE) and water reuse practices. Despite the potential benefits offered by IMC, little is known about how could contribute to fostering WCE adoption. The article develops and uses a framework to assess the role of IMC in advancing WCE strategies, addressing three key dimensions: involvement of IMC in advancing WCE, robust governance for WCE, and territorial fit and spatial concerns. It uses Portugal as a case study within the South European Union, where water scarcity and interest in IMC approaches are growing. Considering the emphasis on collaboration in legal and legislative frameworks, the results show the constrained role of inter-municipal communities in promoting the WCE through water reuse in Portugal. In addition, the limited integration of water reuse into territorial strategies highlights the lack of integration of water management and spatial planning. Moreover, the robustness of governance is hindered by a lack of funding, inadequate infrastructure, spatial barriers, a lack of experts or knowledge, and a deficiency in common goals or diversity of interests. Further research is essential to address territorial fit and spatial considerations critical to WCE adoption.

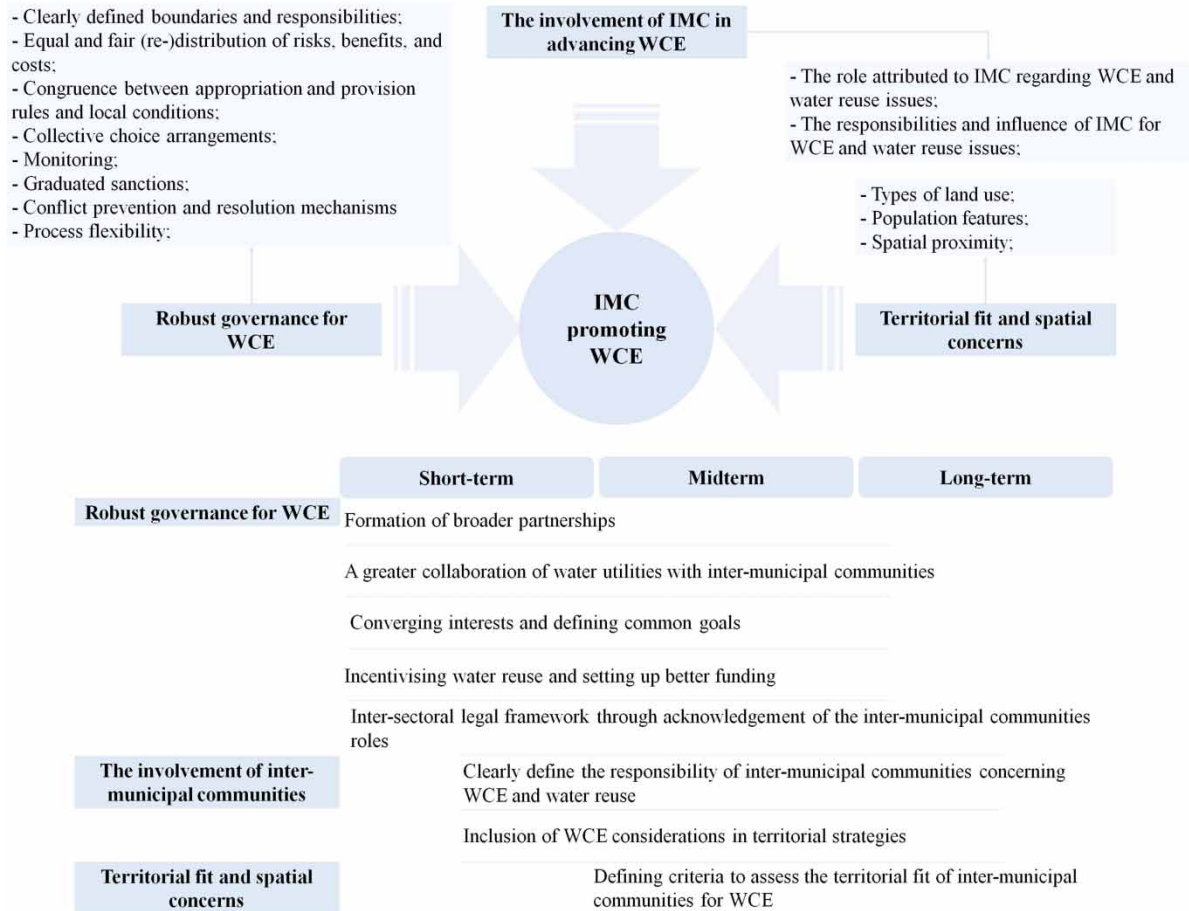
**Key words:** Governance solution, Inter-municipal cooperation, Territorial fit, Water circular economy, Water reuse

### HIGHLIGHTS

- The transition towards a water circular economy (WCE) in the sense of water reuse requires institutional collaboration and territorial alignment.
- Inter-municipal cooperation could play a pivotal role in promoting WCE and influencing water scarcity conditions.
- Inter-municipal communities have limited involvement in promoting WCE in Portugal, despite the urgency underscored by the water scarcity issue.

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## GRAPHICAL ABSTRACT



## 1. INTRODUCTION

While the escalating global water scarcity highlights the urgent need to promote water reuse (Bauer & Wagner 2022), the increasing urbanisation and rising population density stress the need to advance water reuse and recycling initiatives (Hargreaves *et al.* 2019). The transition towards a water circular economy (WCE) in the sense of water reuse requires institutional collaboration and territorial fit to address the sectoral nature of water and water policy fragmentation, which is challenging for local governments to achieve (Riazi *et al.* 2022). In this context, inter-municipal cooperation (IMC) may play a significant role in the transition to WCE. It may leverage economies of scale, balance political, socioeconomic, and spatial considerations among local authorities, and facilitate the sharing of experience, knowledge, and information (Kurki *et al.* 2016; Silvestre *et al.* 2018; Armstrong & Jackson-Smith 2019; Bendz & Boholm 2019; Sjöstrand *et al.* 2019; Muraoka & Avellaneda 2021). In Europe, countries have experienced significant territorial reforms and democratic transitions over the past decades to tackle the problem of efficiency and democracy at the lower tiers of government (Teles 2016; Silva *et al.* 2018), and many have adopted inter-municipal initiatives. However, despite the potential benefits offered by IMC, little is known about how IMC could contribute to fostering WCE adoption.

