AG-WaMED | Advancing non conventional water management for innovative climate-resilient water governance in the Mediterranean Area

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National policy document for NCW upscaling - Italy

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Abstract	The present report is produced as deliverable for the task 4.2 of AG-WaMED,Integrated Watershed Management Plans and NCW out-scaling. The document contributes to the development of national policy frameworks for upscaling non-conventional water (NCW) uses in selected Mediterranean countries. It addresses the emerging concept of water transition, understood as a shift towards more sustainable governance and use of water resources. Through a systematic literature review, the study develops a conceptual framework that identifies the key barriers and drivers of water transitions. It applies this framework to a case study of a living lab (Italy) to analyze upscaling processes at the national level. The findings inform future policy recommendations and contribute to broader Mediterranean-scale strategies for NCW deployment.		
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Introduction

This document is intended for the development of Deliverable 4.2.2.5, "National policy documents for NCW upscaling (Italy, Spain, Egypt, Tunisia, Algeria, D34)." Subsequently, the results will also contribute to sub-task 4.3.1, “Policy document for upscaling and out-scaling NCW at the Mediterranean scale (M20-34).”

In the face of increasing global water scarcity driven by the combined effects of climate change and water appropriation regimes, transitioning to more sustainable water governance and usage has become a critical issue for our societies (Brudge 2005, 2007). The objective of this document is to collect data to compare the upscaling processes of NCW at the national level. In a narrower sense, the 'scaling out' process can be defined as the expansion of innovations to a larger group of actors, 'scaling up' as the implementation of political and legal changes, and 'scaling deep' as the enactment of profound cultural and institutional changes (Breaught et al. 2021).

These processes involve water transition, a new key concept in water governance. While several countries around the world claim to be engaging in water transitions, often framed by governments as a promise of success for moving towards water sustainability, the conditions necessary to achieve these objectives need to be better identified. Indeed, local administrations and organisations face obstacles or barriers of various kinds that can prevent, hinder, or slow the implementation of these transitions (Heiberg, Truffer, and Binz 2022; Sixt, Klerkx, and Griffin 2018).

In the field of research, the concept of water transition has been used by several scholars (Sullivan et al. 2017; Hartman et al. 2017; Travassos and Momm 2022). It has become an operational framework for analysing the transformation of water governance, as it implicitly incorporates the idea of a rupture towards more sustainable water uses (Eggimann et al. 2018; Novalia, Rogers, and Bos 2021). Much of this research falls within Sustainability Transition Studies. In the water domain, transition refers to the success of social or technological innovation that leads to the creation and implementation of institutional and technological changes to improve the sustainability of the water system (Hartman et al. 2017).

Although the notion of water transition is increasingly employed in scientific research and public policies, it has not been critically examined from the perspective of water governance research. We have not found any articles within this field that propose defining the contours of this concept. No research has yet undertaken a synthesis of the main empirical barriers and drivers of water transition implemented worldwide. We aimed to fill this gap by defining the boundaries of this concept through a systematic meta-analytical approach (Van Houtven 2007) in the literature on water transitions. By conducting a comprehensive analysis of this phenomenon, we identified the barriers that hinder water transitions globally, as well as the drivers that facilitate their deployment.

This paper is structured in three sections. First, we explain our methodology, which involves literature review. We then present the conceptual framework that we developed by

identifying the barriers and drivers of water transitions. Finally, we present the results of applying this framework to a case study of a living lab. This application helps to understand the upscaling processes of NCW at the national level.

Methods

Based on a literature review on “water transitions”, we have identified the main barriers and drivers to water transitions. We develop a conceptual framework of these barriers and drivers to then identify them in each living lab for understanding the up-scaling process of NCW.

Based on the identification and definition of the various barriers and drivers for the use and promotion of unconventional water use technologies, a questionnaire was developed to gather information on the specific situation of national case studies in each living lab (Spain, Italy, Tunisia/Algeria, and Egypt). This questionnaire was completed by members of each living lab, and the responses were then analyzed both at the country level and in a comparative manner to obtain regional (Mediterranean) results, with the aim of advancing Deliverable 4.2.3.

Literature review

This research relied on a systematic meta-analytical approach (Van Houtven, 2007). This method uses empirical evidence to identify common points and causal mechanisms that contribute to the construction of notions or theories (Oberlack and Eisenack 2014, Wolfram and Kienesberger, 2023). Meta-analytical approaches are increasingly used to address global and regional patterns of socio-environmental change (Author et al. 2017). By capturing these processes, it bridges the gap between global assessments, which often lack detailed case studies.

