Reuse of Drinking Water in the Built Environment: Types of Conflict, Legitimacy and Governance

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Article

Reuse of Drinking Water in the Built Environment: Types of Conflict, Legitimacy and Governance

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Abstract

Potable water reuse (direct and indirect; DPR/IPR) is increasingly proposed to strengthen urban water security under climate variability, water scarcity, and rising demand. Although technological barriers have decreased considerably, many projects continue to face intense social and political conflicts. This article examines the contextual factors that explain why some technically viable reuse initiatives succeed while others fail, by developing a conceptual framework to analyse conflicts associated with DPR/IPR. The study proposes three complementary typological matrices: Justification × Acceptance (J×A), Justification × Urgency (J×U) and Demands × Repertoires (D×R). These matrices integrate the structural conditions of the projects with the strategic dynamics of the actors involved. The framework is illustrated by an empirical corpus of 25 global DPR/IPR cases, compiled through a realistic synthesis of academic literature, technical reports and contextual sources. The analysis shows that project trajectories do not depend solely on technological maturity or water scarcity. They are shaped by the interaction between technical justification, social acceptance, perceived urgency and, especially, the strategy and agency capacity of actors to mobilise demands, narratives and repertoires of action. Consequently, the advancement, transformation or blocking of potable reuse projects is mainly explained by how these strategies shape the legitimacy of water risk governance.

Keywords: potable water reuse; water governance; water security; water conflicts; conflict transformation; sustainability; constructive improvement

1. Introduction

The current debate on potable water reuse reflects underlying tensions surrounding the very justification of such projects [1,2]. Some approaches argue that DPR (Direct Potable Reuse) no longer faces technical barriers [3,4], but rather narrative [1,5,6], where the essential thing is to build trust and a convincing narrative about its safety and necessity [3,6,7]. From this perspective, the problem lies not in treatment capacity [4], but in the ability to communicate risks, benefits and control guarantees [4,8–10].

An alternative approach suggests that DPR is not always necessary or efficient as a first option in the face of scarcity [3,11]. Before resorting to the most expensive and complex alternative, there are non-potable, industrial, agricultural or environmental uses [12,13] that can be deployed with less investment and greater social acceptance [4,14]. In this regard, overemphasizing DPR can have three adverse effects: i) investments with decreasing returns compared to more cost-effective alternatives [14,15]; ii) increasingly complex and costly regulatory frameworks to implement [16,17]; and iii) reinforcement of social biases of mistrust towards water reuse in general [8,18]. Along these lines, several authors warn that water urgency is not sufficient justification [18,19]. The optimal strategy is to prioritize intermediate and scalable solutions that generate immediate benefits and public confidence [1] before moving on to more complex options such as DPR. An additional layer of conflict arises from regulatory barriers and restrictive environmental standards, which may at times

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constitute significant bottlenecks. Despite delivering water quality superior to many conventional sources [3], regulatory fragmentation or inflexible criteria can delay or block projects, even when technically justified [2,16].

These positions reflect how justification is shaped by public and political deliberation [8,20]. Beyond its technical dimension, potable reuse also constitutes a political field in which power, risks and benefits are negotiated, disputed and redefined [18,20]. Urgency, health safety and regulation can be exploited by different actors to accelerate, slow down or redesign projects, making DPR/IPR particularly susceptible to narrative and political disputes [18]. Potable reuse is not a neutral solution, as its justification may be contested and acceptance depends on technical performance and the capacity to build legitimacy under social, political and economic tensions [8,19].

Conflicts surrounding potable water reuse (DPR/IPR) are shaped not only by technical or health factors, but by how these are interpreted, framed and politicized [17,18]. The variables that structure these conflicts, such as health safety, institutional trust, water urgency, energy cost, or even the so-called yuck factor, are highly instrumentalized [4,18,21]. Each of these variables can be amplified or minimized by institutional, political, or media actors, depending on their interests and power strategies, shifting the viability of the project to the political arena [7,18,22,23].

This instrumentalization operates through narrative framing, which functions either as a project driver (water urgency, security of supply) or as a narrative barrier (yuck factor, distrust, perceived risk) [1,21]. In this sense, narratives are strategically deployed to enable or block project viability in the public arena. The “yuck factor” acts as a barrier with the capacity for symbolic veto, particularly in contexts of low institutional trust [1,24,25], whereas water urgency functions as a driver that legitimizes accelerated decision-making [19,22]. Moreover, the same factor can be instrumentalized in opposing ways. While water urgency may justify rapid action, it can also be interpreted by opposing actors as a means to limit deliberation and restrict public participation [22,26].

To analyze these dynamics, this study draws on three complementary bodies of scholarship. First, it builds on social conflict theory, where conflict is understood as a strategic interaction among actors contesting resources, meanings, and power through claims and repertoires of action, as developed Tilly, Tarrow and McAdam [27]. Second, it adopts a sociotechnical legitimacy perspective grounded in the broader legitimacy literature, where legitimacy is treated as a constructed and dynamic condition that enables the acceptance and stabilization of infrastructures within institutional contexts, following contributions from Suchman [28] and Binz [29]. Third, it engages with the literature on potable water reuse, which moves beyond individual perception models toward societal legitimacy and social acceptability, with trust, governance, and narratives shaping project viability [1,23,30].

Despite these contributions, conflict remains under-theorized in explaining potable reuse trajectories, leaving limited understanding of why technically justified projects are advanced, reconfigured, or blocked across contexts [17]. This study addresses this gap by developing a typological framework that explains how legitimacy is constructed, contested, and transformed in potable reuse governance.

2. Methodological Approach

The study of the dynamics and conflicts surrounding potable water reuse requires a framework that articulates its technical, social, political, and strategic dimensions [17,31,32]. This study develops a framework of three comparative matrix typologies to analyze conflicts in potable water reuse (DPR/IPR). It integrates structural conditions with social interaction dynamics that shape project trajectories, following the multidimensional typology approach of Collier et al. [33]. The novelty of the study lies in proposing an explanatory framework that integrates justification, acceptance, urgency, and strategic agency to explain differences in potable reuse trajectories. It provides a structured basis for analyzing how specific configurations of these dimensions are associated with patterns of project advancement, redesign, or blockage, positioning agency as the central explanatory variable. The approach organizes conflicts through the intersection of these analytical dimensions.

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Their effects emerge in combination rather than isolation [17,21], with particular emphasis on how actors mobilize demands, narratives, and repertoires of action [18,34].

First, the *Justification* × *Acceptance* (J×A) typology classifies cases by project soundness and social support, enabling analysis of alignments and gaps between technical validity and trust. Secondly, the *Justification* × *Urgency* (J×U) typology shows how water crises reconfigure decision thresholds and narratives of need, without implying legitimacy or sustainability. Thirdly, the *Demands* × *Repertoires* (D×R) matrix by Paredes [34] was adapted to characterize actor agency and strategy, crossing the type of mobilized demand (*what is being claimed*) with the disruptiveness of the repertoires through which projects are opposed, conditioned, or contained (*how it is claimed*). The repertoire axis is defined as a range from low-disruption actions (e.g., participation, petitioning, negotiation) to high-disruption strategies (e.g., protest, litigation, boycott, or administrative blockade), including forms of institutional imposition. Their intersection yields analytical configurations such as resistance, negotiation, subordination, and dependence.

To empirically ground and illustrate this framework, a documentary corpus was constructed using a Realist Synthesis approach [35], combining a structured search of case studies in academic literature on potable reuse projects and controversies. Complementarily, grey literature and media-reported documentation were incorporated to provide contextual depth and triangulation for reconstructing conflict dynamics. Case selection proceeded iteratively until a corpus sufficient to capture variation in conflict dynamics was achieved. Empirical validation was based on a corpus of 25 cases of direct and indirect potable reuse (DPR/IPR) reported in the literature.

The academic search was conducted in Google Scholar and Web of Science using combinations of keywords related to potable reuse (e.g., “potable water reuse”, DPR, IPR, “direct/indirect potable reuse”) and social conflict (e.g., “conflict”, “controversy”, “opposition”, “mobilisation”, “acceptance”, “public perception”), complemented by cross-citation tracking. Sources in English and Spanish were considered.

Case studies were included only if sufficient contextual information was available to reconstruct conflict dynamics (justification, acceptance, urgency, and actor repertoires).Therefore, cases with no documented social or political conflict, or with insufficient empirical detail, were excluded. This approach, consistent with Flyvbjerg’s emphasis on the strategic selection of information-rich cases for explanatory analysis [36], may introduce a bias towards well-documented, conflict-visible cases, but is appropriate for a process-oriented design focused on conflict dynamics rather than statistical representativeness. Cases were then qualitatively coded using theory-driven criteria derived from the three typologies (J×A, J×U and D×R), based on evidence reported in the analyzed corpus on technical justification, water emergency context, social responses, and repertoires of action. This approach provides a structured basis for systematic classification and comparison across cases and contexts (see Appendix B for coding criteria).

Following Jaakkola [37], typologies are constructed here not only as classificatory devices, but also as explanatory mechanisms. The J×A, J×U, and D×R matrices specify relationships among justification, acceptance, urgency, and agency, enabling the identification of how potable reuse trajectories are generated, blocked, or reconfigured. Each configuration yields analytical mechanisms and testable propositions, while defining the conditions for their application and empirical evaluation.

3. Results

The analysis of the specialized literature and the empirical cases examined made it possible to identify a set of analytical dimensions that define the dynamics of conflicts surrounding potable water reuse (DPR/IPR). These dimensions are presented below.

3.1. Conflicts over Potable Water Reuse (DPR/IPR)

Controversies surrounding DPR/IPR can be explained by a set of structural variables, such as psychological aversion or the “yuck factor” [1,38–40], risk perceptions [40,41], water scarcity [18,38],

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costs [14,15], previous experiences [1,19], and notions of justice [20]. Instrumental variables linked to management, regulation, or communication also play a role, including institutional trust [8,38], regulatory frameworks [16,17], technological reliability [14,42], transparency [7,17], narratives [6,18,19], and operational capacities [17]. Although these variables are heterogeneous, they converge in three dimensions that structure the dynamics of DPR/IRD conflicts: *Justification, Acceptance and Urgency* (Al-Saidi, 2021), modulated transversally by the legitimacy of governance [2,17]. In this context, the maturity achieved by treatment technologies is insufficient on its own [1,7,9] and the trajectory of each DPR/IPR project depends on the political, social and regulatory framework that shapes both its justification and its acceptance [15–17].

3.1.1. Justification

Justification refers to the technical, economic, legal and environmental soundness of potable reuse projects [16,43]. It includes the technological maturity of processes such as reverse osmosis (RO) and advanced oxidation with UV (UV-AOP), regulatory robustness and cost-benefit analysis relative to alternatives such as desalination, recharge, or loss [14,15]. It also covers the assessment of comparative risks compared to other sources, where the risk of planned reuse is significantly lower than *de facto* reuse, and the guarantee of safety and sustainability standards [6,12]. A solid justification does not depend exclusively on water urgency, but on the ability to demonstrate long-term viability and convenience compared to alternative uses of the resource, such as agricultural or environmental [38,44,45].

3.1.2. Urgency

Urgency corresponds to the structural context of pressure [6,21]. In contexts of recurrent or prolonged droughts, or risks of supply collapse, the perception of immediate need can act as a catalyst by modifying decision thresholds, reinforcing the political justification for projects or reducing cost sensitivity [17,21,46].

In Windhoek (Namibia), chronic water scarcity and the absence of viable conventional supply alternatives made it possible to sustain a pioneering global model of direct potable reuse (DPR) [3,42]. This case illustrates a positive convergence of urgency and justification, where extreme aridity enabled early resistance to be overcome and technical legitimacy to be sustained through continuous, safe operation since 1968 [2]. This alignment was reinforced through a narrative based on quality ("*water judged by quality, not history*"), visible political endorsement, and more than five decades of incident-free operation, which gradually normalized reuse as ordinary infrastructure. This case illustrates how structural necessity, coupled with sustained performance, can stabilize legitimacy over time [2].

However, urgency does not automatically generate sufficient justification [22]. This dimension can be exploited, leading to hasty and fragile decisions [19]. In Wichita Falls (USA, 2014), an emergency direct potable reuse (DPR) project was implemented under extreme pressure but dismantled once the drought ended. The system remained inactive for years, as acceptance proved highly volatile once the sense of need disappeared as soon as the drought ended [47,48]. Urgency conditions both the timing and the manner of decision-making, but it does not guarantee by itself sufficient technical or social justification in the long term [21].

3.1.3. Acceptance

Acceptance is a contingent outcome that reflects the social and psychological reactions generated by potable reuse projects [2,4,49]. Variables such *as* the *yuck factor*, risk perception, trust in institutions, the notion of distributive justice, the quality of participation, and previous experience with reuse directly influence citizen support or rejection [1,4,19,20]. Acceptance is not equivalent to automatic legitimacy [29,30,50]. It can be fragile if based on apathy, information asymmetries, conformism, or

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participatory fatigue [19,24], and may shift to rejection when benefits, risks, and costs are perceived as inequitable [20,51].