This study explores and assesses the role of IMC in promoting WCE and water reuse practices. It uses Portugal as a case study within the European Union member states, where increasing water scarcity and growing interest in IMC approaches are visible. It focuses on inter-municipal communities, the specific legal entities formed through IMC – inter-municipal cooperation – in Portugal, which is a collaborative effort among municipalities. The study addresses the following questions: How do Portuguese institutional arrangements for water management include inter-municipal communities to facilitate WCE and water reuse initiatives? How and to what extent do inter-municipal communities promote WCE and water reuse initiatives through ITDS, and how do these vary according to the spatial distribution of water scarcity problems? This research develops and applies a framework encompassing three primary dimensions: robustness of governance for WCE, the involvement of inter-municipal communities in advancing WCE, and territorial fit and spatial concerns. This article analyses the role attributed to inter-municipal communities within Portugal's legal framework and policies concerning WCE and water reuse and the embeddedness of WCE and water reuse in the ITDS. The study identifies regions requiring greater attention regarding their water scarcity condition, recognises the barriers and drivers, and creates a roadmap that fosters the role of inter-municipal communities for the mentioned concerns.

The article is organised into six sections. Section 2 introduces the potential of the involvement of inter-municipal communities in advancing WCE and water reuse. Section 3 provides an in-depth exploration of the analytical framework and its various dimensions, methodological steps, and data collection. Section 4 presents the empirical results derived from the study, including water exploitation conditions and inter-municipal communities in Portugal, the role assigned to the inter-municipal communities for water reuse, water circularity-related contents in the ITDS, and insight into the robustness of inter-municipal communities governance for WCE. Section 5 discusses the results. Furthermore, this section critically examines the potential and limitations inherent in the proposed framework. Finally, Section 6 concludes with final notes and recommendations for future research.

## 2. LITERATURE REVIEW

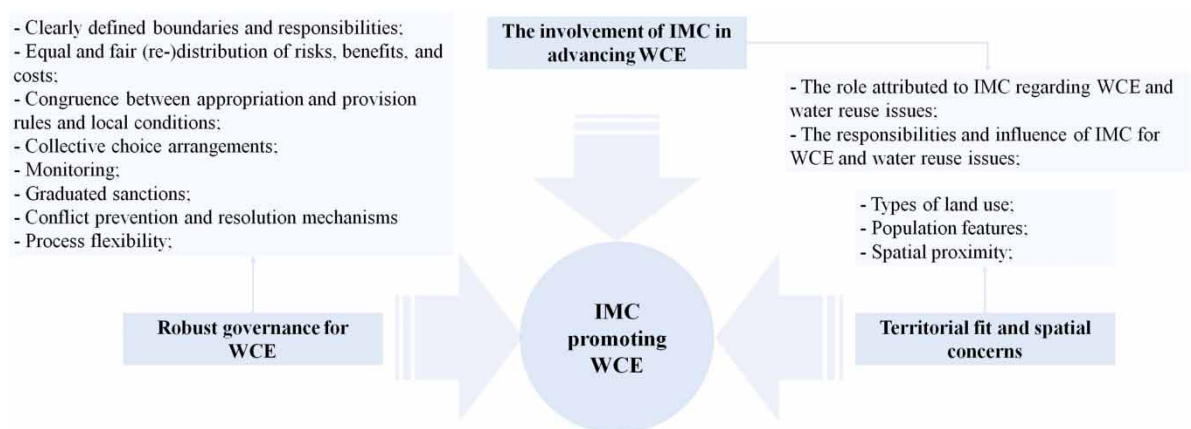
This section reviews the literature on WCE governance and IMC, highlighting the WCE governance requirements and the potential of IMC to enhance WCE practices. The review specifically emphasises three key dimensions for promoting WCE practices, in the sense of water reuse, which is central to WCE (Voulvoulis 2018).

Urban water problems expand along with cities' growth, leading cities to move away from inefficient linear models towards WCE (Delgado Martin *et al.* 2021). WCE reduces the pressure on water resources by developing innovative and efficient methods of using and reusing water and alternative resources (Abu-Ghunmi *et al.* 2016). However, effective governance models, and policy and institutional frameworks, play a significant role in hindering or driving the implementation and operation of WCE (Govindan & Hasanagic 2018; Ezeudu & Ezeudu 2019). Governance arrangements and institutional context matter in WCE by creating the necessary conditions for these activities (Tapia *et al.* 2021; Arfaoui *et al.* 2022; Luthra *et al.* 2022). Governance is the process and mechanism run by institutions to determine the power, responsibilities, and participation to guide individual and group behaviour by fairly sharing costs and benefits (Ostrom 1990). The institutional context includes the national state structure, legislation, and incentive structures (Hulst & van Montfort 2012), which can incentivise water reuse by providing regulatory incentives and incentives for reducing misuse (Abderrahman 2000; Brown & Farrelly 2009). However, the WCE adoption is challenging, introducing new types of stakeholders and institutional requirements, such as new responsibilities and monitoring systems and standards, causing governance and institutional risks (Fidélis *et al.* 2021). In particular, WCE governance necessitates collaborative, cross-sectoral, and cross-organisational approaches that address territorial needs (e.g., population density, land use concerns, and territorial fit) (Baggio *et al.* 2021; Haldar *et al.* 2021; Köhler *et al.* 2022). This context underlines the focus of the study on one specific form of governance model, IMC, and its role in promoting WCE practices.

IMC is one of the governance models that states choose to deal with the problems of territorial scale and recourse rationing (Citroni *et al.* 2013; Silva *et al.* 2018). It has emerged to address challenges for small municipalities, including scarcity of financial resources, limitation of power for local governments (Citroni *et al.* 2013), weakness of traditional hierarchical governance (Sorrentino & Simonetta 2013), and efficiency and effectiveness problems resulting from fragmentation (Rayle & Zegras 2013; Castelnovo & Simonetta 2015). IMC is a plural phenomenon, ranging from an alternative to privatisation or municipal amalgamation to an instrument of efficient service delivery or policy implementation, as well as a matter of governance and democratic concern (Teles 2016). For the WCE adoption, IMC may induce cost-savings and generate economies of scale (Soukopová *et al.* 2017). It involves interactions with neighbouring municipalities and influences decision-making and collaborative actions (Usui *et al.* 2015). IMC can also create a platform for sharing knowledge and experiences and collaboration with other sectors (Moran & Woods 2009; Kang 2021). However, the outcome of collaborative governance remains uncertain (Newig *et al.* 2018). IMC governance for water reuse must, thus, include the identification and collaboration with key stakeholders, including government agencies, water utilities, industries, agriculture, environmental organisations, communities, researchers, and regulators, and their engagement in the adoption processes (Emerson & Nabatchi 2015; Lu *et al.* 2020).