Our research is based on systematic case selection and theory-grounded coding. First, the text corpus was constructed by consulting articles published between 2014 and 2024 from two databases: Social Sciences and Humanities Proceedings (ISI WOS) and Scopus “Social Sciences.” The search was conducted by combining several keywords (see Table 1).

Table 1. Keywords used for article research. Source: Authors, 2024.

WOS Social Science		
Search string	**Hits**	**Date**
“sustainab* system” AND Water	14	08-dic

(sustainab* AND socio*techn*) AND Water	46	08-dic
“sustainability transition*” AND Water	140	08-dic
(sustainab* AND transition*) AND Water	1006	08-dic
(sustainab* AND [niche* OR regime*]) AND Water	458	08-dic
(sustainab* AND pathway*) AND Water	535	08-dic
(“system transition*” OR “system transformation*”) AND Water	41	08-dic
(system* AND [transformation* OR transition*]) AND Water	1615	08-dic
(system* AND [niche* OR regime*]) AND Water	653	08-dic
(system* AND [niche* OR regime*] AND [transformation* OR transition*]) AND Water	145	08-dic
(system* AND pathway*) AND Water	770	08-dic
(system* AND pathway* AND [transformation* OR transition*]) AND Water	142	08-dic
([transformation* OR transition*] AND socio*techn*) AND Water	50	08-dic
([transition* OR transformation*] AND pathway*) AND Water	235	08-dic
(“transition stud*” OR “transition theor*” OR “transition approach*”) AND Water	31	08-dic
([niche* OR regime*] AND socio*techn*) AND Water	28	08-dic
(pathway* AND socio*techn*) AND Water	7	08-dic
SCOPUS Social science		
Search String	**Hits**	**Date**

“sustainab* system” AND Water	56	08-dic
(sustainab* AND socio*techn*) AND Water	31	08-dic
“sustainability transition*” AND Water	64	08-dic
(sustainab* AND transition*) AND Water	731	08-dic
(sustainab* AND [niche* OR regime*]) AND Water	522	08-dic
(sustainab* AND pathway*) AND Water	375	08-dic
(“system transition*” OR “system transformation*”) AND Water	30	08-dic
(system* AND [transformation* OR transition*]) AND Water	2066	08-dic
(system* AND [niche* OR regime*]) AND Water	1372	08-dic
(system* AND [niche* OR regime*] AND [transformation* OR transition*]) AND Water	147	08-dic
(system* AND pathway*) AND Water	642	08-dic
(system* AND pathway* AND [transformation* OR transition*]) AND Water	86	08-dic
([transformation* OR transition*] AND socio*techn*) AND Water	26	08-dic
([transition* OR transformation*] AND pathway*) AND Water	184	08-dic
(“transition stud*” OR “transition theor*” OR “transition approach*”) AND Water	34	08-dic
([niche* OR regime*] AND socio*techn*) AND Water	10	08-dic
(pathway* AND socio*techn*) AND Water	4	08-dic

After removing duplicates, we reviewed the titles of the results (n = 2184) to check whether they were concerned about water resources or drinking water. During this first screening, a large number of publications had to be excluded due to terminological overlaps but lacking relevant content (e.g. ocean, fish in rivers, and maritime transport). Second, the abstracts of the remaining articles (n = 350) were examined according to two criteria: first, whether the article mentioned governance issues, and second, whether the issue of change or transition reflected in the title was substantiated. Third, for the selected articles (n = 74), we reviewed the full text by reading the introduction, methodology, and results to verify that the article's analysis focused on a case study of water transition, even if the author did not necessarily use this term. This resulted in a corpus of 52 publications. We then coded the articles on Atlas-TI to describe these studies by identifying the theoretical framework, object of analysis (innovation, regime, or other), and use of hydrological data. Next, we sought to outline the contours of water transitions according to their application domains and geographical characteristics (country, space, and scale). Finally, we identified textual elements referring to barriers or drivers of transition.

Theorical framework proposal

In this section, we present the barriers and drivers identified from the literature review. For each of them, we provide a definition.

Barriers of water transitions

The analysis of the corpus identified eight types of barriers to water transition in 26 articles (Table 2).

Table 2. Presentation of eight barriers to water transition. Source: Authors, 2024.