The legitimacy of governance should be understood as a dynamic process of institutional, social and political construction that modulates the relationship between justification (technical, economic and regulatory soundness) and acceptance (social trust and citizen support) [29,30]. It extends beyond legal frameworks and technical capacity to encompass the practical capabilities that sustain governance: transparency [23], external auditing [52], effective oversight [23] and open spaces for incidental participation beyond the information deficit-based model [19,53]. Together, these capacities support sustained trust and reduce perceived social risk [41,53,54]. Legitimacy is also expressed in the ability to project and sustain perceptions of trust and transparency [1,12], in how institutions are observed, interpreted, and evaluated by social actors [4,41].

In this sense, acceptance cannot be analyzed without considering governance structures, whether authoritarian or deliberative [29,55]. What is decisive is not the form of the political regime in the abstract, but the capacity of institutions to produce and sustain legitimacy [29,30] and how this is perceived through practice [8,41].

Acceptance, therefore, is not a simple reflection of citizen adherence, but a relationship modulated by political culture and government and governance practices [29,56]. In societies with a tradition of disciplinary collectivism, such as China or Singapore, the centralization of decisions is interpreted less as an imposition and more as a guarantee of collective security [6,57,58]. There, legitimacy is based on the performance of state performance, including visible results, continuity of supply and narratives of national resilience [6,58]. In contrast, in societies with traditions of direct participation, such as the United States, Australia, or Europe [29,54], the same centralization is often perceived as an illegitimate imposition. This is especially the case when it lacks transparency, effective deliberation, and mechanisms for social control [7,22,41,53].

This contrast illustrates a crucial point, the legitimacy of governance is relational and culturally mediated [2,19]. The same project may be deemed successful in its own context due to alignment among policies, institutions, and regulations [17]. From an external perspective, however, it may appear as a technocratically closed process [19], defined by manufactured consent [18] or induced conformity where individuals follow the behavior of the majority rather than rather than forming independent [24].

3.1.4. Conflict Configuration

The implementation of potable reuse projects, both direct (DPR) and indirect (IPR), constitutes a socio-technical process [19] that transforms the hydro-social cycle and reconfigures relationships between institutions, communities and material water flows [59]. These transformations generate tensions and areas of dispute where technical knowledge, public trust and distributive justice converge [60], generating conflicts that transcend the technical and express political tensions over risk and legitimacy [61]). To understand the diversity of these controversies, it is useful to apply the framework proposed by Paredes (2022), which classifies conflicts according to two dimensions: the framing of demands (*what is being claimed*), and the degree of disruption of repertoires of action (*how claims are made*). This dual axis allows conflicts over DPR/IPR to be represented as political expressions of risk governance and tensions between necessity, acceptance and social control.

3.1.5. Demands

The way in which actors formulate their demands reveals their position on the project and the motives and logic that drive them. In DPR/IPR conflicts, two main orientations can be distinguished: demands for cancellation, which seek to halt the project completely [7,15,16]. In contrast, demands for coexistence or conditions, accept reuse but require guarantees of safety, transparency, equity and robust institutions [30,53].

Following Matland, (1995) *Ambiguity* × *Conflict* model, potable reuse (DPR/IPR) is predominantly located in the Political Implementation quadrant (low ambiguity and high conflict).

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In this scenario, although the means and technical standards are clearly defined and validated by science (low ambiguity), the objectives or their implementation face strong opposition from various social actors (high conflict). Therefore, implementation shifts from an engineering challenge to a predominantly political process, where outcomes depend on power relations, coalition strength, and the management of contested legitimacy within the community.

In conflicts associated with water, social demands tend to revolve around different dimensions. First, there are health demands, focused on the perception or management of risks to human health [19,53]. Second, there are ecological demands, linked to the protection of aquatic ecosystems and the preservation of their natural dynamics [5,43]. Thirdly, distributive or hydro-social demands, which question the reconfiguration of flows, access and rights associated with water [59]. Finally, procedural demands seek to ensuretransparency, participation and legitimacy in water resource governance processes [1].

Demands for cancellation arise when reuse is perceived as a threat to health, purity or environmental integrity [2,20]. Health-based concerns focus on emerging pathogens and contaminants (e.g., drugs, PFAS, microplastics) [12,63–65], calling for absolute safety and framing scientific uncertainty as a form of political negligence [4,66]. Cultural and emotional framings invoke the "*yuck factor*", linking wastewater-to-drinking-water transitions to transgression and violations of moral purity embedded in shared water imaginaries [1,2,4].

In potable water reuse schemes that interact with aquifers, such as indirect potable reuse (IPR) or managed aquifer recharge (MAR), reclaimed water can alter subsurface geochemistry, mobilizing geogenic contaminants (e.g., arsenic, manganese) [67]. It may also facilitate the transport and persistence of anthropogenic compounds already present or newly introduced into groundwater systems, as recent studies document [68]. This convergence of natural and anthropogenic risks increases the complexity of water quality management and regulatory uncertainty, shifting the emphasis from treatment performance to risk governance and public acceptance [69]. Recent assessments of chemicals of emerging concern (CECs) in water reuse indicate that current regulatory frameworks still only partially capture human and environmental risks, especially for persistent compounds [70]. This concern is reinforced by recent evidence showing that aquatic chemical risk assessment remains fundamentally limited by sparse monitoring, with exposure data available for less than 1% of potentially relevant chemicals. This gap widens the divide between managed risk and actually knowable risk in potable reuse systems [71].

Ecological demands emerge when reuse is perceived to alter the dynamics of receiving bodies (rivers, aquifers, reservoirs), affecting water quality, ecosystem functioning, and associated uses, often coupled with perceived environmental and health risks. In some contexts, reuse is framed as "*hydro-social dispossession*", where technological efficiency redefines water rights [59]. In indirect potable reuse (IPR), concerns focus on potential contamination or degradation of aquifers and surface reserves used as environmental buffers or supply sources [12,59]. Risk is thus interpreted not only in health terms but as a loss of ecological and symbolic integrity, as aquifers shift from common goods to instrumental components of the urban water cycle [59]. This transformation generates disputes over environmental quality and the distribution of risks between dependent communities and beneficiaries of reused water [60].

Finally, distributive or environmental justice demands question who bears the risks and who receives the benefits [20]. When affected communities perceive that projects are imposed on their territories while the benefits are concentrated in urban or industrial sectors, rejection turns into an ethical demand for equity and redress [8]. In contexts of water stress or prolonged crisis, acceptance of reuse may become more pragmatic, but conditional [2,72]. Institutional and regulatory demands call for robust governance frameworks, ongoing audits, public monitoring of critical control points, and multiple safety barriers [23]. Here, legitimacy does not derive from blind trust in engineering, but from transparency and social oversight [1,8]. Economic and distributional demands seek a balance between financial sustainability and social justice. They call for affordable rates, subsidies for vulnerable households, tax incentives for efficient technologies, and mechanisms to prevent water

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poverty ([72]. Recent studies suggest that, in water infrastructures, NIMBY ("*not in my backyard*") type opposition is driven by perceived proximity and local externalities, whereas in potable reuse, general acceptance declines with direct consumption [73], shifting from a spatial logic (NIMBY) to a bodily one ("*not in my body*" or "*not in my tap*").

3.1.6. Repertoires of Action

Repertoires of action refer to the means through which actors express and materialize their demands and how technical controversies are converted into political action [1,7]. In conflicts over DPR/IPR, they unfold between two poles: open disruption and institutional containment. Disruptive repertoires are those capable of altering institutional routines or generating direct political costs for the authorities [34]. These include political vetoes, media campaigns and referendums that have succeeded in halting projects, as in Toowoomba (Australia, 2006) or in the initial phases of San Diego [1,7]. Strategic litigation transfers the conflict to the judicial sphere, challenging permits or licenses on the grounds of lack of transparency or participation [53] Counter-discourses, for their part, introduce narratives of suspicion (privatization, crisis manipulation, technocratic profit) that question the official narrative of necessity and redefine the conflict as a dispute over meaning [18]

The repertoires contained therein are dominated by forms of institutional advocacy within the margins of governance. Participatory governance facilitates deliberation through citizen panels, expert juries or advisory councils, transforming confrontation into collective learning [29]. Public communication and the rebranding of water, such as NEWater in Singapore or "reclaimed water" in California, seek to change the symbolic associations of reuse, transforming revulsion into technological pride or narratives of innovation [6,8,24,74]. Finally, regulatory reform constitutes a field of negotiation and gradual institutionalization of conflict, where demands are translated into norms, standards or incentives, becoming part of public policy [16].

3.1.7. Conflict Dynamics

Conflicts over DPR/IPR should be understood as dynamic trajectories, not fixed states. The same case can be viewed from different angles (e.g., *justification–acceptance* or *demands–repertoires*). Its evolution depends not only on substantive variables (health risk or "*yuck factor*"), but also on the interaction between governance deficits, legitimacy disputes and changes in the arena. As urgency and, above all, confidence in monitoring, accountability, and participation arrangements vary, actors may reformulate demands (from veto to conditional acceptance, and vice versa) and adjust repertoires (from contained to disruptive actions, and vice versa). In this process, actors operate strategically on cross-cutting factors, including knowledge management, narrative disputes, alliances and trust-building. These dynamics can amplify or contain conflict and accelerate shifts between quadrants as the debate moves across institutional participation, litigation, mobilization, and media arenas. [75]. Therefore, the typology should not be applied as a rigid framework, but as an analytical tool to track trajectories and identify critical moments where demands, repertoires, and criteria of legitimacy are rearranged.

In conflicts over DPR/IPR, the groups involved do not operate as homogeneous blocs, but rather manifest diverse, plural and, at times, fragmented social responses. Within them, sub-actors with unequal capacities for agency, differentiated frames of meaning and different thresholds of risk and legitimacy coexist [75]. Therefore, within the same scenario, different forms of conflict (resistance, negotiation, subordination and dependence) can coexist simultaneously. There is therefore no single pattern of demands or repertoires of action. The same project may face radical veto from some groups and conditional acceptance from others, depending on how each group interprets its grievances and organizes its collective experience [4].

In this context, factions and alliances tend to realign, fragment or modify their strategies, from restrained to disruptive actions and vice versa, as governance conditions and the field of confrontation change. Likewise, the position of the same actor can transform throughout the conflict, shifting between different forms of support, negotiation or resistance as the conditions of the process

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evolve. In these trajectories, actors can deploy multiple repertoires of action simultaneously or sequentially, alternating between institutional participation, litigation, mobilization and media dispute according to cycles of escalation, negotiation or de-escalation [16].

4. Discussion

Research on potable water reuse has evolved from a focus on public acceptance to broader concerns of legitimacy and governance. Harris-Lovett et al. [30], recast adoption as a problem of societal legitimacy, Binz et al. [29], emphasized the role of institutional work in constructing technological legitimacy, and Al-Saidi [2] systematized social acceptability as a process, while Moesker and Pesch [19] extend the debate toward ethical governance. From a legal perspective, Kenney [22] shows that opposition is shaped by distrust, risk perception, and regulatory design, framing resistance primarily as a governance challenge to be managed within specific institutional contexts.

Building on these contributions, this study shifts the analytical focus from conditions of acceptance and governance design to conflict dynamics. While prior work addresses legitimacy, acceptability and regulation, it rarely treats conflict as a central analytical dimension. Potable reuse is thus conceptualized as a dynamic process in which conflicts, mediated by justification, urgency and actor strategy, shape project trajectories, explaining why technically viable projects are consolidated, reconfigured or blocked across governance contexts.

Based on the dimensions identified in the previous section, the framework is articulated through three complementary matrices to examine conflicts in direct and indirect potable reuse (DPR/IPR) projects. The *Justification* × *Acceptance* (J×A) matrix diagnoses alignment between technical robustness and social legitimacy. In parallel, the *Justification* × *Urgency* (J×U) matrix introduces the pressure context, showing how water scarcity and crisis narratives reshape decision thresholds and timing without strengthening structural justification. Complementing these, the *Demands* × *Repertoires (D×R)* matrix centers agency, as actors reconfigure trajectories through the strategic mobilization of demands and repertoires, translating legitimacy configurations into outcomes such as veto, conditional acceptance, subordination or dependence. Figure 1 presents the conceptual framework used to explain the emergence, evolution, and governance implications of conflicts associated with potable water reuse.

Figure 2 presents the integrated structure of these three typologies (Justification × Acceptance, Justification × Urgency, and Demands × Repertoires). This integration enables identification of mechanisms, specification of boundary conditions by quadrant, and consistent application and comparison with empirical evidence.