The strategy to support IMC for fostering WCE adoption, especially for water reuse, includes three dimensions (Figure 1). The first dimension to consider, which is rooted in the legal and policy framework, is the involvement of IMC in advancing WCE. It includes the role attributed to IMC in WCE and water reuse-related laws and policies and the establishment of collaborative policies and actions for WCE and water reuse. The involvement of IMC in advancing WCE requires coherence between policies and their implementation in the WCE adoption (Eneng *et al.* 2018) and defining planning instruments with clear goals (Soares *et al.* 2005; Marome & Pholcharoen 2019). Water circularity must be brought into policy narratives to enable unambiguous objective definitions and transition actions (Fidélis *et al.* 2021). The policy and plans must design and formulate an upgraded framework containing quality standards and guidelines while interlinking water management with the spatial aspect (Trapp *et al.* 2017).

The second dimension to consider fostering the role of IMC in the context of WCE is the robustness of governance, including institutional design principles for WCE. Governance robustness refers to the capacity of governance of water reuse to adapt to uncertainties and emerging challenges, allowing for adjustments based



**Fig. 1** | The dimensions fostering the role of inter-municipal cooperation in the WCE and water reuse adoption.

on technologies and altered regulations (Riazi *et al.* 2023). This study considers the institutional design principle of Ostrom (2005) developed for WCE governance to understand the robustness of governance for WCE. These institutional design principles are clearly defined boundaries and responsibilities, equal and fair (re-)distribution of risks, benefits, and costs, congruence between appropriation and provision rules and local conditions, collective choice arrangements, monitoring and evaluation of the process, graduated sanctions, conflict prevention and resolution mechanisms, and process flexibility (Riazi *et al.* 2023).

The third dimension is territorial fit and spatial concerns. Building on the legal and policy framework in the first dimension, territorial fit refers to the alignment of factors that influence how the circular economy functions, particularly at regional and local levels, such as land use, population distribution and density, accessibility conditions, and knowledge and technology enablers (Tapia *et al.* 2021). While CE provides opportunities for local and regional development and contributes to the sustainable development agenda, there is a question about determining the relationship between circularity and territory and the fit of the CE with various regional or local policies (Bourdin *et al.* 2022; Corvellec *et al.* 2022). The feasibility and efficiency of water savings can be influenced by spatial planning, as it directly impacts the positioning and urban densities of new constructions, consequently affecting factors such as rainfall patterns, roof areas, and the allocation of rainwater per individual (Hargreaves *et al.* 2019). The type of land use (such as apartments, commercial spaces, constructions, and independent houses) influences the cost of reuse (UNESCO & WSSM 2020). The population and the distribution of the population affect the cost and efficiency of services (Sarraf *et al.* 2020). In addition, the spatial proximity of the treatment facilities to agricultural areas and the closeness between companies and industries foster industrial symbiosis, which may facilitate territorial symbiosis and WCE adoption (Giurco *et al.* 2011; Dare *et al.* 2017). Nevertheless, territorial fit for WCE is challenging regarding the interdependence of spatial, socioeconomic, and political contexts and technical–financial arrangements (Tapia *et al.* 2021; Williams 2023). The most efficient territorial scale may depend on the purpose, types, and reuse or recycling technologies (Barraqué 2022).

### 3. METHODS

This section presents the methodology used to analyse the role of IMC in promoting WCE and water reuse practices, while also introducing the case study.

#### 3.1. Methodological steps and data collection

To analyse the current features of inter-municipal communities concerning WCE and water reuse, this study focuses on two dimensions of the framework, robustness of governance for WCE and the inter-municipal communities for WCE. While the study does not directly analyse territorial fit, it assumes that this dimension can be apprehended indirectly through the other two dimensions, i.e., with IMC functioning as a form of territorial approach forging connections between municipalities and water utilities through a supra-local lens, thereby enhancing the effectiveness of WCE implementation. The institutional design principles provide a basis for understanding the robustness of the governance model facilitating the WCE adoption, while the involvement of inter-municipal communities in advancing WCE examines how cooperation contributes to WCE initiatives through ITDS. Three methodological steps are employed to investigate the role of inter-municipal communities in the implementation of WCE and water reuse practices in Portugal. While inter-municipal communities in Portugal are formally constituted into 23 inter-municipal communities and two metropolitan areas, this study focuses on 23 of such arrangements located on the mainland. Table 1 outlines the steps of the study, their objectives, the data used, and the analyses conducted.

The first step aims to understand the role attributed to inter-municipal communities regarding WCE and water reuse issues. It involves identifying and analysing the primary policies and legal framework for WCE, water reuse,



**Table 1** | The main steps of the analysis undertaken.

	Step 1	Step 2	Step 3
Objective	To understand the role attributed to inter-municipal communities in WCE and water reuse-related laws and policies	To understand the responsibilities and influence of inter-municipal communities for WCE and water reuse issues, regarding the law of inter-municipal communities, and by formulating Integrated Territorial Development Strategies	To analyse the robustness of the governance regarding the eight institutional principles for WCE
Data	<ul style="list-style-type: none"> <li>- EU CE action plans;</li> <li>- Leading the Transition–Action Plan for Circular Economy in Portugal: 2017–2020;</li> <li>- Strategic Plan for Water Supply, Wastewater, and Rainwater Sanitation 2030;</li> <li>- Regional Hydrographic Plans, third cycle 2022–2027;</li> <li>- Decree-Law No. 119/2019, the legal regime to produce water for reuse, obtained from the treatment of wastewater, as well as its use</li> </ul>	<ul style="list-style-type: none"> <li>- Decree-Law No. 75/2013, the legal framework for local authorities, approves the statute for inter-municipal entities, the legal framework for the transfer of powers from the state to local authorities and inter-municipal entities and approves the legal framework for municipal associations;</li> <li>- Integrated Territorial Development Strategies 2021–2027</li> </ul>	<ul style="list-style-type: none"> <li>- Interviews sent to 23 Portuguese inter-municipal communities</li> </ul>
Analysis	Content analysis; by searching inter-municipal cooperation in the content	Content analysis; by searching for keywords such as WCE and water reuse in the content	Content analysis; open coding
Software	WebQDA	WebQDA	WebQDA

and IMC. There are two CE action plans relevant to the European Union (EC 2015, 2020) and Portugal (APCEP 2017). In addition, the Strategic Plan for Water Supply, Wastewater, and Rainwater Sanitation (APA 2024) aims to achieve effective, efficient, sustainable services with more added value for society is considered. Considering that municipal and IMC activities should be conducted following their respective locations within the hydrographic region, following the relevant plans, the latest version (third cycle, 2022–2027) of the eighth Regional Hydrographic plans which encompass Portugal's mainland river basins have been identified. In addition, the analysis incorporates two water reuse laws (Decree-Law No. 119/2019 and Decree-Law No. 16/2021) that form part of the legal framework.