	Barriers	**Definition**	**References**
1	Intersectoral barrier	Lack of relationships between actors at different levels, absence of individuals, collective, and technical synergies, and/or emergence of conflicts around an innovation.	(9) Ward and Butler 2016; Hess 2018; Liu and Jensen 2018; van Welie et al. 2018; Savini and Giezen 2020; Novalia, Rogers, and Bos 2021; Heiberg, Truffer, and Binz 2022 ; Nilsson and Blomkvist 2021; Travassos y Momm 2022

2	Political barrier	Lack of clear political support for local initiatives, absence of participation and consideration of local needs, and international orientation by funders towards policies and projects unsuitable for Southern regions.	(7) Acheampong, Swilling, and Urama 2016; Ward and Butler 2016; Silvestri et al. 2018; Sixt, Klerkx, y Griffin 2018; Yasmin, Farrelly, and Rogers 2018; Afghani, Hamhaber, and Frijns 2022; Travassos y Momm 2022
3	Institutional barrier	Institutional fragmentation and internal coordination problems, strong institutionalization of the existing sociotechnical regime entrenched in daily institutional practices and logics.	(6) Herslund et al. 2018; Kundu et al. 2018 ; Sixt, Klerkx, y Griffin 2018; Suleiman 2021 ; Helgegren et al. 2021 ; Pakizer et al. 2023
4	Economical barrier	Lack of visualization of the benefits and economic viability of the innovation compared to established regimes, or costs too high relative to demand uncertainty.	(6) Domènech et al. 2015; Xu et al. 2016; Ward y Butler 2016; Kundu et al. 2018; Silvestri et al. 2018; Sixt, Klerkx, y Griffin 2018
5	Normative barrier	Regulatory obstacles produced by legal frameworks or poor definition of laws leading to interpretation issues.	(5) Baigorrotegui, Parker, y Estenssoro 2014; Domènech et al. 2015; Ward y Butler 2016; Liu y Jensen 2018; Afghani, Hamhaber, y Frijns 2022
6	Technical barrier	Inadequate infrastructure, difficulties in use or malfunction of the innovation.	(4) Domènech et al. 2015 ; Kundu et al. 2018 ; Eggimann et al. 2018 ; Nilsson y Blomkvist 2021
7	Cognitive barrier	Lack of knowledge to use or maintain new technologies.	(4) McConville et al. 2017; Liu y Jensen 2018; Suleiman 2021; Afghani, Hamhaber, y Frijns 2022
8	Behavioral barrier	Failure to consider contexts (practices, habits, beliefs) in developing innovation and the economic, social, and environmental benefits it can provide.	(3) Kundu et al. 2018; Silvestri et al. 2018; Afghani, Hamhaber, y Frijns 2022

The most recurrent type of barrier-to-water transition is the intersectoral barrier. This refers to situations where there are no relationships between actors (social, institutional, political, and economic) at different levels, or there is a lack of synergies and alignments to support innovation. It also refers to the presence of resistance or conflict regarding innovation. The second type is political barriers. In this case, the lack of political support for local initiatives, failure to consider the needs of local populations, and implementation of ill-suited projects by international donors and organisations hinder water transitions. The third type is institutional barriers, which are linked to institutional fragmentation and coordination problems among institutional actors or excessive institutionalisation of the existing sociotechnical regime, generating path dependence situations.

The fourth type is economic barriers. The lack of visibility of benefits and economic viability of innovation, compared to established regimes, as well as high costs relative to demand uncertainty and market existence, can hinder water transitions. The fifth barrier is normative barriers, referring to the obstacles produced by the current legal and regulatory frameworks. A lack of clarity in law definitions can also create difficulties in local interpretation and hinder water transition. The sixth is technical barriers related to difficulties in using innovation due to poor design or malfunction. Dependence on centralised infrastructure which is unsuitable for local practices, can also hinder transition. The seventh type is cognitive barriers: a lack of knowledge to use or maintain new technologies can slow water transitions. Finally, behavioural barriers to water transitions are linked to disregard for contexts (practices, habits, and beliefs) in which innovation can be adopted, as well as economic, social, and environmental benefits.

Drivers of water transitions

The analysis of the corpus identified eight types of water transition drivers in 28 articles (Table 3).

Table 3. Presentation of eight drivers of water transition. Source: Authors, 2024.