4.1. Justification × Acceptance

This typology is based on two central dimensions: (i) the justification of projects, i.e., whether they are technically, economically, and legally sound or weak [17]; and (ii) the level of social acceptance, understood as the degree to which they achieve high or low levels of trust, participation, and legitimacy [19,41,76]. The intersection of these dimensions allows projects to be classified into four quadrants: (i) consolidated legitimacy (high justification + high acceptance), such as Orange County, which has managed to align technical success with a complete "legitimacy portfolio" [30]; (ii) disputed legitimacy (high justification + low acceptance), such as San Diego in the 1990s, where the support of experts and technical panels was not enough to prevent public rejection due to a lack of transparency and participation [41,53]; (iii) apparent legitimacy (low justification + high acceptance), with a high risk of reputational collapse as it is based on induced conformity or majority follow-up without real processing of technical information [24,76]; and (iv) double legitimacy deficit (low justification + low acceptance), as in certain projects in Spain conditioned by institutional fragmentation and the lack of clear regulatory frameworks for domestic use [23,77]. This typology enables analysis of project outcomes and distinguishes genuine acceptance from fragile support. Table 1 summarizes these types and Figure 1 illustrates their configuration and empirical examples.

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4.1.1. Consolidated Legitimacy

Consolidated legitimacy refers to the point at which potable reuse transitions from a controversial innovation to an integrated ordinary infrastructure, resultimg from the converge of robust technical and institutional justification with sustained social support [29,30]. Sufficient justification is not limited to the reliability of multiple barriers (e.g., membranes and advanced oxidation) [12,61]; it requires consistency between technical performance, clear institutional arrangements, and effective operational organization [17,23]. In practice, this translates into consistent alignment of policies, institutions, and regulation that supports the financial model and ensures strict compliance with public health standards [17,21].

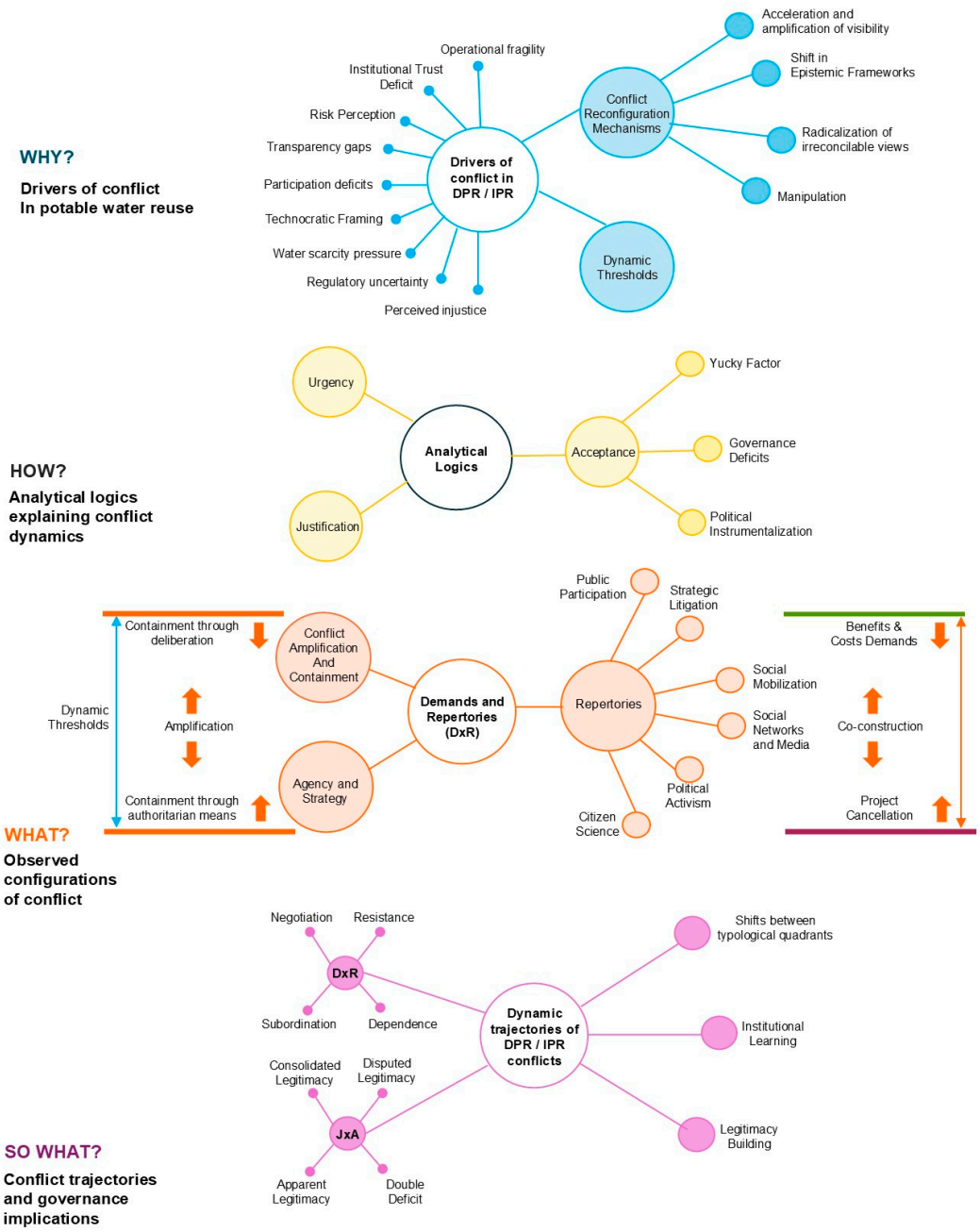

Figure 1. Conceptual framework for the analysis of conflicts over potable water reuse (DPR/IPR).

The framework shows how structural drivers, analytical mechanisms and actor strategies interact to shape the trajectories of conflicts in potable water reuse projects.

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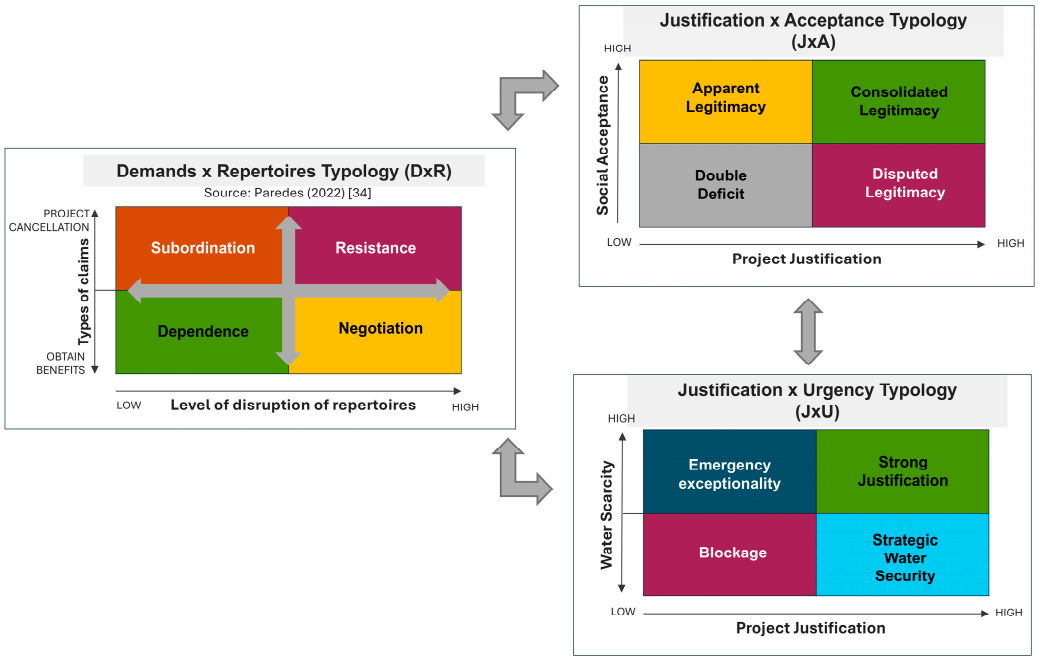

Figure 2. Integrated typological framework for the analysis of conflicts over potable water reuse.(DPR/IPR).

High acceptance is cumulative, emerging from sustained legitimacy-building beyond formal measures such as surveys, and reflected in practices, trust, and the absence of contestation [2,29]. It is based on procedural justice, participatory engagement and trust in experts, scientists and operating agencies [2,8,41]. Transparency, accompanied by verifiable "seeing is believing" mechanisms (such as plant visits and process demonstrations), acts as a critical driver in defusing the "yuck factor" and building a shared social identity between community and institution [4,19,41]. The outcome is the normalization of the resource, with reclaimed water perceived as safe, stable, and valuable within the urban portfolio, often reinforced by narratives of climate resilience and water security [6,30]. Cases such as Singapore (NEWater), Orange County (GWRS) and Windhoek illustrate this convergence between solid justification and stable social support [2,4,6,12,30,78].

Although this study uses the category of consolidated legitimacy to describe cases where high justification and acceptance converge, it should not be understood as a definitive state [29]. Legitimacy is a dynamic process that is continuously reproduced through practices of transparency, institutional learning and negotiation between actors, even in contexts of apparent stability [2,53].

Technical and institutional robustness translates into verifiable trust through transparency, regulatory compliance, and consistent operational performance. This trust, in turn, feeds back into the stability of the institutional arrangement, generating a mutually reinforcing relationship between technical performance, regulatory consistency, and social legitimacy. Under these conditions, a form of reputational resilience emerges [16]. Minor technical incidents or narrative fluctuations tend to be absorbed without triggering systemic crises, provided that mechanisms for transparency, public monitoring, and regulatory compliance remain operational [79]. Stability does not depend on the absence of risks, but rather on the existence of institutions capable of sustaining trust through verifiable performance and meaningful participation [8,80].

4.1.2. Legitimacy in Dispute

Legitimacy disputes arise in projects with sufficient justification, reliable engineering, robust alignment of policies, institutions and regulation [17,40], yet are blocked by low social acceptance [7,61]. In these cases, robustness is not limited to technological efficiency or the adoption of multiple barrier approaches. As Kaiser et al., [61] point out, it also encompasses the economic viability and legal certainty necessary to sustain the operation and financial model over time [14,17]. The

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governance of potable reuse does not depend exclusively on the technical robustness of the systems. The dispute shifts to another level, where legitimacy is eroded by mistrust of operating agencies [19,41], and persistent symbolic barriers, especially the "*yuck factor*" [1,22,24]. This scenario can be induced or intensified through political instrumentalization, where vested interests or electoral competition turn water reuse into a political dispute [40]. Narratives of suspicion and information manipulation are then mobilized to delegitimize proposing institutions and their capacity to sustain the project [7,22,53]

The conflict tends to escalate when institutions adopt a knowledge deficit approach, assuming opposition reflects technical ignorance, and follow a Decide–Announce–Defend (DAD) script [8,19]. This closes deliberative spaces and reinforces perceptions of opacity or technocratic imposition. Such an approach overlooks that perceived risk is shaped not only by technical evidence but by cultural meanings, local identity, and ethical judgments associated with water [4,8,19].

Consequently, what begins as a technical controversy can quickly turn into a political dispute, enabling citizen veto repertoires and leading to institutional paralysis [1,41].

Cases such as the Toowoomba plebiscite (Australia) and the failed WRP in San Diego and East Valley (Los Angeles) illustrate this quadrant. They show technically sound projects that failed due to suspicion campaigns ("*toilet-to-tap*"), procedural transparency deficits, or perceived environmental injustice [7,22,41]. In this sense, risk is co-produced by cultural frameworks, affect, and institutional trust. Project viability thus depends on translating technical performance into social legitimacy.

4.1.3. Apparent Legitimacy

Apparent legitimacy is characterized by projects that lack a solid structural basis but enjoy broad public support due to non-technical factors [24]. In this quadrant, insufficient justification manifests itself in the absence of coherent integration of policies, institutions and regulations, ambiguous legal frameworks or financial planning that does not ensure long-term cost recovery [17]. Likewise, weakness may arise from ineffective operational organization, insufficient certified personnel to manage complex technologies, or reliance on temporary subsidies that undermine long-term financial sustainability [21].

On the other hand, high acceptance does not necessarily arise from confidence in the project's solvency, but from powerful drivers such as climate urgency. Narratives of extreme crisis, such as the "*Day Zero*" scenario, serve to mobilize acceptance of reuse as survival necessity, often overshadowing the "*yuck factor*" and concerns about management [18]. The mechanism of social conformity also operates, as individuals follow majority behavior or norms imposed by social pressure. This produces pragmatic acceptance even without complete technical information [24].

The outcome in this quadrant is fragile legitimacy. When coordination between technical performance, institutional clarity, and operational capacity is weak [23], social support may wane if urgency declines [24,76] or a quality incident occurs [19]. In this context, a *"boomerang effect"* may emerge, affecting not only trajectories, but also delegitimizing future interventions by eroding systemic trust in the sector [18,30].

4.1.4. Double Legitimacy Deficit

The double legitimacy deficit occurs when potable reuse initiatives lack a coherent strategic basis and face outright social rejection [17,21]. The weakness manifests as misalignment among policies, institutions, and regulations, leading to fragmentation, unsustainable financial models, and limited legal capacity to guarantee long-term water security [17].

At the same time, low acceptance is shaped by the persistence of the "yuck factor" and systemic mistrust of operating agencies. This is exacerbated by perceptions of opaque or unfair processes [22,41,61], or by past failures in water management [7,8].