The second step aims to understand the responsibilities and influence of inter-municipal communities for WCE and water reuse issues regarding the Law of inter-municipal communities (Decree-Law No. 75/2013) and by formulating ITDS 2021–2027 across 23 inter-municipal communities. The content analysis of these policy documents evaluates how WCE and water reuse are embedded in the different sections (problem showcase, visions and objectives, actions, governance and stakeholders, and indicators) (Fidélis *et al.* 2021). The culmination of these steps results in the specification of the major drivers and barriers to cooperation, paving the way for the creation of a roadmap outlining the optimal role of IMC in WCE governance.

The third step aims to analyse the robustness of governance for WCE, eight institutional design principles, to assess the robustness of WCE governance in inter-municipal communities, focusing on their collaborations – specifically, how they collaborate, to what extent, and with whom. This step involves conducting a series of

interviews with inter-municipal communities and analysing the content of their responses (using WebQDA software (Souza *et al.* 2016)) as follows:

- Do you consider that inter-municipal cooperation can lead to greater sustainability by reducing environmental and health risks, about water resources?
- How does the inter-municipal community/metropolitan area contribute to water reuse? Is there any specific initiative, strategy, or project you are developing/implementing for water reuse? If yes, can you indicate them?
- Does the inter-municipal community cooperate with other stakeholders (from the public and/or private sector) to develop water reuse schemes, plans, or strategies? If yes, can you identify them?
- What are the main factors that lead municipalities to cooperate with each other on water reuse?
- What are the main obstacles that the inter-municipal community/metropolitan area faces in promoting water reuse? Can you explain why?
- Which of the following aspects, both from a governance and regulatory point of view, do you consider hindering the development of water reuse systems within the framework of inter-municipal cooperation? (1) Lack of motivation of municipalities, (2) lack of experts/knowledge, (3) unclear responsibilities, (4) lack of common goals or diversity of interests, (4) lack of a monitoring process, (5) lack of a fair pricing system, (6) lack of sanctions or conflict resolution mechanisms, (7) other(s), which ones?
- In your opinion, what could the inter-municipal community/metropolitan area seek to do to be more successful in supporting water reuse?

In the questionnaires, while the aim – analysing and understanding the main barriers and challenges to a circular water economy and the role of inter-municipal institutions in this context – was clearly stated, specific concepts such as circular economy and WCE were not explicitly defined or discussed. This may have led to variability in respondents' answers and their interpretation of these concepts. The resulting data collection of the robustness of WCE governance in inter-municipal communities is presented in Supplementary material, Table S1.

### 3.2. Case study

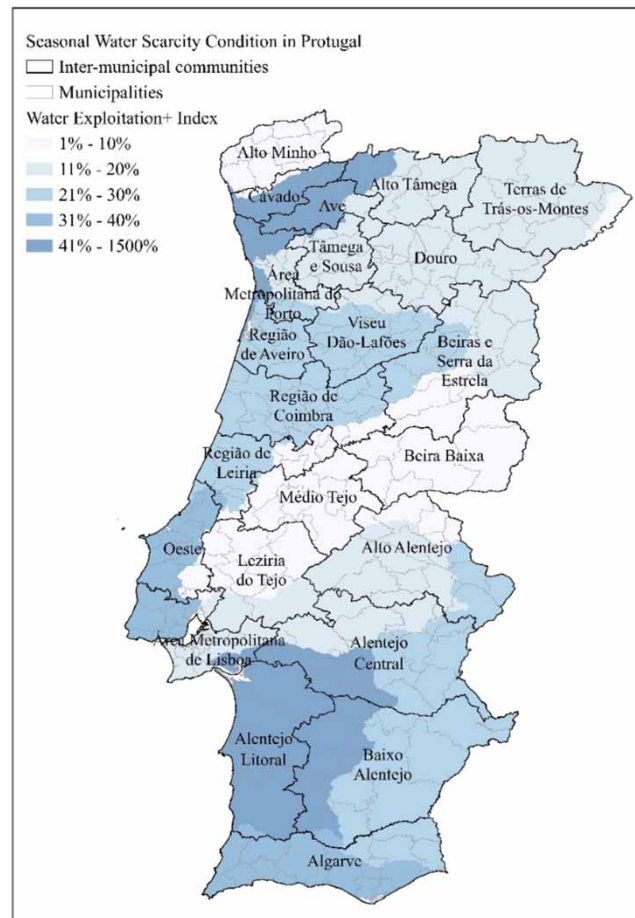
#### 3.2.1. Water scarcity and WCE initiatives in Portugal

Portugal stands out as one of the European nations grappling with pronounced water scarcity that has gathered scholarly attention due to its implications for sustainable water resource management (EEA 2023). Promoting WCE and water reuse practices in Portugal is significantly tailored by the country's high water exploitation conditions, and the complexity of its governance models and institutional framework for water sector organisation. The country faced one of the worst water scarcity conditions in Europe on a seasonal scale, with a seasonal Water Exploitation Index Plus (WEI+) (Summer) of 66% (EEA 2023) (Figure 2). The WEI+ measures water consumption as a percentage of renewable freshwater resources available at the river sub-basin level, calculated for each of the four quarters of the year (three consecutive months). WEI+ values above 20% indicate that water resources are under stress, and values above 40% indicate severe stress and unsustainable freshwater use.

Despite Portugal's old historical challenges regarding infrastructure and water-related legislation (Rebello *et al.* 2020), it has advanced in addressing these issues. The enactment of new water reuse legislation in Portugal (Decree-Law No. 119/2019) and the adoption of the national circular economy (CE) action plan (APCEP 2017) stand as noteworthy examples within the European Union member states.