	Drivers	**Definition**	**References**
1	Shared vision driver	The existence of a common vision that shifts collective perception towards a new regime or widespread adoption of innovation.	(7) Fam et al. 2014; van der Voorn and Quist 2018; White et al. 2019; Lennartsson et al. 2019; Criqui, 2020; Miörner et al. 2022; Mguni et al. 2022
2	Cognitive driver	The creation and assimilation of knowledge to enhance policy orientation; the presence of professional knowledge to support innovation; individual and social learning to change practices.	(7) Hoolohan et al. 2019; Criqui, 2020; Herrfahrdt-Pähle et al. 2020; McConville et al. 2022; Mguni et al. 2022; Binz et al. 2016 ; Blomkvist et al. 2020

3	Institutional driver	The existence of formal and informal institutions to drive experimentation, a coherent and flexible framework, and multiple institutional mechanisms to facilitate regime change and support this transition.	(6) Werbeloff et al. 2017; Wutich et al. 2020; Herrfahrdt-Pähle et al. 2020 ; Ampe et al. 2021; Pollachi et al. 2023; Nastar 2014
4	Individual driver	The presence of a promoter who uses their influential power to support the transition, particularly from the beginning of the process and to steer towards regulatory framework change.	(6) Werbeloff et al. 2017; Wutich et al. 2020; Ampe et al. 2021; Pollachi et al. 2023; Travassos and Momm 2022; Nastar 2014
5	Networks drivers	The existence of networks with actors located at other scales to support innovations, their diffusion, or scaling up.	(5) Lieberherr and Truffer 2015; Mguni et al. 2022; da Conceição et al 2023; Dobre et al. 2018; Nastar 2014
6	Political driver	Political support from state actors and coherence of public policy instruments to support the transition.	(5) Sullivan et al. 2017; García Soler et al. 2018; Hoolohan et al. 2019; Karimi et al. 2021; Suleiman et al. 2020
7	Normative driver	Legal support through the presence of clear and strict regulatory measures, and assistance to stakeholders for their proper implementation.	(3) Werbeloff et al. 2017; Hartman et al. 2017; Suleiman et al. 2020
8	Economic driver	The existence of financial support from various stakeholders and demand or market to support the innovation.	(3) McConville et al. 2022; Binz et al. 2016 ; Suleiman et al. 2020

The most common driver of water transition is sharing a common vision among different actors. This refers to the existence of a collective vision built in collaboration among stakeholders that generates a change in perception, favouring a new sociotechnical regime. User support (both public and consumer) is also a key element in adopting innovation and supporting transitions. The second type is cognitive drivers. In this case, the creation and assimilation of knowledge improves policy orientation, and decision-making accelerates water transitions. Additionally, improving professional knowledge (2) and individual learning to integrate the use of innovation are key elements in their development.

The third type of driver, institutional, is linked to the existence of formal and informal institutions that can drive experimentation, a coherent and flexible framework, and several institutional mechanisms that can provide a solid foundation for water transitions. The fourth category refers to individual drivers. The presence of promoters, leaders with particular skills, and creative minds who use their influence to support the transition is key. This role is particularly important if engaged early in the transition process towards changing regulatory frameworks.

The fifth driver is associated with the existence of networks. The presence of contact and relationships with actors at other scales supports innovation, diffusion, and scaling up. Political drivers refer to the importance of political support from state actors as well as the integration and coherence among different public policy instruments to support the water transition. The seventh type of driver is legal: legal support for innovations and regime changes through strict and clear regulatory measures and the training of officials and managers for their proper application strengthens the success of transitions. Finally, economic drivers are linked to the financial assistance required for innovation development, as well as the formation of demand by users, and thus, a market for further development.

Barriers and drivers in Italy

In this section, we aim to analyze the barriers and drivers identified for the case of Italy. These were derived from two main sources: the responses to the guidelines provided to the countries (a methodology specific to this deliverable) and the inputs from Deliverable 4.1.1, Integrated Governance and Policy Analysis Report.

Barriers

Intersectoral Barrier: Lack of Coordination and Synergies Between Actors

One of the main barriers to the expansion of NCW in Italy is the fragmentation of water governance and the lack of coordination among institutions and stakeholders. In Val d'Orcia, there are no public irrigation systems, and farmers manage their water storage independently, with interactions mainly limited to public authorities rather than forming collaborative networks. At the regional level, multiple institutions influence water management, operating within complex and sometimes ambiguous regulations, which, according to stakeholders, complicates approval processes for new reservoirs.

The distribution of responsibilities among different governance levels—state, regional, and local—has led to tensions over decision-making authority, making it difficult to implement water storage solutions efficiently. Although efforts have been made to improve coordination through District Authorities, challenges persist in establishing consistent governance mechanisms at the basin level. The approval of reservoirs requires multiple revisions, often requested by institutions such as the regional environmental protection agency (ARPAT), which, according to stakeholders, contributes to delays in project implementation. Farmers,

municipalities, and reclamation consortia have expressed the need for additional water storage infrastructure and have urged the regional government to engage with national authorities to address regulatory challenges. A notable case is the San Piero in Campo dam, which has received local support but remains unfunded and stalled.