In this quadrant, recourse to the deficit model operates differently than in cases of disputed legitimacy. There, it tends to aggravate conflict in technically sound projects. Here, it functions as a discursive substitute for weak governance, assuming opposition stems from misunderstanding and

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relying on information or persuasion rather than correcting structural flaws. By ignoring that perceived risk is a social and psychological judgement, and that opposition reflects real governance deficits, disruptive repertoires are activated. These include referendums and campaigns of distrust, which impose high political costs and can force project abandonment [7,22,41]. The outcome is institutional paralysis, where reuse is perceived as a threat and as indicator of unreliable government management [7,19,21,22,59].

In the absence of an urgency *driver*, such as a persistent drought that provides strategic justification for the project, these dynamics may tend to generate systemic blockages. Unlike other quadrants, where one dimension can partially compensate for the other, in the double deficit there is no stabilizing element [21,38]. Without external pressure to reorder political priorities or reframe public perceptions of need, institutional weakness and low social legitimacy reinforce each other [21,80]. Projects then often enter cycles of contention, failed implementation, and rising political costs. Institutional failures, technical incidents, or communication controversies can intensify the spiral of delegitimization, deepening the distance between authorities and citizens and reinforcing perceptions of risk or injustice [38,46]. These patterns suggest that failures in reuse projects arise not only from symbolic disputes or communication deficits but from deeper governance crises. Under these conditions, strategies to improve communication or expand participation are insufficient unless institutional foundations and operational capacity are first rebuilt.

Table 1. Typology Justification × Acceptance in DPR/IPR: comparative examples.

Quadrant	Definition	Examples/Cases
B1 High justification + High acceptance.	**Consolidated legitimacy** Technical and social coherence.	**-Windhoek (Namibia)**: DPR since 1968, legitimized by extreme necessity and transparency [3,42]. **Orange County (California, USA)**: GWRS, intensive education campaigns aimed at building high acceptance [20]. **Singapore (NEWater)**: national pride, positive framing [6,81]. **Perth (Australia):** Beenyup aquifer recharge project (2010). Justified by a 50-year strategic plan and legitimized after an open data pilot that generated institutional trust [16]. **El Paso (Texas):** Desert city with a culture of scarcity where 84% of the community supports direct potable reuse due to transparent and diversified resource management [15]

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Quadrant	Definition	Examples/Cases
		Toowoomba (Australia): Rejected in a 2006 referendum despite severe drought [7]. **San Diego (USA, 1990s)**: projects blocked by "toilet-to-tap" framing [53]. **East Valley, Los Angeles (USA):** Technically viable 38,000 m^3/d IPR project with infrastructure built in the late 1990s.
B2 High technical justification + Low social acceptance.	**Contested legitimacy** Rejection despite technical soundness.	It was blocked politically in 2000 due to criticism of lack of transparency, forcing the water to be redirected to non-potable uses [16]. Canberra, Australia. IPR plan proposed during the *Millennium Drought*. It was rejected in public consultation, showing that the provision of official scientific information failed to reverse polarization or perceptions of risk among skeptical groups [16].
B3 Low technical justification + High acceptance (superficial or induced).	**Apparent legitimacy** Acceptance induced by urgency. Stability is fragile, collapsing in the face of incidents.	- **Spain (law prohibits DPR, but high acceptance of agricultural reuse)**: confused social perception affecting legitimacy. [59,77] - Cases with official campaigns presenting DPR as a "technological fad" without real need [2,18] - **Technocratic authoritarianism**: when acceptance is manufactured (state media, censorship, clientelism) without solid technical justification [4,53].
B4 Low justification + Low acceptance	**Double legitimacy deficit** Projects blocked from the outset. Design flaws, high costs, or lack of urgency or water scarcity that would make them necessary.	DPR proposals in contexts without real water shortages (e.g., cities with abundant surface water sources). Pilot attempts discarded due to excessive costs or total lack of social support **Cloudcroft, New Mexico,** Sardana et al., (2025) [21] **Scotland, United Kingdom**, Duckett et al., (2024) [38]

4.2. Justification x Urgency (Decision-Making Context)

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The *Justification* × *Acceptance* typology, complemented by Justification × Urgency, frames DPR/IPR conflicts as processes linking technical feasibility with social and political dynamics, where governance legitimacy becomes decisive. It differentiates when justification translates into legitimate acceptance. Incorporating urgency and legitimacy explains why some projects consolidate as reliable infrastructure while others fail despite having equivalent technology.

A key point is that water urgency does not automatically translate into a robust justification [18]. Urgency refers to the context of pressure imposed by scarcity, drought or a supply crisis, while justification denotes the technical, economic and institutional-regulatory soundness of the project, assessed in relation to available alternatives [14,38]. Furthermore, urgency can operate in two dimensions that do not necessarily converge**,** since perceived urgency (political/social) does not always coincide with objective hydrological urgency [18,38].

In some cases, high urgency and high justification coincide, as in Windhoek (Namibia**)**, where chronic drought forced the development of a solid and sustained DPR scheme [3,42]. However, there are also contexts in which urgency drives decisions with weak justification, such as in Wichita Falls (USA, 2014), where an emergency 19 MLD DPR plant was operated for 377 days under a stage-4 drought emergency [12,47]. Extreme urgency enabled rapid alignment among authorities, experts, and stakeholders around the need to secure supply, supported by intensive transparency measures, including a 45-day verification trial, full regulatory compliance, and dedicated public communication. This configuration, however, was contingent on the persistence of scarcity. Record rainfall in May 2015 rapidly restored reservoir levels and reduced perceived necessity. The project was discontinued and reconfigured into a permanent IPR scheme, showing how urgency-driven legitimacy can dissolve once structural pressure subsides.

Conversely, a project may have strong justification even without immediate urgency, as in Singapore, where the NEWater program was adopted as a long-term water security strategy despite the availability of other sources [6,81]. Since 2003, IPR and DPR have been implemented as part of a national self-sufficiency agenda, supported by a high alignment between justification and acceptance through a national security framing. The Public Utilities Board (PUB) and expert panels promoted a closed water loop to reduce dependence on imports. This strategy combined technological validation with symbolic repertoires, including the "Four National Taps" narrative, NEWater branding, public engagement, and political endorsement. A key turning point was the shift from technical communication to a broader narrative linking water to national survival. The program has since consolidated, supplying a significant share of national demand, illustrating how legitimacy can be stabilized through symbolic performance and strong institutional alignment.

Finally, low urgency can undermine technically well-founded projects, as in early cases in Los Angeles and San Diego, where reuse was rejected because it was not perceived as an immediate need [1,8]. In San Diego, an IPR scheme was proposed despite reliance on imported water and regulatory pressure to reduce ocean discharge. High institutional justification coexisted with low social acceptance and fluctuating urgency. Opposition mobilized "*toilet-to-tap*" narratives and environmental justice claims. Following the 1998 NRC report and rejection by a local expert panel, the project was cancelled. The case shows how weak perceived necessity allows risk narratives to be converted into an effective veto by opposing actors.

These combinations show that urgency acts as a catalyst, while not replacing the need to rigorously justify the option of potable reuse [6,58]. The divergence between hydrological reality and the public narrative of crisis is explained not only by data but also by political, communicational, and technical-institutional mechanisms [18,61]. These mechanisms reconfigure how scarcity is perceived and what decisions become "possible" under pressure. Warner and Meissner [18] identify four recurring mechanisms. First, scarcity operates as a political framework. Beyond its biophysical basis, it is socially constructed and reflects disputes over distribution, responsibility, and the desired water order [61]. In this sense, it can be instrumentalized to legitimize extraordinary interventions that, under normal conditions, would face greater opposition [19]. Second, urgency functions as an affective condition, in which narratives of extreme crisis channel uncertainty into emotional

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responses such as anxiety, fear, or solidarity. This generates an "emotional convergence" that facilitates acceptance of measures and technologies under pressure, rather than through rational deliberation [24,76]. Third, manufactured crises and their spectacle dimension, where certain actors semantically intensify the threat to accelerate decisions and break institutional inertia [19]. When debate shifts from evidence to media drama, the state and project developers may gain capacity for action. However, the risk of a boomerang effect increases if the crisis is deactivated without substantive changes in environmental conditions. Fourth, the fallacy of predictive certainty consists of setting exact dates for collapse ("*doomsday clock*") to convey a certainty that hydrology, due to its structural uncertainty, rarely allows. Although this narrative may enable extraordinary decisions in the short term, if the forecast does not materialize as announced, technical credibility is eroded. This opens space for accusations of instrumentalization or fabrication of the crisis [18]. It may also generate a boomerang effect on the agendas initially promoted.

Table 2 operationalizes the *Justification* × *Urgency* typology as an extension of the *Justification* × *Acceptance* dimensions, showing how combinations of water pressure and technical-institutional strength shape legitimacy trajectories in DPR/IPR projects. By classifying cases into four quadrants, the table shows that urgency acts as a contextual catalyst, not a substitute for justification. Political sustainability ultimately depends on alignment between the technical basis, public narrative, and verifiable governance.

Table 2. Justification × Urgency Typology in DPR/IPR Conflicts – Comparative Examples.

Quadrant	Definition	Examples
A1. **High justification + High urgency**	**High justification and urgency** Projects perceived as indispensable: solid technical basis and evident water crisis.	**Windhoek (DPR):** du Pisani (2006) [3]; van Rensburg (2016) [78]; Aleksić & Šušteršič (2022) [42]; **Orange County:** Ormerod et al [20]; Markus and Torres (2020) [9];
A2. **Low justification + High urgency**	**Emergency exceptionality** Urgency enables hasty solutions: deliberation and safeguards are cut short. Acceptance is pragmatic but volatile; if the crisis subsides or there is an incident, the "boomerang effect" may occur.	**Wichita Falls (DPR 2014**): Jeffrey et al. (2022) [12]; Mukherjee & Jensen. (2020) [16]. **Cape Town (*Day Zero*):** Warner & Meissner (2021) [18]; Ziervogel (2019) [26]
A3. **High justification + Low urgency**	**Strategic Security** Solidity without immediate scarcity. Anticipatory projects for water security and long-term resilience. Legitimacy is built without the coercion of immediate scarcity, often as state policy	**Singapore (Netzer):** Lefebvre (2018) [6]; Lee & Tan (2016) [58]; Tortajada & Bindal (2020) [81] **Los Angeles (Operation NEXT):** Binz et al (2016) [29]; Ormerod et al (2019) [20]
A4. **Low justification + Low urgency**	**Structural Blockage** Projects without urgency or sufficient technical basis, exposed	**San Diego (1990s):** Hartley (2006) [53]; Mann (2021) [8];

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Quadrant	Definition	Examples
	to rejection or abandonment. Scenario where counter-narratives (toilet-to-tap stigma) and perceptions of environmental injustice thrive due to insufficient justification to society	Smith. (2018) [1]

4.3. Demands and Repertoires

In DPR/IPR contexts, social and political demands cover issues such as water safety and quality [4,19], distributive justice in costs and benefits [15,51], transparency in management, and institutional trust [8,20]. In turn, actors deploy diverse repertoires ranging from technical and regulatory legitimization through the support of experts and agencies [4,29] and the use of 'purified water' narratives [1,22]. They also engage in social and political contestation through media campaigns [6,53], referendums, strategic litigation and urban protests [1,7,18,26].

Based on the interaction between the actors' objectives (demands for cancellation or benefits) and the resources mobilized (disruptive repertoires or content), four quadrants are configured. These summarize the most recurrent scenarios: resistance, negotiation, subordination and dependence. Each reflects not only positions toward DPR/IPR, but also the capacity for social agency [2,19,20] and how the socio-technical legitimacy of governance is constructed or eroded [1,19,30].

This typology extends the Justification × Acceptance framework. It shows that conflicts are shaped by technical soundness, social trust, and the interaction between collective demands and the forms of action used to defend them. Sardana et al., [21] offer a systematic inventory of technical, institutional, and sociocultural drivers and barriers that tend to enable or hinder the deployment of DPR/IPR. This analysis shows that these factors do not operate automatically and are instead shaped by actor strategies, agency, and repertoires [34]. Conflicts do not evolve linearly , but rather through critical moments that reconfigure perceptions of risk, alliances and repertoires of action [21,34]. From this perspective, the proposed typologies allow controversies to be studied as processes of strategy and instrumentalization of factors.

Figure 3 summarizes these dynamics by showing temporal trajectories of conflict and legitimacy in potable reuse projects. The cases analyzed suggest that projects do not always remain in a stable configuration. Many cases transition across quadrants as institutional responses, technological validation, and public narratives underpinning legitimacy evolve.

Conflict trajectories are not static. They are shaped by relational balances and power asymmetries between actors, allowing cases to move between quadrants as governance conditions or environmental contexts change. Ultimately, the outcome of the project depends on the ability of actors to rearrange alliances and innovate tactically. They also depend on shifting the balance between basic benefits and demands for total cancellation [34,75].