#### 3.2.2. Portuguese governance models and institutional framework for water sector

The Portuguese governance models and institutional framework for water sector organisation are complicated (Rodrigues *et al.* 2024). Among the diverse agencies, it is worth outlining in the context of this article, that at



**Fig. 2** | Seasonal water scarcity in Portugal (Summer) (EEA 2023).

the central level, the Ministry of the Environment and Climate Action is responsible for the design of the overall environmental policy and, within it, the Portuguese Environment Agency (APA) that focuses on its implementation. Also, at the central level, there is the Water and Waste Services Regulatory Authority (ERSAR) which regulates and enforces compliance in water and sanitation services, surveilling the performance of water utilities. At the regional level, it is worth outlining the deconcentrated agencies from APA and the regional hydrographic administrations, responsible for drafting and implementing River Basin Management Plans, water permitting and monitoring. Also relevant in the Portuguese institutional context is Águas de Portugal (AdP), a state-owned company, as its main activity, sells water and provides wastewater services to most of the municipalities, which, in turn, serve the population (Marques & Simões 2020). Moreover, there is a spatial planning system structured into four levels: national, regional, inter-municipal, and municipal. Nationally, the Parliament sets the legal foundation for spatial planning, while the central government develops and implements regulations, except in autonomous regions with special legal status. Regionally, spatial planning is managed by the Regional Coordination and Development Commissions. At the inter-municipal and local levels, inter-municipal and municipal bodies handle planning, with the latter operating under delegated powers (DGT 2021).



Despite this comprehensive framework, these organisations and agencies are water-specific, with limited integration regarding spatial planning strategies, reinforcing a sector-specific rather than territorially coordinated approach. Inter-municipal communities are established to address the absence of regional-level governance (given that administrative governance comprises two levels: central and local) and are highly motivated and incentivised by European Regional Development Funds as the main factor in mobilising the political will for institutional reform (Teles 2016). Inter-municipal communities may play a crucial role in bridging the governance gap at the regional level by fostering collaborative efforts among stakeholders to coordinate initiatives aimed at achieving sustainable water resource management. Although the primary purpose of establishing inter-municipal communities does not focus exclusively on water governance (Decree-Law No. 75/2013), according to Article 81, inter-municipal communities coordinate the actions of municipalities, particularly in wastewater treatment, urban waste management, and basic sanitation infrastructure (Official Gazette 2013). Given the benefits of cooperation for effective water resource management and addressing the gap between the national and local, the significance of inter-municipal communities has been neglected.

## 4. RESULTS

This section presents findings on the role of inter-municipal communities in promoting the WCE through water reuse in Portugal. It is organised into three subsections: the role of inter-municipal communities within the institutional context of WCE and water reuse, their responsibilities in this domain, and an analysis of the robustness of inter-municipal communities' governance for advancing WCE.

### 4.1. The role assigned to the inter-municipal communities within the WCE and water reuse institutional context

The European CE action plans (EC 2015, 2020) are the most significant accomplishments for resource-efficient use. The first EU action plan (EC 2015) aimed at facilitating the transition to CE by focusing on measures at the EU level. The second version of the EU action plan (EC 2020) lays out a vision for a cleaner and more competitive Europe, looking for the participation of economic actors, consumers, citizens, and civil society organisations. These plans underscore the importance of cooperation among stakeholders across sectors and regions: *'As set out in the 2014 Green Action Plan for SMEs<sup>51</sup>, the Commission is acting to support these companies, analyse the barriers they encounter to a better use of resources and waste management, and to encourage innovation and cooperation across sectors and regions'* (EC 2015, p. 19). *'It will require an alignment and cooperation of all stakeholders at all levels – EU, national, regional, and local, and international'* (EC 2020, p. 24). Following the European CE action plans (EC 2015, 2020), Portugal adopted its first CE action plan, Leading the Transition: Action Plan for Circular Economy in Portugal: 2017–2020 (APCEP 2017). The Portuguese action plan refers to water reuse and water efficiency at the macro level, regenerating the resources. Like European action plans, cooperation at the core remains pivotal. While the collaboration between municipalities is entrusted with numerous roles and responsibilities (APCEP 2017, p. 29, 35, 49), inter-municipal communities receive a single mention, yet their potential contributions are overlooked *'At the micro level, the focus is on the regions and speeding up strategies for the circular economy that are most appropriate for the socio-economic profile [...] In designing these agendas, the local sector must be involved, either via local authorities, inter-municipal communities or metropolitan areas'* (APCEP 2017, p. 18).

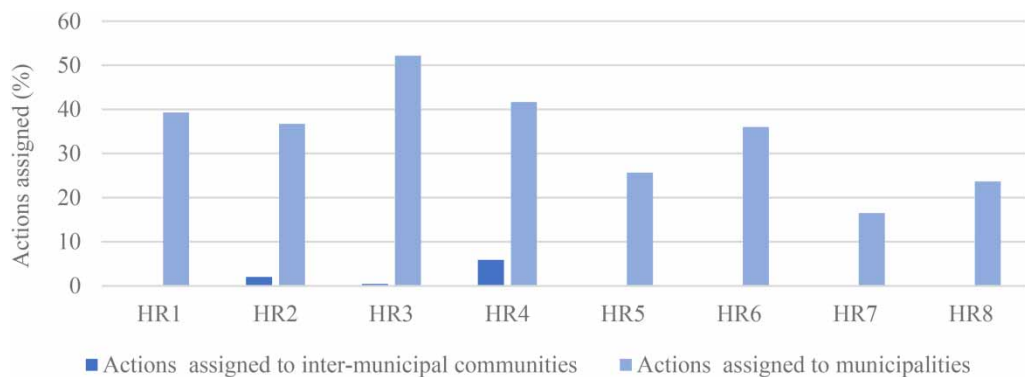
A new strategic plan for water service, known as the Strategic Plan for Water Supply, Wastewater, and Rainwater Sanitation (2021–2030) (APA 2024), expands its scope beyond traditional water supply and wastewater management to include rainwater management. The primary objective of the plan is to ensure the long-term sustainability of the water sector. It serves as a guiding framework for urban water cycle policies, particularly

addressing the challenges presented by climate change. This strategic plan underscores a strategic intent to harness the benefits of scale through inter-municipal communities or partnerships with AdP group, in the economic and financial analysis section of the plan. It is highlighted that ‘*All investments must benefit from the scale of aggregation in inter-municipal entities or partnerships with management entities of the AdP-Águas de Portugal group, in order to promote synergy between the entities, increasing the scale of the projects and optimising their management and operating conditions*’ (APA 2024, p. 85). However, it refrains from delineating specific actions or the extent of implementation. The responsibility of AdP lies primarily in providing services, complementing the roles of municipalities. Nonetheless, inter-municipal communities are designed to promote the economic, social, and environmental development of the covered territory, coordinate municipal investments of inter-municipal interest, and manage regional development programmes. This distinction introduces complexity as the strategic alignment between inter-municipal communities and AdP’s service-oriented role.