Stakeholders also report disagreements between agricultural and environmental actors regarding reservoir development and riverbank maintenance. Some environmental agencies have expressed concerns that new reservoirs may alter landscapes or impact ecosystems, leading to restrictions on their installation. Conversely, farmers argue that reservoirs provide benefits beyond irrigation, such as flood prevention, firefighting water storage, and water availability for ecosystems. Similar concerns exist over river and stream maintenance, where environmental protection measures limit the removal of sediment and logs, a restriction that, according to farmers, increases flood risks.

At the technical and operational level, collaboration among different actors remains limited. Since each farm generally installs reservoirs independently, institutional support appears to be scarce. Public entities such as Consorzio di Bonifica 6 Toscana Sud play a minor role, as there are no designated public reservoirs or areas planned for their development. The San Piero in Campo dam is an exception, as it has been promoted by local actors, but it has yet to secure full funding.

Overall, stakeholders have identified governance fragmentation, regulatory complexity, and differing priorities between agriculture and environmental management as barriers to the expansion of NCW in Italy. The information suggests that clarifying institutional roles and regulations, as well as improving coordination mechanisms, could facilitate reservoir development.

Political Barrier: Limited Political Support and Consideration of Local Needs

The expansion of NCW in Italy faces political challenges related to weak prioritization of reservoir projects, limited participation mechanisms for local actors, and misalignment between international funding priorities and regional needs. While there is broad consensus on the importance of increasing water storage capacity, political support remains inconsistent. There are no explicit opponents to reservoir installation, but in some cases, environmental committees have objected to specific projects, leading to delays. More critically, political will to streamline regulatory approvals and promote NCW solutions remains weak, as decision-making authority is fragmented among multiple institutions with varying internal positions on water storage policies. While some policymakers actively support these projects, this is not a coordinated effort, resulting in delays, lack of prioritization, and inconsistent political backing.

Participation in water governance is also limited and inconsistent across regions. In Val d’Orcia, where there are no public irrigation systems, local needs are channeled through municipalities, the reclamation consortium, and farmers' associations, which primarily operate at a regional level, often leaving local concerns unaddressed. The Tuscany Region has implemented a participatory process for the Water Protection Plan, but this was restricted to an online comment section and three public workshops, which significantly

limited the integration of specific local needs into policy decisions. More broadly, participation levels vary considerably between districts, and technical experts often underestimate the potential conflicts that arise when stakeholders are excluded from decision-making.

Another challenge is the misalignment between EU funding mechanisms and regional agricultural needs. The latest EU regulations discourage irrigation expansion in areas that were previously rainfed, which conflicts with the reality that irrigation is becoming increasingly necessary for high-value crops like wine and olive oil in response to climate change. This reflects a broader issue where international funding mechanisms prioritize generalized sustainability goals that do not always align with regional water challenges. The lack of funding flexibility and locally tailored financial mechanisms has been highlighted as a key constraint for adapting water policies to the evolving needs of Southern European agriculture.

Overall, the lack of political prioritization, limited stakeholder participation, and misalignment between EU funding and local needs pose significant challenges to NCW implementation in Italy. While there is no explicit political opposition to water reservoirs, bureaucratic obstacles, fragmented governance, and weak institutional leadership hinder progress. Addressing these barriers requires stronger political commitment, improved multi-level coordination, and funding mechanisms better tailored to regional water management realities.

Institutional Barrier: Fragmentation and Coordination Problems

Stakeholders report that institutional fragmentation, lack of coordination among agencies, and entrenched bureaucratic practices significantly hinder the installation of unconventional water use (NCW) solutions, particularly reservoirs. The absence of clear responsibility distribution among institutions, overlapping regulations, and slow administrative processes are key obstacles identified in water management.

The implementation of the Water Framework Directive (WFD) has exacerbated governance tensions between the central government and the regions, as regulatory powers over environmental matters are now shared among different levels of government. The creation of District Authorities, which replaced River Basin Authorities, was meant to centralize water planning at the basin level. However, these newly formed institutions lack well-defined responsibilities and financial autonomy, and they remain only partially established. As a result, water management responsibilities remain scattered across multiple institutions, creating overlapping mandates and regulatory inconsistencies.