4.3.1. Resistance

Resistance conflicts emerge when social and opposition actors prioritize cancellation and deploy highly disruptive repertoires, such as media campaigns, protests, blockades, litigation, or referendums [7,21,22]. These cases reflect contexts in which the "yuck factor" and institutional mistrust interact to produce outright opposition [22–24]. In this quadrant, conflict remains high and the most likely outcome is cancellation, unless there is a significant change in governance and communication strategies [21,22].

The Toowoomba referendum (Australia, 2006) is a paradigmatic case. Although the IPR project had a solid technical basis, organized social mobilization, with disruptive tactics (referendums, fear-mongering media campaigns), forced the project to be cancelled [7]. The *toilet-to-tap* campaign turned

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perceptions of health risks and feelings of injustice into far-reaching political opposition, ultimately leading to the project's definitive rejection [1,21]. A similar trajectory had been observed in San Diego during the 1990s, where the narrative of symbolic contamination also eroded public confidence and delegitimized the project despite its technical viability [1,8].

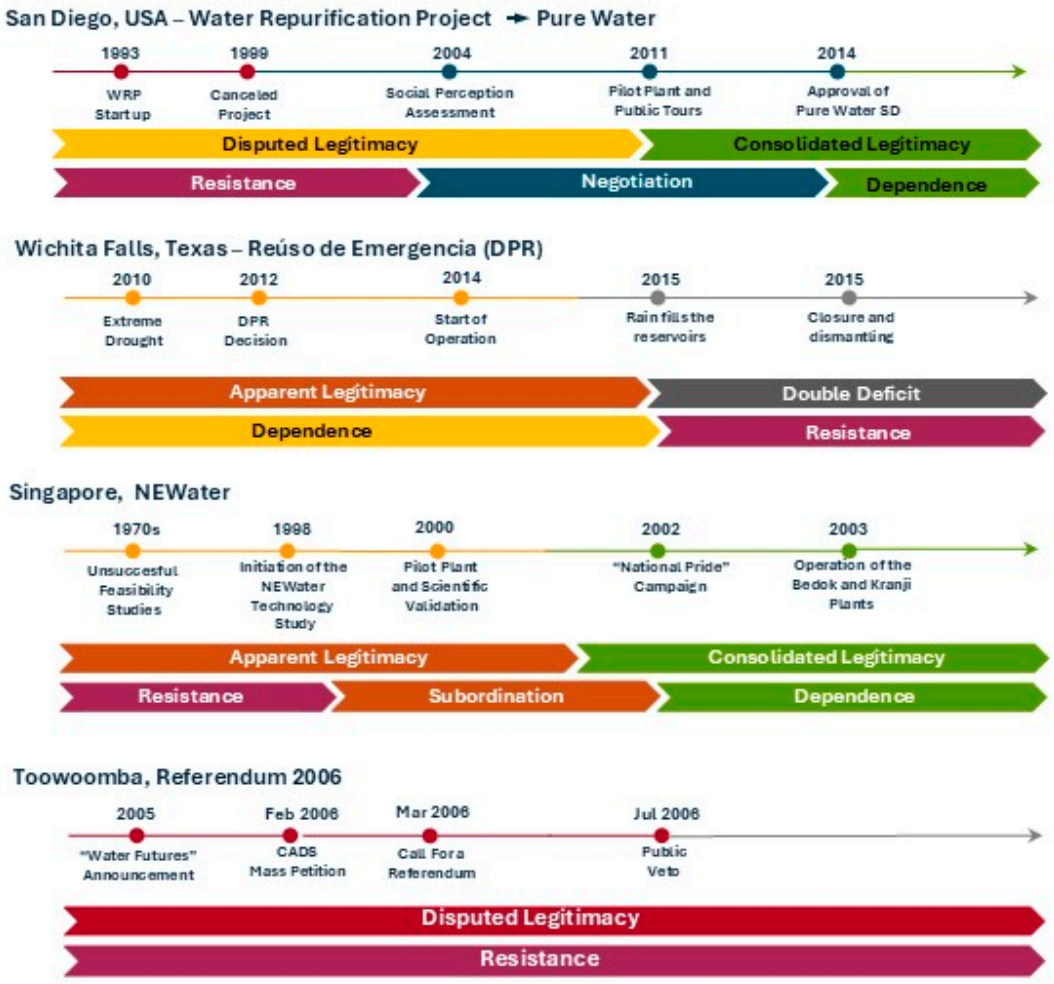

Figure 3. Temporal trajectories of conflict and legitimacy in potable water reuse projects (DPR/IPR).

This configuration can be interpreted as a cumulative legitimacy deficit. Perceptions of technical inadequacy, lack of institutional transparency, and distributive injustice combine to erode social recognition of the project [4,29]. When this rupture becomes entrenched, technical rationality is no longer perceived as a legitimate solution. The conflict can then take the form of a sustained veto, in which infrastructure is perceived as a risk or an imposition rather than a response to water scarcity [7]. In these contexts, conflict tends to intensify symbolically [18]. Narratives of risk or stigmatization reinforce opposition, and any technical incident or media controversy can consolidate rejection and hinder its transformation into negotiation [53]. Resistance thus stabilizes as a logic of blockage that transcends the technical evaluation of the project and is inscribed in broader dynamics of institutional mistrust [60].

4.3.2. Subordination

Subordination emerges when communities reject DPR/IPR or when public acceptance is low or ambivalent. However, repertoires of action remain weak. This may result from limited organizational capacity and resources, fear of institutional reprisals, or the absence of strategic alliances. It may also reflect high mobilization costs, structural dependence on supply authorities, or a lack of effective

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repertoires of action to contest decisions under fragmented responsibilities and weak political leadership [23,34].

This scenario often occurs in contexts of power asymmetry [19] or weak institutions [23]. In these settings, rejection is manifested as latent mistrust linked to opaque processes or past regulatory failures, or as resigned silence when meaningful opportunities for participation or contestation are absent [4,19]. The dominant mechanism is structural containment of the conflict, where mistrust or skepticism does not disappear but remains at latent levels due to the perception that the opposition lacks political or institutional viability. In this configuration, there is no active conditional acceptance or robust delegated trust. Instead, it reflects a form of resigned compliance in which disagreement does not translate into an effective veto.

This was observed in cases in Texas, where up to 45% of the population was unaware of project implementation. As a result, protest capacity remained limited, with opposition expressed as latent mistrust that could escalate if the project failed or environmental conditions changed [82]. Another illustrative example is "de facto reuse", where wastewater, treated or untreated, is discharged into rivers that then supply aqueducts without public deliberation or citizen participation [50,83]. Rejection is expressed latently, without the capacity for effective action, and often appears as passive or apparent acceptance of an invisible health risk. However, this acceptance lacks legitimacy or remains highly fragile, and is vulnerable to health crises or technical failures [12,16,29]. Obedience is forced rather than assumed, and is sustained by the inability to act, fear, disarticulation, or institutional weakness [34].

Under these conditions, projects can move forward with little visible public mobilization, even though critical narratives persist at the informal or symbolic level [1,23]. The absence of open protest does not imply social consensus, but rather the coexistence of latent disagreement with structural limitations on collective action. Trust in authority may remain minimal or instrumental, with project implementation relying more on the lack of veto capacity than on fully consolidated legitimacy. In contexts with high water scarcity, this subordination may stabilize temporarily if necessity reduces incentives for mobilization [38]. However, the balance remains fragile, as technical incidents, media controversies, or shifts in risk perception can activate latent conflict and rapidly transform subordination into open resistance.

4.3.3. Negotiation

The *Negotiation* quadrant is configured when the technical and institutional justification for the project is recognized as sufficient or necessary, but social acceptance remains conditional. Communities do not necessarily seek cancellation. Instead, they accept DPR/IPR conditionally in exchange for redefining the conditions under which it is implemented [8]. Conflict does not operate as a veto, but as a strategic resource for reconfiguring the risk governance framework.

The repertoires of action tend to be intense and disruptive, including litigation, political pressure, referendums, or media campaigns. They seek to exploit controversy to force institutions to open spaces for dialogue, renegotiate the distribution of costs and benefits, or guarantee higher standards of technical and environmental safety [22,84]. Actors may recognize the need for water infrastructure, especially in contexts of water scarcity or vulnerability, but they question technical rigor, operational transparency, and meaningful participation in decision-making spaces, governance, and water quality monitoring [23]. Consequently, they demand mechanisms such as co-monitoring, institutional adjustments, meaningful participation, tariff adjustments, additional quality guarantees, or accountability mechanisms. When these demands are credibly incorporated, negotiation tends to stabilize acceptance and reduce conflict, shifting cases towards more robust configurations of legitimacy. If they are dismissed or perceived as symbolic, trust in dispute can turn into explicit veto, and the conflict shifts to the resistance quadrant.

The case of San Diego illustrates this trajectory. After strong opposition in the 1990s under the "*toilet-to-tap*" narrative, the program was revived in the mid-2000s and reoriented toward co-creation. Demonstration projects, independent expert panels, and sustained outreach helped align justification

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and acceptance, while recurrent droughts reinforced urgency [1,15]. Proponents, including Pure Water SD and the Water Reliability Coalition, advanced water independence through "*seeing is believing*" strategies such as plant tours, taste tests, and rebranding as purified water. A key turning point was the shift from limited stakeholder engagement to broad, citywide participation. The program is now consolidating, with full-scale implementation underway, illustrating how anticipatory legitimacy-building and coalition-based agency can transform opposition into support.

Negotiation can transform conflict into a space for institutional learning and trust-building, allowing public support to increase significantly. However, risks of backsliding persist if agreements are not perceived as respected or if the perception of urgency due to drought diminishes [1].

In intensive reuse contexts such as the Segura basin (Murcia) and the Llobregat axis (Catalonia), although the predominant uses are not DPR/IPR but agricultural and industrial reuse, the literature shows a consistent logic of transactional negotiation. Actors accept reuse as a strategic resource, while conditioning its expansion on disputes over cost recovery, treatment levels, tariffs, and supply guarantees in the face of drought [85,86]. These controversies show that the conflict does not necessarily seek to block reuse, but rather to renegotiate its distributive and regulatory framework.

This pattern does not apply when acceptance is full and sustained without conditions, in which case negotiation loses its centrality. Nor does it apply when water urgency induces technocratic delegation or "*delegated acceptance*" based on survival, without demands for institutional redesign [2]. Likewise, it does not describe cases of insufficient technical justification, which tend towards structural blocking or the definitive cancellation of the project [7].

This quadrant shows that conflict in potable reuse projects is not a binary choice between acceptance or rejection; it functions as a mechanism for institutional adjustment [1,34]. In this sense, legitimacy in DPR/IPR tends to take on a transactional and procedural character, built through the redefinition of responsibilities, standards and forms of social control, rather than through the mere technical demonstration of viability [29,30,60].

Negotiation can express disputed legitimacy, when actors seek to condition or correct a project they consider insufficiently justified or governed. It can also reflect legitimacy under construction, when interaction takes the form of institutional co-creation aimed at building trust, adjusting safeguards, and co-producing conditions of acceptability [1,29].

In this sense, negotiation is not a homogeneous quadrant; it spans configurations from conditioning dispute to collaborative co-construction of legitimacy [34]. Thus, different forms of negotiation can coexist within the same case, from adversarial approaches aimed at imposing conditions to cooperative modes of co-producing trust. Negotiation functions as both a repertoire for containing conflict and a mechanism of transition through which legitimacy can shift from initial dispute to collective construction and eventual consolidation.

4.3.4. Dependency

Conflicts characterized by dependency arise when actors make demands for basic benefits (water security, quality, continuity of service), compensation, or specific adjustments. Such demands are accompanied by low repertoires of action, expressed through institutional and technical channels. This configuration emerges when acceptance is sufficient to allow implementation. It is based mainly on delegated trust in technical authority rather than on intense public deliberation or explicit negotiation of conditions [4,16]. It typically occurs in contexts of extreme water urgency, where the DPR/IPR is perceived as the only viable alternative to ensure supply.

The dominant mechanism is delegated legitimacy based on necessity, in which citizens explicitly or implicitly trust the technical competence of operators and regulators to manage complex risks and guarantee the safety of the system [12,79]. In this scenario, low levels of conflictive mobilization, restrained repertoires and a public narrative focused on the inevitability or technical rationality of the project predominate.

This dependence does not imply automatic legitimacy, and its stability depends on operators maintaining high technical, regulatory, and communication standards [3,79]. In this framework,

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dependence refers not to the universal biological need for water, but to socio-institutional reliance on infrastructure and its regime of operation and control. The need for service continuity raises the cost of veto and reduces the political margin for opposition [21]. Unlike subordination, where opposition is absent due to lack of veto power, in dependence veto is avoided because its cost is too high (risk of shortages) and minimal trust is placed in the operator [30].

Unlike extractive conflicts such as mining, where dependency is typically ren-tier-territorial (e.g., employment, wealth distribution, social investment) and raises the opportunity cost of opposition [34], potable reuse projects are characterized by infrastructural dependency on supply security. In this context, veto implies an immediate risk of shortage of a vital resource [3,42]. Therefore, stability depends less on economic compensation than on verifiable performance, transparency, and the absence of incidents. When these conditions fail, delegation quickly turns into contested trust, triggering negotiation or resistance.