In addition, Portugal’s water planning process includes the National Water Plan, a strategic instrument that establishes national water policy options and guiding standards for revision and updating the Regional Hydrographic plans, which are regional in scope and cover the river basins within a river basin district. Portugal has begun the third cycle of planning to achieve its environmental goals by 2027. Portugal contains eight Hydrographic Regions (HRs), namely, Minho and Lima (HR1), Cávado, Ave and Leça (HR2), Douro (HR3), Vouga, Mondego and Lis (HR4), Tejo and Ribeiras do Oeste (HR5), Sado and Mira (HR6), Guadiana (HR7), and Ribeiras do Algarve (HR8). The Portuguese river basin management plans are undergoing the third Water Framework Directive planning phase. Figure 3 shows how municipalities and inter-municipal communities are called to implement measures in the eight HR plans.

The responsibilities of inter-municipal communities are scarce and only noticeable in HR4 (centre region), HR2, and HR3 (northern region). It is also noticeable that the allocation of responsibilities to municipalities is lower in the southern region (HR6, HR7, and HR8), where water scarcity is higher.

The legal regime to produce water for reuse is Decree-Law No. 119/2019, which later amends the multi-municipal systems in Decree-Law No. 6/2021 for the collection, treatment, and rejection of effluents. The field of water production for reuse has seen significant advances, starting with the approval of the legal regime through Decree-Law No. 119/2019. Given the importance of the efficient use of scarce resources such as water and as a tool for CE, the Portuguese government foresees the reuse of treated wastewater as one of the measures to improve the management of the urban water cycle (Decree-Law No. 16/2021). The water legal framework (Decree-Law No. 119/2019) outlines rules for water reuse but does not establish provisions for collaboration.



**Fig. 3** | The percentage of actions assigned to the municipalities and inter-municipal communities by HR plans.

#### 4.2. The responsibility of inter-municipal communities regarding WCE and water reuse

According to article 81, 75/2013, inter-municipal communities coordinate the articulation of action of the municipalities, especially for wastewater treatment and urban waste and basic sanitation infrastructure. Nevertheless, Decree-Law No. 75/2013 is unrelated to water reuse and WCE. However, inter-municipal communities Decree-Law No. 75/2013 does not refer to water reuse and recycling.

The content analysis of the five available ITDS for 2020–2027 indicates that, while the plans acknowledge the significance of the CE, the integration of WCE and water reuse is not well-established (Table 2).

Although water reuse is briefly mentioned in the problem showcase and objectives, it lacks emphasis and dedicated actions, governance, stakeholders, and indicators. Accordingly, the integration of water reuse initiatives into spatial development strategies is lacking, leading to significant challenges in land utilisation and water scarcity issues. While ITDS offers a framework for aligning territorial planning with water reuse and circular economy goals, it is evident that inter-municipal communities face challenges in fully leveraging spatial strategies. These limitations often stem from a lack of integration between water management policies and territorial planning at the regional level, which hinders the robust implementation of water reuse initiatives and sustainable practices. This necessitates embedding principles of water circularity and reuse within policy frameworks (by defining goals, measures, and indicators), particularly in ITDS.

#### 4.3. Insight into the robustness of inter-municipal communities governance for WCE

Inter-municipal communities can lead to greater sustainability by reducing environmental and health risks, particularly water resources. This assertion finds support in the interview responses gathered, where all (five out of 23) respondents underscored the pivotal role of inter-municipal communities in addressing these challenges. This assertion is corroborated by interview responses, where all (five out of 23) respondents emphasised the importance of inter-municipal communities in this context. Inter-municipal communities contribute a better scale for water resource management (supported by four respondents) and a better scale for water treatment considering capacity and investment (supported by four respondents). Also, inter-municipal communities bring better water treatment and sanitation because of the scale, better monitoring of pollution and disease, and better education and awareness (each one supported by one respondent).

Making a definitive conclusion regarding the contribution of inter-municipal communities to water reuse is challenging due to the diversity of the responses. Although two responses to the questionnaire suggest that inter-municipal communities in Portugal significantly contribute to water reuse through their involvement in the climate change action plan and the implementation of natural engineering solutions for the river basin, inter-municipal communities representatives expressed a lack of contribution. Moreover, two inter-municipal communities noted a collaboration to promote water reuse, while an equal number indicated a lack of such collaboration.

Key factors motivating municipalities to engage in collaborative efforts for water reuse include concerns about water scarcity, and environmental benefits and sustainability by reducing pressure on resources and pollution. Additionally, two inter-municipal communities underscored the significance of water scarcity and a better infrastructure condition in terms of cost efficiency for collection treatment and supply as the driver of collaboration. Moreover, the economic benefit of reusing water (in green areas, agriculture, and industry), the benefits of a more secure water supply (particularly for vulnerable zones), and increased resiliency were each mentioned by one IMC. The advancement of water reuse systems is significantly context-dependent. For instance, in one IMC, spatial considerations, including distance and population density, are identified as the primary barriers. In another IMC, inadequate infrastructure hinders the advancement of water reuse. Nonetheless, the consensus among the three responses highlights the significance of the lack of funding as arguably the most critical barrier

**Table 2** | Water circularity-related contents of the Integrated Territorial Development Strategies.

	<b>Cávado 2030 (CIMCAVADO 2021)</b>	<b>Médio Tejo 2021– 2027 (CIMT 2021)</b>	<b>Region of Coimbra 2021–2027 (CIMRC 2021)</b>	<b>Alentejo Central 2021– 2027 (CIMAC 2020)</b>	<b>Baixo Alentejo 2021– 2027 (CIMBAL 2021)</b>
Problem showcase			‘In its environmental values, <u>circular economy</u> , water resources, transition to clean and equitable energy, adaptation to climate change and risk prevention’ (7)	‘Climate policy and energy transition; adaptation and territorial valorisation; sustainable mobility; <u>circular economy</u> and waste management; energy efficiency in cities; sea economy; <u>urban water cycle</u> ; agriculture and forestry (5)	This structuring areas of intervention should bring together interventions aimed at improving the coverage and performance of infrastructure networks and services related to the urban water cycle and urban waste, including raising awareness and training all relevant stakeholders (consumers, producers, system managers, etc.) on the issues of responsible consumption and the <u>circular economy</u> (29)
Visions and objectives	- ‘Environmental awareness and education projects for adults, young people and children on <u>circular economy</u> issues such as energy and <u>water</u> efficiency and <u>recycling</u> , reuse to be coordinated by the Inter-	- ‘The response to the problems of ageing and childhood, the transformation of the landscape of vulnerable forest territories, the reform of the prevention and fight against rural fires, and water management	- ‘In its environmental values, <u>circular economy</u> , <u>water resources</u> , transition to clean and equitable energy, adaptation to climate change and risk prevention’ (74). - ‘Water Subdomain Vision of the Regional Strategy for Intelligent	- ‘Development of interventions to adapt to CA (Agriculture and forestry, Economy, Safety of people and goods, Transport and communications, Biodiversity and landscape, Health, Energy and energy security, <u>Water resources</u> – Central Alentejo Inter-municipal Climate	

(Continued.)