The absence of a harmonized framework has led to inconsistencies in water planning, with River Basin Management Plans and Flood Risk Management Plans developed using different methodologies and objectives. These governance gaps create uncertainty for stakeholders, as the responsibilities of different institutions are unclear, leading to delays and administrative inefficiencies. Bureaucratic approval processes are perceived as long and unclear, as each institution has its own regulations and interpretation of environmental laws, such as Decreto Legislativo n. 152 del 3/04/2006 ("Testo Unico Ambientale"). Given that granting an authorization also means assuming legal responsibility, many public officials proceed cautiously, further prolonging decision-making and increasing uncertainty and costs for applicants.

Another major challenge is the lack of coordination between departments within regional authorities, creating contradictory policy incentives. The Department for Soil Protection, Department of Water Resources Protection, Department of Environment and Landscape, and Department of Agriculture all have roles in regulating reservoirs, yet their competing priorities often work against each other. For instance, while one department may promote reservoirs through co-funding mechanisms, another may impose environmental restrictions that complicate implementation. This institutional misalignment leads to inconsistent policy application and uncertainty for stakeholders.

Although recent decrees on drought (DL 39/2023) and floods (DL 100/2023) were intended to simplify procedures for the construction of hydraulic infrastructure, bureaucratic obstacles persist. Farmers and local stakeholders have requested the Ministry to streamline the authorization process for small reservoirs and hillside ponds, but administrative hurdles remain. Current procedures often require multiple approvals from different institutions and can take up to two years, discouraging investment in water storage solutions.

Despite these challenges, it is not impossible to install new reservoirs, as some large farms with significant financial resources have successfully navigated bureaucratic hurdles. However, for smaller farms and local actors, institutional barriers remain a significant constraint. The need for stronger interdepartmental coordination and clearer regulatory frameworks has been widely recognized as essential to reducing delays and promoting the adoption of NCW solutions.

Economic Barrier: High Costs and Limited Perception of Financial Viability

The installation of unconventional water use (NCW) solutions, such as reservoirs, faces significant economic challenges related to high costs, uncertainty about long-term financial benefits, and limited access to funding for smaller farms. Stakeholders report that installation costs are perceived as very high, which reduces interest in reservoir construction despite the acknowledged benefits. A key issue is the lack of clear economic metrics to compare reservoir water costs with conventional water sources, making it difficult to quantify financial advantages and justify investment decisions.

In the wine sector, where profit margins are generally higher, some winemakers have been able to finance their own reservoirs. However, for smaller farms and those cultivating crops like olives and cereals, the situation is more complex. While these crops could significantly benefit from irrigation, stakeholders indicate that high installation costs combined with low profit margins make investment in reservoirs nearly impossible without external funding. This challenge is exacerbated by the fact that agricultural costs for these crops are already high compared to their potential profit, discouraging private investment in water storage solutions.

Beyond individual farms, there are broader economic and technical challenges to expanding reservoir infrastructure. Connecting existing reservoirs could improve water distribution and benefit small farmers who lack the financial resources to build their own storage facilities. However, technical and economic constraints make such projects difficult to implement. Even though rainwater reservoirs are widely recognized as a potential solution for water

scarcity, their development remains limited due to high implementation costs and financial uncertainty.

Overall, the lack of clear economic assessments, high upfront costs, and funding constraints for small and mid-sized farms represent key barriers to the expansion of NCW solutions in Italy. Addressing these issues would require improved financial incentives, cost-sharing mechanisms, and better integration of reservoirs into regional water management strategies.

Normative Barrier: Regulatory Complexity and Interpretation Issues

The installation of reservoirs is significantly hindered by complex and restrictive environmental regulations, legal uncertainties, and interpretation inconsistencies across institutions. Stakeholders indicate that the authorization process for new reservoirs is highly demanding, primarily due to strict environmental protection regulations. In some cases, additional regulatory challenges arise from institutions affiliated with the Ministry of Culture, particularly when projects intersect with protected landscapes or heritage sites.

One major challenge is the regulation of sediment and excavated soil disposal, which makes both the restoration of existing reservoirs and the construction of new ones more difficult and costly. According to stakeholders, current laws impose strict controls on the disposal of sediments, classifying them as waste rather than a resource, which increases disposal costs and limits potential agronomic benefits. Under the Lunardi law on excavated soils and rocks (DPR 120/17), the reuse of sediments requires prior chemical analysis, yet there is no clear guidance on the criteria that determine whether sediments are reusable or must be disposed of as waste. Even when sediments are deemed reusable, their redistribution is restricted to the land of the same farm that generated them, preventing potential collaborations between businesses or neighboring farms for efficient sediment managemen.

Another key issue is the lack of uniform interpretation of regulations. Stakeholders report cases where different officials within the same institution interpret the same law differently, leading to uncertainty and delays in project approval. This issue appears to be partially linked to recent institutional reorganizations in the water sector, which may have resulted in inconsistent application of legal frameworks.