In passive dependency, acceptance is often resigned but not driven by political or organizational incapacity. Doubts may persist, yet latent rejection is less marked than in subordination. Even when capabilities exist, actors refrain from veto or escalation because the cost of opposition is too high, risking supply continuity, quality, or security under scarcity and lack of alternatives [4,24]. Trust is, therefore, a pragmatic delegation of technical authority (delegated epistemic legitimacy), sustained insofar as operational performance and transparency are maintained [76]. Communities accept the solution out of necessity for service continuity, even without initial conviction. A representative example is Windhoek in its early decades, where acceptance was driven by the lack of water alternatives and extreme aridity. This occurred before public participation was considered crucial for project implementation [21,22].

Active dependence leads to a more consolidated legitimacy in which the population not only accepts but internalizes the DPR/IPR as part of its water identity [24,76]. In economic terms, the system enters a phase of infrastructural normalization. As verifiable water security benefits (continuity, quality and risk reduction) accumulate and high justification and acceptance are sustained over time, the conflict shifts from a legitimacy dispute (J×A) to routine governance with low repertoires (D×R). Cases such as Singapore (NEWater) and Orange County illustrate this trajectory, where, after decades of institutional construction and transparency, reuse stabilizes as a public asset associated with resilience and sustainability [21,22]. Social participation does not disappear, but it takes on a mainly regulatory-informal role of social control (monitoring, surveillance and verification), rather than active dispute [23,30].

Under this configuration of active dependency, the system tends to stabilize, though not necessarily in a deliberative form. Dependency shifts from resignation to functional institutional trust, reducing the need for social mobilization [48]. This stability depends less on intense participatory procedures than on operational continuity and the absence of health crises or transparency controversies [79]. If such events occur, or if the perceived urgency diminishes significantly, delegated trust can quickly transform into contested trust, shifting the case towards negotiation or even resistance [42].

This configuration does not apply when acceptance is merely apparent and masks underlying mistrust (subordination), or when explicit demands for institutional redesign signal a shift towards conditional acceptance (negotiation). Nor does it describe contexts where technical justification is widely questioned, since in such cases epistemic legitimacy fails to sustain acceptance. This quadrant shows that stability in DPR/IPR projects can, in many cases, be based on a pragmatic delegation of authority rather than on deliberative consensus. Such legitimacy is functional under conditions of scarcity and high need, but it is structurally fragile and susceptible to abrupt reconfigurations in the face of contextual changes or institutional failures [38,76].

4.4. Practical Implications

4.4.1. Implications for Potable Reuse Projects

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From an implementation perspective, potable reuse is more likely to succeed when treated as a process of anticipatory legitimacy-building rather than a predefined technical solution. Previous studies highlight governance alignment, participation, and trust as enabling conditions [19,69]. However, the analysis suggests that viability is strongly shaped in early stages. It depends on the capacity of developers to align institutions, frame necessity, build coalitions, and establish credible conditions for participation and trust, even if subsequent interactions reconfigure legitimacy conditions. This implies that early stages should prioritize actor mapping, interest alignment, identification of veto points, and assessment of the strategic capacity of developers.

At the same time, consistent with conflict and governance literature on actor strategies [34], opposing actors mobilize demands, narratives, and repertoires that position projects across configurations of resistance, negotiation, subordination, or dependence. In practical terms, these configurations shape the governance responses required and drive trajectories of escalation or containment. Project developers must therefore anticipate and adapt to evolving opposition, particularly under conditions of low trust or high disruption.

The analysis suggests that viability depends on the capacity to govern conflict as a constitutive dimension of the project rather than an external constraint. Building on approaches that emphasize participation, transparency, and oversight as pillars of legitimacy [16,17,23], the typological framework can be read as a tool to support the sequencing of interventions and respond to shifting legitimacy conditions. Under this perspective, success emerges from the strategic interplay among competing forms of agency, where alignment, contestation, and negotiation define what is politically and socially achievable.

4.4.2. Policy Implications for Water Governance

A central implication of the framework is the need to distinguish between system-level governance and project-level conflict governance. Existing scholarship frames potable reuse governance through regulatory coherence, institutional capacity, technological standards, public trust, risk communication, and water scarcity as structuring conditions of legitimacy [17,29,30]. These factors define baseline governance environments. By contrast, at the project level these conditions are enacted and contested through actor demands, narratives, and repertoires, so that local disputes reflect broader governance tensions rather than isolated failures.

A key implication of this analysis is that governance should be understood not only as institutional design, but as a field of collective strategic agency. Rather than being defined primarily by formal arrangements emphasized in existing scholarship [16,34], governance here emerges from the interaction of distributed and unequal actor capacities.

From this perspective, the central governance challenge in lies in configuring institutional environments capable of absorbing conflict, processing strategic interaction, and sustaining legitimacy across scales. This perspective suggests shifting the evaluation of governance from formal design alone toward agential performance. In this sense, governance is understood as the capacity to activate constructive agency (coalitions, credible spokespersons, mediation, trust-building), channel conflictive agency to prevent escalation into veto or polarization, and contain opportunistic agency that exploits narratives of risk, disgust, urgency, or injustice.

In some cases, this may also imply that failure or blockage reflects a corrective capacity of governance, particularly where reuse projects are poorly justified, prematurely advanced, or weakly [7,17,19]. Governance should therefore be assessed not by whether projects advance, but by its ability to discriminate between viable, fragile, and inappropriate interventions, and to produce the appropriate outcome in each case (stabilisation, redesign, containment, or blockage).

5. Conclusions

This article proposes an integrated typological framework to analyze conflicts surrounding potable water reuse (DPR/IPR), articulating three dimensions: *Justification* × *Acceptance*, *Justification* × *Urgency*, and *Demands* × *Repertoires*. Rather than attributing outcomes to technological maturity or

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scarcity alone, the framework shows that reuse projects are political processes in which governance legitimacy mediates between technical feasibility, contextual pressure, and actor agency.

The *Justification* × *Acceptance* typology distinguishes consolidated, disputed, apparent, and deficit legitimacy, showing that acceptance does not follow technical soundness. The *Justification* × *Urgency* typology indicates that crisis can catalyze decisions but does not substitute for robust justification or ensure political sustainability. The *Demands* × *Repertoires* dimension highlights the agency of the actors, showing how trajectories shift between resistance, negotiation, subordination, and dependence over time.

The proposed framework seeks to contribute to a more accurate understanding of how legitimacy is built, or eroded, in highly sensitive water infrastructure projects. In this sense, potable reuse is also a field of dispute where risks, justice, and authority are negotiated. Understanding these typological configurations is key to designing water policies that are not only technically sound, but also socially and politically sustainable.

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Appendix A. Cases of DPR/IPR Used in the Analysis

This appendix presents the list of cases of potable water reuse that make up the documentary corpus used to define the typological framework developed in this study. The corpus includes 25 documented cases of direct potable reuse (DPR) and indirect potable reuse (IPR) identified from academic literature, technical reports, and contextual sources. Each case was classified according to the three analytical typologies used in the article: *Justification* × *Acceptance (J×A), Justification* × *Urgency (J×U) and Demands* × *Repertoires (D×R).* The classification reflects the predominant configuration identified from the analysis of the literature and, where possible, the trajectory observed in the evolution of the conflict. The corpus is not intended to be exhaustive, but rather to provide a comparative empirical basis for illustrating the analytical framework and the diversity of governance trajectories associated with potable water reuse projects.

Table A1. DPR/IPR cases used in the analysis.

Case/Project	City/Region	Country	Type of reuse	References	J×A - Quadrant	J×U - Quadrant	D×R - Quadrant
San Diego (1990s)	California	USA	IPR	(Hartley, 2006); (Kenney, 2019)	B2 (Disputed legitimacy)	A3 (Strategic Security)	Resistance
San Diego (Pure Water)	San Diego, CA	USA	IPR → DPR	Hartley (2006); Mann (2021); Kenney (2019)	B2 → B1 (Disputed Legitimacy → Consolidated Legitimacy)	A3 (Strategic Security) → A1 (Justification/Urgency)	Resistance → Negotiation
Toowoomba	Queensland	Australia	IPR	Hurlimann & Dolnicar (2010)	B2 (Legitimacy disputed)	A1 (High Justification/Urgency)	Resistance

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Windhoek (Goreangab)	Windhoek	Namibia	DPR	du Pisani (2006); Australian WRC / Swarz (2015); (Harris-Lovett, 2015);	B1 (Consolidated legitimacy)	A1 (High Justification / Urgency)	Subordination
Orange County (GWRS)	California	USA	IPR	Markus & Torres (2019); Ormerod (2017)	B1 (Consolidated legitimacy)	A1 (High Justification/Urgency)	Negotiation
Singapore (NEWater)	Singapore	Singapore	IPR/DPR	Lee & Tan (2016); Lefebvre (2018); (Lefebvre, 2018);	B1 (Consolidated Legitimacy)	A3 (Strategic Security)	Subordination → Dependency
Wichita Falls (Emergency)	Texas	USA	DPR → IPR	Australian WRC / Swarz (2015); Aleksić (2022); Jeffrey (2022)	B3 → B4 (Apparent Legitimacy → Double Deficit)	A2 (Emergency Exceptionality → A4 (Structural Blockage)	Dependency
Perth (Beenyup)	Western Australia	Australia	IPR	Mukherjee & Jensen (2020)	B1 (Consolidated Legitimacy)	A1 (High Justification/Urgency)	Negotiation
Cape Town (Day Zero)	Cape Town	South Africa	IPR/DPR	Warner & Meissner (2021); Ziervogel (2019)	B3 → B2 (Apparent legitimacy → Disputed legitimacy)	A2 (Emergency exceptionalism → A4 (Structural deadlock)	Dependence → Resistance
Big Spring	Texas	USA	DPR	Aleksić & Šušteršič (2022); Scruggs (2020)	B1 / B3	A1 (High Justification / Urgency)	Subordination → Dependency
Cloudcroft	New Mexico	USA	DPR	Aleksić & Šušteršič (2022); Scruggs (2020); Sardana (2025)	B2 (Disputed Legitimacy) → B4 Double Deficit	A1 (High Justification/Urgency)	Resistance
East Valley (L.A.)	Los Angeles	USA	IPR	Mukherjee & Jensen (2020); Markus (2019); Sardana (2025)	B2 (Contested Legitimacy)	A3 (Strategic Security)	Resistance
Canberra	Canberra	Australia	IPR	Mukherjee & Jensen (2020); Smith (2018)	B2 (Disputed Legitimacy)	A1 (High Justification/Urgency)	Resistance
Tampa	Florida	USA	IPR	Mukherjee & Jensen (2020)	B2 (Contested Legitimacy)	A3 (Strategic Security)	Resistance

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Torelle (Wulpen)	Flanders	Belgium	IPR	Van Houtte & Verbauwhede (2012)	B1 (Consolidated legitimacy)	A3 (Strategic Security)	Dependency
Upper Occoquan	Virginia	USA	IPR	Angelotti & Grizzard (2013)	B1 (Consolidated Legitimacy)	A3 (Strategic Security)	Negotiation → Dependence
Beaufort West	Western Cape	South Africa	DPR	Aleksić (2022); WRC (2015)	B1 (Consolidated legitimacy)	A1 (High Justification/Urgency)	Dependency
Brownwood	Texas	USA	DPR	Scruggs et al. (2020)	B3 (Apparent Legitimacy) → B2 (Disputed Legitimacy)	A2 (Emergency Exceptionalism) → A3 (Strategic Security)	Resistance
Monterrey (IHSAP V)	Monterrey	Mexico	DPR/IPR	(Juárez Ramírez, 2022)	B3 → B1	A1 (High justification/urgency) → A3 (Strategic security)	Dependency
El Paso	Texas	USA	DPR		B1 (Consolidated Legitimacy)	A3 (Strategic Security)	Negotiation
Dublin San Ramon	California	USA	IPR	(Marks, 2006)	B2 (Contested Legitimacy)	A3 (Strategic Security)	Resistance
Western Corridor	Queensland	Australia	IPR	(Sardana, 2025)	B3 → B4 (Apparent Legitimacy → Double Deficit)	A1 (High Justification/Urgency)	Resistance
Torreele	Koksijde	Belgium	IPR	(Frijns, 2016); (Smith, 2018)	B1 (Consolidated legitimacy)	A3 (Strategic Security)	Dependency
eThekwini	Durban	South Africa	Potable	(Kaiser et al., 2024)	B2 (Contested Legitimacy)	A3 (Strategic Security)	Resistance
Yarkon River	Tel Aviv	Israel	IPR	(Garcia & Pargament, 2015)	B1 (Consolidated Legitimacy)	A1 (High Justification)	Dependency
Pure Water Monterey	Monterey County, California	USA	IPR	Monterey One Water / Pure Water Monterey; WateReuse (2024/2025)	B1 (Consolidated legitimacy)	A3 (Strategic security)	Negotiation

Appendix B. Typological Coding Framework

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This Appendix formalises the coding logic underlying the three typological matrices (J×A, J×U, D×R), translating the conceptual framework into a structured and replicable analytical protocol. While the dimensions are defined as discrete variables, configurations are treated as dynamic process states. Project trajectories emerge from shifting interactions between structural conditions, pressure contexts and actor strategies, rather than fixed categorical positions.