Table 2 | Continued

	Cávado 2030 (CIMCAVADO 2021)	Médio Tejo 2021– 2027 (CIMT 2021)	Region of Coimbra 2021–2027 (CIMRC 2021)	Alentejo Central 2021– 2027 (CIMAC 2020)	Baixo Alentejo 2021– 2027 (CIMBAL 2021)
	municipal community with schools and the general public. The establishment of links with the arts and culture should be favoured' (47)	for the storage and <u>reuse of water</u> are also points in common between the two plans' (63)	Specialisation of the Centre in the <u>Water subdomain</u> : To innovate in the models of knowledge, protection, use, <u>reuse and management of water</u> , with the aim of guaranteeing the sustainability of its ecosystems and positively impacting its quality and resilience, in relation to floods and droughts and other extreme meteorological phenomena resulting from climate change (80)	Change Adaptation Plan); Promotion of the transition to the <u>circular economy</u> ; Valorisation of renewable energies (37)	
Actions			–	–	
Governance and stakeholders			–	–	
Indicators			–	–	

to collaboration. Focusing on the institutional aspect, the hindrances stem from a lack of experts or knowledge (human resources) and a deficiency in common goals or diversity of interests. In addition, to promote water reuse, the respondents recommend the establishment of a specific work group for CE, initiatives focused on education and awareness, and the formation of broader partnerships.

## 5. DISCUSSION

This section presents a discussion of the results, highlighting key insights and their implications, followed by an analysis of the scope and limits of the framework.



### 5.1. Discussion of the results

This study aimed to assess the role of inter-municipal communities in promoting WCE and water reuse practices in Portugal. Although the need for collaboration in CE strategies is highlighted (Usui *et al.* 2015; Soukopová *et al.* 2017), and IMC is known to enhance synergies between agencies, stakeholders, and different spatial contexts (Riazi *et al.* 2022), the result reveals a limited integration of inter-municipal communities in WCE and water reuse initiatives due to three main reasons.

First, the existing legislative framework and policies concerning CE lack explicit roles and responsibilities attributed to inter-municipal communities. Considering that adoption of WCE requires clearly defining responsibilities, and the creation of a broader collaboration, especially with water utilities, brings new responsibilities (Riazi *et al.* 2023). This ambiguity results in a lack of clear guidance for inter-municipal communities on how to contribute effectively to these initiatives. Unlike what literature emphasises the role of inter-municipal communities in the creation of a platform to share and enhance funding, knowledge, and collaboration with other sectors (Moran & Woods 2009; Kang 2021), inter-municipal communities are absent in the governance of the WCE and water reuse. This oversight creates a governance gap, where inter-municipal communities are neither empowered nor incentivised to engage in WCE and water reuse issues. The absence of detailed legislative and policy framework mandates for inter-municipal communities means that the potential contributions remain underutilised, and their involvement in WCE practices is minimal. In addition, the responsibilities of inter-municipal communities in HR plans are scarce, especially in southern regions struggling with harsher water scarcity conditions. It calls for more supportive institutional frameworks, dedicated actions, and comprehensive stakeholder engagement to fully realise the potential of inter-municipal communities in addressing water scarcity and promoting WCE practices, especially in vulnerable inter-municipal communities, including Alentejo Litoral, Alentejo Central, Baixo Alentejo, and Algarve in the south, and Cávado and Ave in the north.

Second is recognising that WCE principles are integral to achieving a synergistic balance between developmental activities, land use planning, and the preservation of water resources. The embeddedness of the WCE concept within the ITDS remains insufficient. While these plans integrate the water reuse and recycling concepts within their overarching visions and objectives, a notable absence of specific measures and indicators is observed. Given that IMC actively formulate climate change action plans, which may encompass initiatives related to water reuse and protection of water resources, the absence of comprehensive integration of water CE principles into spatial planning is a critical oversight (UNESCO & WSSM 2020; Baggio *et al.* 2021; Halder *et al.* 2021). Neglecting the inclusion of WCE considerations in spatial planning hinders the synchronisation of sustainable land use and water management. Also, it compromises the overall efficacy of ITDS (Fidélis *et al.* 2021). The ITDS plays a significant role in aligning land use planning with water resource management and the orderly development of human activities within defined spatial boundaries.

Third, despite the growing importance of collaboration in addressing complex issues like water management, IMC often is isolated from water utilities. The success of WCE adoption is less likely without the collaboration of inter-municipal communities with primary stakeholders, particularly water utilities (Emerson & Nabatchi 2015; Lu *et al.* 2020). While other municipal associations, such as multi-municipal organisations, exist for water reuse, they operate independently and primarily focus on water supply and sanitation, with no formal connection to inter-municipal communities. This disjointed approach reflects a lack of recognition of the potential contributions of inter-municipal communities in these areas by other stakeholders. The absence of formal connections between inter-municipal communities and these organisations leads to missed opportunities for collaboration and coordination in WCE and water reuse initiatives. The multi-municipal system is a sectoral association, while inter-municipal communities are primarily concerned with spatial development.

Nonetheless, the successful governance solutions for WCE adoption in Portugal require the acknowledgement of the complexity of the Portuguese governance models for the water regarding different stakeholders at various levels. The major drivers and barriers fostering the role of inter-municipal communities for WCE adoption in Portugal are delineated in Figure 4.

This roadmap is crafted to enhance the role of inter-municipal communities in WCE and water reuse adoption (Figure 5). The roadmap creation assumes importance as it delineates a strategic, time-based approach comprising guidelines aimed at shaping a governance model conducive to achieving desirable outcomes.