Recent legislative changes, such as Decree PNRR-3 (Article 48), have attempted to simplify the management and disposal of excavated soils and sediments, but challenges remain in their implementation. Additionally, any new reservoir project must undergo an environmental impact assessment, further extending the approval timeline and administrative burden.

Overall, the complexity of environmental laws, the rigid classification of sediments as waste, and inconsistencies in legal interpretation across institutions present significant barriers to NCW implementation in Italy. Addressing these issues would require clearer regulatory guidelines, streamlined authorization processes, and greater flexibility in sediment management regulations.

Technical Barrier: Infrastructure Limitations and Operational Challenges

The expansion of unconventional water use (NCW) in Italy faces technical challenges related to inadequate infrastructure, reservoir degradation, and spatial constraints. In Val

d'Orcia, a mapping of small agricultural reservoirs identified 1,097 units covering 161 hectares, with an estimated total storage capacity of 6.1 million cubic meters. However, many of these reservoirs are abandoned or underutilized, with reduced storage capacity due to sediment accumulation. Stakeholders suggest that restoring these existing reservoirs would already provide a significant contribution to water security in the region.

One of the main technical issues is the insufficient number and deteriorating condition of reservoirs for rainwater storage. The decline in precipitation has directly impacted water availability for agriculture, further emphasizing the need for improved water storage infrastructure. Additionally, there are spatial limitations for installing new reservoirs, as suitable land is constrained by terrain slope, feasibility of filling, location, and land ownership issues. In some cases, the cost of land and potential expropriation requirements further complicate the implementation of new reservoirs.

Infrastructural needs extend beyond reservoirs themselves, as irrigation systems are often required to complement storage facilities. These additional costs can pose a barrier, particularly for smaller farms with limited financial capacity. However, stakeholders indicate that no major infrastructure is required for the installation and maintenance of small reservoirs.

From an engineering perspective, technical solutions for NCW are generally available, and consultancy agencies and small and medium enterprises (SMEs) provide assistance to farmers. However, stakeholders note that technical service providers are not always fully up to date on regulatory changes, which can lead to delays and increased costs for farmers. Additionally, while there is interest in connecting existing reservoirs to optimize water distribution, this remains technically and economically challenging.

Overall, the deterioration of existing reservoirs, spatial constraints for new installations, and technical-regulatory knowledge gaps among service providers represent key challenges to NCW implementation in Italy. Addressing these barriers would require investment in reservoir rehabilitation, improved spatial planning for new storage facilities, and enhanced coordination between technical service providers and regulatory frameworks.

Cognitive Barrier: Knowledge Gaps and Adoption Challenges

The implementation of NCW solutions, such as reservoirs, does not appear to be significantly hindered by a lack of basic technical knowledge among farmers and stakeholders. However, gaps in knowledge persist regarding soil and water conservation practices, particularly in erosion reduction techniques, which are crucial for maintaining reservoir capacity. While farmers are generally aware of these practices, only a limited number of techniques—such as alternate mowing—are widely implemented, and further improvements in agricultural practices could help reduce sediment accumulation in reservoirs .

Stakeholders suggest that, rather than formal training, a demonstration-based approach led by pioneer farmers could be more effective in encouraging broader adoption of improved land and water management practices. Until clear, economically viable examples of these practices are established, farmers may remain reluctant to modify existing management approaches. Over the past few years, an increasing number of experts and consultants have

started providing technical support and training, which is seen as a positive development. However, additional financial incentives for implementing conservation practices could further facilitate their adoption.

Overall, the main cognitive barrier to NCW expansion in Italy is not a lack of technical expertise, but rather the absence of widespread adoption of improved conservation practices. Encouraging demonstration projects, peer-to-peer learning, and financial support mechanisms could help accelerate the integration of sustainable soil and water management techniques that enhance reservoir functionality and reduce irrigation needs .

Behavioral Barrier: Social Perceptions and Conflicting Priorities

The expansion of NCW solutions, such as reservoirs, is shaped by economic motivations, local practices, and tensions between agricultural and environmental priorities. Most stakeholders recognize the need to create new reservoirs to ensure water availability for irrigation and advocate for better regulations and financial support. However, conflicts arise with regional and local environmental authorities, who argue that reservoirs could alter landscapes and harm ecosystems. This reflects broader tensions between securing water for agriculture and preserving environmental and cultural landscapes, particularly in areas such as Val d'Orcia.