Table A2. Core Dimensions.

Dimension	Operational definition	Indicators	Coding	Thresholds
Justification (J)	Technical, economic, legal and institutional robustness, independent of urgency	Reliability; regulation; cost-benefit; operations; financial viability	High: multi-domain coherence; Low: structural weakness	Urgency never upgrades Justification. Require ≥2 domains aligned (technical + regulatory/economic/operational).
Acceptance (A)	Social support and trust beyond passive compliance	Trust; participation; transparency; narratives; support/rejection	High: sustained, trust-based support; Low: mistrust, stigma, veto	Survey approval alone insufficient. Must include legitimacy-building mechanisms.
Urgency (U)	Hydrological or perceived pressure shaping decisions	Drought; supply risk; crisis discourse; acceleration	High: alters thresholds; Low: non-crisis context	Distinguish objective vs constructed urgency; both valid if decision-shaping.
Demands (D)	Orientation of claims from cancellation to conditional acceptance	Cancellation calls; risk framing; safeguards; equity demands	High: blockage; Low: conditional acceptance	Code dominant orientation, not isolated claims.
Repertoires (R)	Disruptive capacity of action	Protest; litigation; referendum vs participation, negotiation	High: disruptive; Low: contained/weak	Rhetoric ≠ disruption. Code effective capacity.

Table A3. Justification x Acceptance (J×A). Legitimacy configuration.

Quadrant	Label	Mechanism	Pattern	Risk/trajectory

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High J + High A	Consolidated Legitimacy	Mutual reinforcement between performance and trust	Stable operation, normalization	Durable but require continuous reproduction
High J + Low A	Disputed Legitimacy	Technical validity overridden by mistrust and narratives	Conflict, veto, politicization	Blockage, escalation
Low J + High A	Apparent Legitimacy	Social support compensates weak structure	Crisis-driven acceptance	Collapse when conditions shift
Low J + Low A	Double Deficit	Negative feedback between weak governance and distrust	Recurrent failure	Structural blockage

Table A4. Justification x Urgency (J×U). Decision Context.

Quadrant	Label	Mechanism	Pattern	Risk/trajectory
High J + High U	Strong Justification	Positive convergence	Solid technical basis and evident water crisis.	Success and consolidation of technical legitimacy.
High J + Low U	Strategic Water Security	Anticipatory solidity	Preventive planning and long-term resilience.	Gradual legitimacy built without the coercion of scarcity.
Low J + High U	Emergency Exceptionality	Decision acceleration	Pragmatic but volatile acceptance due to extreme necessity.	Boomerang effect: project dismantling once the crisis ends.
Low J + Low U	Structural Blockage	Absence of strategic drivers	Projects without urgency or sufficient technical basis.	Abandonment or paralysis due to lack of perceived need

Table A5. Demands x Repertories (D×R).

Quadrant	Label	Mechanism	Pattern	Risk/trajectory
High D + High R	Resistance	Cancellation + disruption	Protest, veto, litigation	Blockage, escalation
Low D + High R	Negotiation	Conditional acceptance + leverage	Institutional bargaining	Adaptive stabilization
High D + Low R	Subordination	Opposition without capacity	Latent conflict	Sudden escalation risk
Low D + Low R	Dependence	Acceptance by necessity	Delegated trust, Low mobilization	Fragile stability

Table A6. Cross Matrix Integration Rules.

Rule	Explanation
J×A = legitimacy state	Diagnoses alignment between structure and social support
J×U = decision context	Explains timing and pressure shaping decisions
D×R = agency dynamics	Explains how actors transform trajectories

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Non-redundancy	J×U does not measure legitimacy; D×R does not measure structure
Analytical sequence	(1) Code dimensions → (2) assign matrices → (3) interpret trajectory

Table A7. Coding Decision Protocol.

Issue	Rule
Contradictory evidence	Prioritize evidence explaining project trajectory, not isolated claims.
Temporal dynamics	Code by phase; configurations may shift across quadrants as conditions evolve. Record transitions when they explain trajectory changes.
Acceptance vs legitimacy	Acceptance is observable; legitimacy is inferred from governance practices.
Urgency vs justification	Urgency shapes timing and thresholds but, does not substitute structural robustness.
Low-conflict ambiguity	Distinguish dependence (delegated trust) from subordination (latent opposition).
Actor heterogeneity	Configurations may coexist; code dominant or disaggregate by actor group.
Analytical implication	Configurations act as process states; transitions across matrices enable inference of likely trajectories and risks.

References

1. Smith, H.M.; Brouwer, S.; Jeffrey, P.; Frijns, J. Public Responses to Water Reuse – Understanding the Evidence. *J. Environ. Manage.* 2018, *207*, 43–50.
2. Al-Saidi, M. From Acceptance Snapshots to the Social Acceptability Process: Structuring Knowledge on Attitudes Towards Water Reuse. *Front. Environ. Sci.* 2021, *9*.
3. du Pisani, P.L. Direct Reclamation of Potable Water at Windhoek's Goreangab Reclamation Plant. *Desalination* **2006**, *188*, 79–88, doi:10.1016/j.desal.2005.04.104.
4. Nkhoma, P.R.; Alsharif, K.; Ananga, E.; Eduful, M.; Acheampong, M. Recycled Water Reuse: What Factors Affect Public Acceptance? *Environ. Conserv.* 2021, *48*, 278–286.
5. Rosenberg Goldstein, R.E.; Gerdes, M.E.; Fix, S.; Vivino, A.; Rainey, K.; Bernat, E. Evaluating the Impact of Water Reuse Educational Videos on Water Reuse Perceptions Using EEG/Event Related Potential. *J. Environ. Manage.* **2024**, *349*, doi:10.1016/j.jenvman.2023.119560.
6. Lefebvre, O. Beyond NEWater: An Insight into Singapore's Water Reuse Prospects. *Curr. Opin. Environ. Sci. Health* 2018, *2*, 26–31.
7. Hurlimann, A.; Dolnicar, S. When Public Opposition Defeats Alternative Water Projects - The Case of Toowoomba Australia. *Water Res.* **2010**, *44*, 287–297, doi:10.1016/j.watres.2009.09.020.
8. Mann, A. Public Involvement in Technology Integration: Understanding San Diego's Successes and Failures with Potable Reuse; 2021;
9. Markus, M.R.; Torres, E. How to Overcome Public Perception Issues on Potable Reuse Projects; 2020;
10. Tortajada, C.; Nambiar, S. Communications on Technological Innovations: Potable Water Reuse. *Water (Switzerland)* **2019**, *11*, doi:10.3390/w11020251.
11. Stefan, E.; Scapulatempo, C.V. Water Availability and Water Reuse: A New Approach for Water Resources Management. In *Water reuse within a circular economy context Series II. Global Water Security Issues (GWSI)*; UNESCO Publishing: Paris, 2020 ISBN 9789231004131.
12. Jeffrey, P.; Yang, Z.; Judd, S.J. The Status of Potable Water Reuse Implementation. *Water Res.* 2022, *214*.
13. Akpan, V.E.; Omole, D.O.; Bassey, D.E. Assessing the Public Perceptions of Treated Wastewater Reuse: Opportunities and Implications for Urban Communities in Developing Countries. *Heliyon* **2020**, *6*, doi:10.1016/j.heliyon.2020.e05246.

 doi:10.20944/preprints202604.1727.v1

14. Herman, J.G.; Scruggs, C.E.; Thomson, B.M. The Costs of Direct and Indirect Potable Water Reuse in a Medium-Sized Arid Inland Community. *Journal of Water Process Engineering* **2017**, *19*, 239–247, doi:10.1016/j.jwpe.2017.08.003.
15. Scruggs, C.E.; Thomson, B.M. Opportunities and Challenges for Direct Potable Water Reuse in Arid Inland Communities. *J. Water Resour. Plan. Manag.* **2017**, *143*, doi:10.1061/(asce)wr.1943-5452.0000822.
16. Mukherjee, M.; Jensen, O. Making Water Reuse Safe: A Comparative Analysis of the Development of Regulation and Technology Uptake in the US and Australia. *Saf. Sci.* **2020**, *121*, 5–14, doi:10.1016/j.ssci.2019.08.039.
17. Rodrigues, P.M.; Pinto, F.S.; Marques, R.C. A Framework for Enabling Conditions for Wastewater Reuse. *Sustain. Prod. Consum.* **2024**, *46*, 355–366, doi:10.1016/j.spc.2024.02.022.
18. Warner, J.F.; Meissner, R. Cape Town's "Day Zero" Water Crisis: A Manufactured Media Event? *International Journal of Disaster Risk Reduction* **2021**, *64*, doi:10.1016/j.ijdrr.2021.102481.
19. Moesker, K.; Pesch, U.; Doorn, N. Public Acceptance in Direct Potable Water Reuse: A Call for Incorporating Responsible Research and Innovation. *J. Responsible Innov.* **2024**, *11*, doi:10.1080/23299460.2024.2304382.
20. Ormerod, K.J.; Redman, S.; Kelley, S. Public Perceptions of Potable Water Reuse, Regional Growth, and Water Resources Management in the Reno-Sparks Area of Northern Nevada, USA. *City and Environment Interactions* **2019**, *2*, doi:10.1016/j.cacint.2019.100015.
21. Sardana, P.; Javernick-Will, A.; Cook, S.M. Facilitators and Barriers of Global Water Reuse: A Systematic Literature Review. *ACS ES and T Water* 2025, *5*, 3–19.
22. Kenney, S. Purifying Water: Responding to Public Opposition to the Implementation of Direct Potable Reuse in California; 2019;
23. Frijns, J.; Smith, H.M.; Brouwer, S.; Garnett, K.; Elelman, R.; Jeffrey, P. How Governance Regimes Shape the Implementation of Water Reuse Schemes. *Water (Switzerland)* **2016**, *8*, doi:10.3390/w8120605.
24. Leong, C.; Lebel, L. Can Conformity Overcome the Yuck Factor? Explaining the Choice for Recycled Drinking Water. *J. Clean. Prod.* **2020**, *242*, doi:10.1016/j.jclepro.2019.118196.
25. Rozin, P.; Haddad, B.; Nemerof, C.; Slovic, P. Psychological Aspects of the Rejection of Recycled Water: Contamination, Purification and Disgust. *Judgment and Decision Making* **2015**, *10*, 50–63, doi:10.1017/s193029750000317x.
26. Ziervogel, G.; Franklin, B.; Thorson, J. UNPACKING THE CAPE TOWN DROUGHT:LESSONS LEARNED Report for Cities Support Programme Undertaken by African Centre for Cities; 2019;
27. Mcadam, D.; Tarrow, S.; Tilly, C. Dynamics of Contention. *Soc. Mov. Stud.* **2003**, *2*, 99–102, doi:10.1080/14742837.2003.10035370.
28. Suchman, M.C. Managing Legitimacy: Strategic and Institutional Approaches. *The Academy of Management Review* **1995**, *20*, 571, doi:10.2307/258788.
29. Binz, C.; Harris-Lovett, S.; Kiparsky, M.; Sedlak, D.L.; Truffer, B. The Thorny Road to Technology Legitimation - Institutional Work for Potable Water Reuse in California. *Technol. Forecast. Soc. Change* **2016**, *103*, 249–263, doi:10.1016/j.techfore.2015.10.005.
30. Harris-Lovett, S.R.; Binz, C.; Sedlak, D.L.; Kiparsky, M.; Truffer, B. Beyond User Acceptance: A Legitimacy Framework for Potable Water Reuse in California. *Environ. Sci. Technol.* 2015, *49*, 7552–7561.
31. Sgroi, M.; Vagliasindi, F.G.A.; Roccaro, P. Feasibility, Sustainability and Circular Economy Concepts in Water Reuse. *Curr. Opin. Environ. Sci. Health* 2018, *2*, 20–25.
32. Dingemans, M.M.L.; Smeets, P.W.M.H.; Medema, G.; Frijns, J.; Raat, K.J.; van Wezel, A.P.; Bartholomeus, R.P. Responsible Water Reuse Needs an Interdisciplinary Approach to Balance Risks and Benefits. *Water (Switzerland)* 2020, *12*.
33. Collier, D.; LaPorte, J.; Seawright, J. Putting Typologies to Work: Concept Formation, Measurement, and Analytic Rigor. *Polit. Res. Q.* **2012**, *65*, 217–232, doi:10.1177/1065912912437162.
34. Paredes, M. One Industry, Different Conflicts: A Typology of Mining Mobilization. *Extractive Industries and Society* **2022**, *9*, doi:10.1016/j.exis.2022.101052.
35. Nilsson, D.; Baxter, G.; Butler, J.R.A.; McAlpine, C.A. How Do Community-Based Conservation Programs in Developing Countries Change Human Behaviour? A Realist Synthesis. *Biol. Conserv.* 2016, *200*, 93–103.