Breaking the barriers and challenges requires designing a comprehensive framework with short-term, mid-term, and long-term milestones to monitor progress. Considering that the Portuguese framework suffers primarily from fragmentation, which exacerbates other challenges, the proposed solution can be structured into three phases: Short-term: focus on the initial adoption or trial of solutions, such as implementing policy changes and establishing new cooperation agreements; Mid-term: emphasise achieving operational outcomes, including the implementation of water reuse projects and fostering inter-municipal collaboration; and Long-term: aim for broader systemic impacts, such as enhancing water sustainability and improving governance mechanisms. The following recommendations aim to enhance governance conditions to better support the implementation of WCE policies:

- Robustness of inter-municipal communities for water reuse and circularity: Policymakers must establish robust collaboration between inter-municipal communities and water utilities, ensuring a cohesive and comprehensive approach to water management. Municipalities of an IMC unit must create working groups comprising representatives from various municipalities and water utilities.
- The involvement of inter-municipal communities for water reuse and circularity: Although Portugal has implemented various initiatives to promote water reuse, including relevant legislation (Decree-Law No. 119/

<p><b>Barriers</b></p>	<ul style="list-style-type: none"> <li>- Lack of an inter-sectoral legal framework for water reuse through acknowledgement of the inter-municipal communities' role;</li> <li>- Lack of spatial concern acknowledgement in water reuse scheme development and integration of water reuse management and spatial planning;</li> <li>- Lack of embeddedness of water reuse in strategies and policies influencing water reuse adoption;</li> <li>- Lack of acknowledgement of the roles of inter-municipal communities in water reuse plans and policies and the HR plans actions;</li> <li>- Lack of key stakeholders' engagement in planning the river basin and developing spatial strategies in accordance with HR plans;</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of collaboration with water utilities in water reuse schemes;</li> <li>- Lack of CE work groups, initiatives focused on education and awareness, and the formation of broader partnerships, especially with water utilities and private companies;</li> <li>- Lack of funding;</li> <li>- Lack of experts or knowledge;</li> <li>- Lack of common goals or diversity of interests</li> </ul>
<p><b>Dimensions</b></p>	<p><b>The involvement of inter-municipal communities</b></p>	<p><b>Robust governance for WCE</b></p>
<p><b>Drivers</b></p>	<ul style="list-style-type: none"> <li>- Existence of new water reuse legal framework;</li> <li>- Existence of CE action plan;</li> </ul>	<ul style="list-style-type: none"> <li>- Economies of scale;</li> <li>- Governance Capacity;</li> <li>- Better scale of monitoring and planning;</li> <li>- Water scarcity;</li> <li>- Environmental benefits and sustainability by reducing pressure on resources and pollution;</li> </ul>

**Fig. 4** | The major drivers and barriers fostering the role of inter-municipal communities for WCE adoption in Portugal.

	Short-term	Midterm	Long-term
<b>Robust governance for WCE</b>	Formation of broader partnerships		
	A greater collaboration of water utilities with inter-municipal communities		
	Converging interests and defining common goals		
	Incentivising water reuse and setting up better funding		
	Inter-sectoral legal framework through acknowledgement of the inter-municipal communities roles		
<b>The involvement of inter-municipal communities</b>		Clearly define the responsibility of inter-municipal communities concerning WCE and water reuse	
		Inclusion of WCE considerations in territorial strategies	
<b>Territorial fit and spatial concerns</b>			Defining criteria to assess the territorial fit of inter-municipal communities for WCE

**Fig. 5** | The roadmap for enhancing inter-municipal communities for WCE adoption in Portugal.

2019), the Portuguese Parliament must draft and disseminate clear guidelines that define the specific operational roles and responsibilities of inter-municipal communities in water reuse projects.

- Developing territorial strategies considering water scarcity and reuse: inter-municipal communities must adopt comprehensive strategies that balance the needs of different land uses while promoting water conservation and efficiency. It happens by integrating water reuse into ITDS goals and measures, fostering the transition towards WCE.

## 5.2. Scope and limitations of the framework

The framework provides insights into the features of the involvement of inter-municipal communities in advancing WCE and water reuse issues. The framework is flexible and comprehensive enough to be used to analyse collaborative governance for various purposes, such as environmental management, urban and regional planning, and public health initiatives. The framework outlines three main dimensions of governance for WCE: involvement of IMC in advancing WCE, robust governance for WCE, and territorial fit and spatial concerns. It enables an examination of institutional arrangements for WCE and territorial fit simultaneously. Benefiting from the institutional design principle to the framework enables the framework to investigate the institutional barriers and the governance flexibility regarding the challenges caused by new circumstances (Ostrom 2005). Although this study added the institutional design principles of Ostrom (2005), later developed for water reuse by Riazi *et al.* (2023), the institutional design principles may be adapted by future scholars for CE in energies, materials, or other resources. Depending on the purpose of future studies, one or two dimensions of the framework might be chosen to investigate, making the framework more convenient for scholars to use.

This study, however, has shortcomings. It builds the framework based on the IMC approach and does not analyse and compare all popular analytical governance frameworks in the literature. While the study does not assess the territorial fit and spatial concerns of inter-municipal communities in WCE efforts and water reuse, it presents valuable insights into these issues. Furthermore, while this study analysed ITDS, exploring the extent to which such collaborative efforts influence the formulation of policies and decision-making processes related to water

reuse initiatives, these strategies are currently unavailable for analysis. It underscores the need for additional scholars to conduct content analyses of the strategies in the regions facing higher water scarcity. Finally, analysing the budget plans formulated by inter-municipal communities and the Portuguese multi-municipal systems could provide valuable insights into evaluating inter-municipal communities' roles in advancing the transition towards WCE. Although the absence of data from ITDSs and responses limits the analysis, it provides a foundation for developing a comprehensive roadmap.

## 6. CONCLUSION

This study highlights the critical need for robust governance arrangements and comprehensive legislative and policy reforms to strengthen the role of inter-municipal communities within water management frameworks. Considering the emphasis on collaboration in legal and legislative frameworks, the results show the constrained role of inter-municipal communities in promoting the WCE through water reuse in Portugal. In addition, the limited integration of water reuse into territorial strategies highlights the lack of integration of water management and spatial planning. By setting joint goals, developing cohesive policies, and coordinating spatial planning efforts, inter-municipal communities hold significant potential to address water scarcity challenges. Moreover, the robustness of governance is hindered by a lack of funding, inadequate infrastructure, spatial and contextual barriers, a lack of experts or knowledge, and a deficiency in common goals or diversity of interests. However, to fully leverage the benefits of inter-municipal communities, legislative adjustments are necessary to deepen consideration of inter-municipal communities in water governance structures. This entails fostering greater collaboration between inter-municipal communities and water utilities to advance water reuse strategies, implement policy changes, and establish mechanisms for progress monitoring. Further research should explore the territorial fit and spatial dimensions critical for WCE adoption.

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## DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

## CONFLICT OF INTEREST

The authors declare there is no conflict.

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