 doi:10.20944/preprints202604.1727.v1

36. Flyvbjerg, B. Five Misunderstandings about Case-Study Research. *Qualitative Inquiry* **2006**, *12*, 219–245, doi:10.1177/1077800405284363.
37. Jaakkola, E. Designing Conceptual Articles: Four Approaches. *AMS Review* **2020**, *10*, 18–26, doi:10.1007/s13162-020-00161-0.
38. Duckett, D.; Troldborg, M.; Hendry, S.; Cousin, H. Making Waves: Promoting Municipal Water Reuse without a Prevailing Scarcity Driver. *Water Res.* **2024**, *249*, doi:10.1016/j.watres.2023.120965.
39. Nemeroff, C.; Rozin, P.; Haddad, B.; Slovic, P. Psychological Barriers to Urban Recycled Water Acceptance: A Review of Relevant Principles in Decision Psychology. *Int. J. Water Resour. Dev.* **2020**, *36*, 956–971, doi:10.1080/07900627.2020.1804841.
40. Ormerod, K.J. Illuminating Elimination: Public Perception and the Production of Potable Water Reuse. *Wiley Interdisciplinary Reviews: Water* 2016, *3*, 537–547.
41. Ross, V.L.; Fielding, K.S.; Louis, W.R. Social Trust, Risk Perceptions and Public Acceptance of Recycled Water: Testing a Social-Psychological Model. *J. Environ. Manage.* **2014**, *137*, 61–68, doi:10.1016/j.jenvman.2014.01.039.
42. Aleksić, N.; Šušteršič, V. Future of Water Recycling: A Review of the Direct Potable Water Reuse. *Reciklaza i odrzivi razvoj* **2022**, *15*, 27–39, doi:10.5937/ror2201029a.
43. Tzanakakis, V.A.; Capodaglio, A.G.; Angelakis, A.N. Insights into Global Water Reuse Opportunities. *Sustainability (Switzerland)* 2023, *15*.
44. Keller, A.A.; Su, Y.; Jassby, D. Direct Potable Reuse: Are We Ready? A Review of Technological, Economic, and Environmental Considerations. *ACS ES and T Engineering* 2022, *2*, 273–291.
45. Garcia, X.; Pargament, D. Reusing Wastewater to Cope with Water Scarcity: Economic, Social and Environmental Considerations for Decision-Making. *Resour. Conserv. Recycl.* **2015**, *101*, 154–166, doi:10.1016/j.resconrec.2015.05.015.
46. Diodosio, K.; Ripberger, J.; Foltz, M.; Mangalgiri, K.; Gupta, K.; Carlson, N. Is It Still the Yuck Factor? Public Support and Willingness to Pay for Municipal Wastewater Reuse in Oklahoma. *Science of the Total Environment* **2025**, *986*, doi:10.1016/j.scitotenv.2025.179749.
47. Benjamin, J.A.; Southard, M.; Adams, H.; MacNevin, D.; Zornes, G.; Nix, D.; Ikehata, K. The Emergency DPR Experience: Water Quality Lessons from Wichita Falls, TX. *Water Reuse* **2026**, doi:10.2166/wrd.2026.103.
48. Scruggs, C.E.; Pratesi, C.B.; Fleck, J.R. Direct Potable Water Reuse in Five Arid Inland Communities: An Analysis of Factors Influencing Public Acceptance. *Journal of Environmental Planning and Management* **2020**, *63*, 1470–1500, doi:10.1080/09640568.2019.1671815.
49. Wester, J.; Timpano, K.R.; Çek, D.; Broad, K. The Psychology of Recycled Water: Factors Predicting Disgust and Willingness to Use. *Water Resour. Res.* **2016**, *52*, 3212–3226, doi:10.1002/2015WR018340.
50. Barnes, J.L.; Krishen, A.S.; Hu, H. fen Public Tap Water Perceptions and Potable Reuse Acceptance: A Cognitive Dissonance Theoretical Understanding. *J. Clean. Prod.* **2023**, *429*, doi:10.1016/j.jclepro.2023.139587.
51. Kollmann, J.; Harris-Lovett, S.; Nelson, K.L.; Contzen, N. Mandated On-Site Wastewater Reuse in San Francisco: The Role of Distributive Fairness for Policy Acceptance. *npj Urban Sustainability* **2025**, *5*, doi:10.1038/s42949-025-00283-z.
52. Sikkema, S.; Berendse, K. 231219 BTO 2023.071 Socio-Technological Legitimation of Water Related Reuse; 2011;
53. Hartley, T.W. Public Perception and Participation in Water Reuse. *Desalination* **2006**, *187*, 115–126, doi:10.1016/j.desal.2005.04.072.
54. Marks, J.S. Taking the Public Seriously: The Case of Potable and Non Potable Reuse. *Desalination* **2006**, *187*, 137–147, doi:10.1016/j.desal.2005.04.074.
55. Stenekes, N.; Colebatch, H.K.; Waite, T.D.; Ashbolt, N.J. Risk and Governance in Water Recycling. *Sci. Technol. Human Values* **2006**, *31*, 107–134, doi:10.1177/0162243905283636.
56. Leong, C. The Role of Emotions in Drinking Recycled Water. *Water (Switzerland)* **2016**, *8*, doi:10.3390/w8110548.

 doi:10.20944/preprints202604.1727.v1

57. Zhu, Z.; Li, A.; Wang, H. Public Perception and Acceptability of Reclaimed Water: The Case of Shandong Province, China. *Journal of Water Reuse and Desalination* **2018**, *8*, 308–330, doi:10.2166/wrd.2017.022.
58. Lee, H.; Tan, T.P. Singapore's Experience with Reclaimed Water: NEWater. *Int. J. Water Resour. Dev.* **2016**, *32*, 611–621, doi:10.1080/07900627.2015.1120188.
59. March, H.; Gorostiza, S.; Saurí, D. Redrawing the Hydrosocial Cycle Through Treated Wastewater Reuse in the Metropolitan Area of Barcelona. *Water Alternatives* **2023**, *16*.
60. Ormerod, K.; Scott, C. Drinking Wastewater: Public Trust in Potable Reuse. *Sci. Technol. Human Values* **2013**, *38*, 351–373, doi:10.2307/23474473.
61. Kaiser, F.A.C.; Ribeiro, A.R.; Montagner, C.C. Environmental and Socioeconomic Aspects Related to the Acceptance of Direct Potable Reuse in a Metropolitan City in Brazil. *J. Clean. Prod.* **2024**, *466*, doi:10.1016/j.jclepro.2024.142897.
62. Matland, R.E. Public Management Research Association Synthesizing the Implementation Literature: The Ambiguity-Conflict Model of Policy Implementation Synthesizing the Implementation Literature: The Ambiguity-Conflict Model of Policy Implementation; 1995; Vol. 5;.
63. Villacorta-Ranera, C.; Eckstein, G.; Blanco-Gutiérrez, I. Challenges and Prospects of Reclaimed Water Reuse in Spanish Agriculture. *Water Int.* **2025**, *50*, 514–534, doi:10.1080/02508060.2025.2485856.
64. Florides, F.; Giannakoudi, M.; Ioannou, G.; Lazaridou, D.; Lamprinidou, E.; Loukoutos, N.; Spyridou, M.; Tosounidis, E.; Xanthopoulou, M.; Katsoyiannis, I.A. Water Reuse: A Comprehensive Review. *Environments - MDPI* 2024, *11*.
65. Diniz, V.; Rohwedder, J.J.R.; Rath, S. Direct Potable Reuse: A Prioritization of Emerging Contaminants for Monitoring Strategies and Pilot-Scale Advanced Treatment. In; 2025; pp. 425–445.
66. Dolnicar, S.; Hurlimann, A.; Nghiem, L.D. The Effect of Information on Public Acceptance - The Case of Water from Alternative Sources. *J. Environ. Manage.* **2010**, *91*, 1288–1293, doi:10.1016/j.jenvman.2010.02.003.
67. Fakhreddine, S.; Prommer, H.; Scanlon, B.R.; Ying, S.C.; Nicot, J.P. Mobilization of Arsenic and Other Naturally Occurring Contaminants during Managed Aquifer Recharge: A Critical Review. *Environ. Sci. Technol.* 2021, *55*, 2208–2223.
68. Ore, A.; Sigmund, G.; Specker, J.; Helmus, R.; Aguilar-Alarcón, P.; Schriks, M.; van Wezel, A.P.; Sutton, N.B. Removal, Transport, and Transformation of Organic Micropollutants in Managed Aquifer Recharge: Insights from Target and Non-Target Analyses. *Water Res.* **2025**, *287*, doi:10.1016/j.watres.2025.124409.
69. Abbaszadegan, M.; Alum, A.; Kitajima, M.; Fujioka, T.; Matsui, Y.; Sano, D.; Katayama, H. Water Reuse—Retrospective Study on Sustainable Future Prospects. *Water (Switzerland)* 2025, *17*.
70. Specker, J.C.; Praetorius, A.; de Baat, M.L.; Sutton, N.B.; van Wezel, A.P. Risk Characterisation of Chemicals of Emerging Concern in Real-Life Water Reuse Applications. *Environ. Int.* 2025, *195*.
71. Bub, S.; Petschick, L.L.; Stehle, S.; Wolfram, J.; Schulz, R. Limitations of Chemical Monitoring Hinder Aquatic Risk Evaluations on the Macroscale. *Science (1979).* **2025**, *388*, 1301–1305, doi:10.1126/science.adn5356.
72. LaVanchy, G.T.; Winter, K.J. Water Reuse for Cape Town: Investing in Resilience to Avoid Another "Day Zero." *Wiley Interdisciplinary Reviews: Water* 2025, *12*.
73. Ubisse, H.; Naval, L.P. Perception and Acceptability of Reusing Treated Wastewater: Determining Factors and Public Engagement Strategies. *Water and Environment Journal* 2025, *39*, 387–401.
74. Mateo-Sagasta, J.; Drechsel, P. Guidelines to Improve Acceptance of Water Reuse. In *water reuse in the middle east and north africa*; 2023.
75. Franco-Quintero, J.; Rizo-Maestre, C. When AI Intensifies Conflict: Algorithmic Governance and Socio-Environmental Conflicts in EIA. **2025**, doi:10.2139/ssrn.5676914.
76. Sikkema, S.; Berendse, K. 231219 BTO 2023.071 Socio-Technological Legitimation of Water Related Reuse; 2023;
77. Moya-Fernández, P.J.; López-Ruiz, S.; Guardiola, J.; González-Gómez, F. Determinants of the Acceptance of Domestic Use of Recycled Water by Use Type. *Sustain. Prod. Consum.* **2021**, *27*, 575–586, doi:10.1016/j.spc.2021.01.026.
78. van Rensburg, P. Overcoming Global Water Reuse Barriers: The Windhoek Experience. *Int. J. Water Resour. Dev.* **2016**, *32*, 622–636, doi:10.1080/07900627.2015.1129319.

 doi:10.20944/preprints202604.1727.v1

79. Swartz, C.D.. Direct Reclamation of Municipal Wastewater for Drinking Purposes. Volume 1, Guidance on Monitoring, Management and Communication of Water Quality : Report to the Water Research Commission; Water Research Commission, 2015; ISBN 9781431207091.
80. Moesker, K.; Wiarda, M. Value-Sensitive Design of Potable Water Reuse: Aligning Academic Research with Societal Concerns. *Sci. Eng. Ethics* **2025**, *31*, doi:10.1007/s11948-025-00542-3.
81. Tortajada, C.; Bindal, I. Water Reuse in Singapore: The New Frontier in a Framework of a Circular Economy? In; 2020.
82. Wester, J.; Broad, K. Direct Potable Water Recycling in Texas: Case Studies and Policy Implications. *Journal of Environmental Policy & Planning* **2020**, *23*, 1–18, doi:10.1080/1523908X.2020.1798749.
83. Rice, J.; Wutich, A.; White, D.D.; Westerhoff, P. Comparing Actual de Facto Wastewater Reuse and Its Public Acceptability: A Three City Case Study. *Sustain. Cities Soc.* **2016**, *27*, 467–474, doi:10.1016/j.scs.2016.06.007.
84. Bishop, B.Z.J.; Nancarrow, B.E. Community Perceptions of Risk, Trust and Fairness in Relation to the Indirect Potable Use of Purified Recycled Water in South East Queensland: A Scoping Report Citation for Published Version (APA); 2008;
85. Villacorta-Ranera, C.; Blanco-Gutiérrez, I.; Novo, P. Disentangling Social Perspectives on the Use of Reclaimed Water in Agriculture Using Q Methodology. *J. Environ. Manage.* **2025**, *381*, doi:10.1016/j.jenvman.2025.125264.
86. Blanco-Gutiérrez, I.; Esteve, P.; Garrido, A.; Gómez-Ramos, A.; Arce, A.; Zubelzu, S.; Díaz-Ambrona, C.; Sánchez, R.; Calatrava, J.; López-Correa, J. RECLAMO: Unlocking the Potential of Wastewater Reuse for Agricultural Irrigation in Spain . *Res. Ideas Outcomes* **2021**, *7*, doi:10.3897/rio.7.e76793.