While economic profitability is the primary driver for adopting NCW, other motivations, such as maintaining high-quality agricultural production standards, also play a role. Stakeholders suggest that "pride" in agricultural excellence encourages investment in irrigation, particularly in the wine sector. However, conflicting priorities and regulatory barriers slow the implementation of new reservoirs. Similar disputes extend to river and stream maintenance, where restrictions on sediment removal—intended to protect riparian ecosystems—are seen by farmers as increasing flood risks.

Overall, competing interests and the lack of mechanisms to balance them hinder NCW adoption. Addressing these barriers would require a more inclusive policy approach that reconciles economic drivers with environmental concerns, ensuring that both agricultural needs and conservation priorities are integrated into decision-making.

Table 4. Main Barriers to water transition in Italy

	Barriers	**Definition**	**Description**
1	Intersectoral barrier	Lack of relationships between actors at different levels, absence of individuals, collective, and technical synergies, and/or emergence of conflicts around an innovation.	Fragmented governance and lack of coordination among institutions create regulatory delays and conflicting policies, complicating reservoir approval and implementation.

2	Political barrier	Lack of clear political support for local initiatives, absence of participation and consideration of local needs, and international orientation by funders towards policies and projects unsuitable for Southern regions.	Weak prioritization of NCW projects, limited stakeholder participation, and misalignment between EU funding policies and regional water needs slow down adoption.
3	Institutional barrier	Institutional fragmentation and internal coordination problems, strong institutionalization of the existing sociotechnical regime entrenched in daily institutional practices and logics.	Overlapping responsibilities, unclear regulations, and slow bureaucratic processes create administrative bottlenecks that discourage investment in reservoirs.
4	Economical barrier	Lack of visualization of the benefits and economic viability of the innovation compared to established regimes, or costs too high relative to demand uncertainty.	High installation costs and uncertain financial returns limit adoption, particularly for small and mid-sized farms outside high-margin agricultural sectors.
5	Normative barrier	Regulatory obstacles produced by legal frameworks or poor definition of laws leading to interpretation issues.	Strict environmental laws and unclear sediment management regulations make new reservoir construction and existing reservoir restoration costly and complex.
6	Technical barrier	Inadequate infrastructure, difficulties in use or malfunction of the innovation.	Many existing reservoirs are abandoned or underutilized due to sediment accumulation, while spatial constraints and lack of infrastructure hinder new installations.
7	Cognitive barrier	Lack of knowledge to use or maintain new technologies.	Farmers are generally knowledgeable, but limited adoption of conservation practices affects reservoir efficiency. Clear demonstration projects are needed.

8	Behavioral barrier	Failure to consider contexts (practices, habits, beliefs) in developing innovation and the economic, social, and environmental benefits it can provide.	Conflicts between agriculture and environmental protection, along with hesitancy to change farming practices, create resistance to NCW expansion.

Drivers

Shared Vision Driver: General Agreement on the Need for Reservoirs but Limited Recent Mobilization

In Italy, the majority of stakeholders recognize the importance of increasing water storage capacity due to the intensifying effects of climate change, particularly water stress during summer months. This shared understanding supports the creation of new reservoirs and the restoration of existing ones. However, small reservoirs are not perceived as an innovative solution; rather, they are considered a standard practice, especially in Val d'Orcia, where many reservoirs are already present.

While there is a general consensus on the necessity of such infrastructures, recent collective mobilization around their implementation has been limited. Historically, reservoirs were widely installed when agricultural production was a key focus of the Common Agricultural Policy (CAP). Since then, no significant recent initiatives have been documented in Val d'Orcia, though similar efforts may have occurred in other regions.

Cognitive Driver: General Awareness but Limited Structured Learning Initiatives

In Italy, the benefits of installing new reservoirs are well understood, particularly as climate change intensifies and its effects become more evident to farmers. This increasing awareness has led to some degree of political support for water storage solutions, as recognized in the barriers section.

However, there are no specific efforts identified to support professional learning or encourage changes in practices related to reservoir installation and management. The role of individual and social learning in promoting the adoption and maintenance of NCW remains unclear, as no structured initiatives have been reported.

Institutional Driver: Limited but Existing Institutional Support

In Italy, there are some consultants working on promoting improved agricultural practices, but their focus is not specifically on the installation of new reservoirs, which are seen as well-established rather than requiring experimentation.

At the institutional level, Regione Toscana has promoted the installation of new reservoirs through the Programma di Sviluppo Rurale (PSR) and provides funding for improved water management practices in agriculture. However, stakeholders consider these financial resources insufficient to effectively support the widespread adoption and implementation of NCW solutions.

Individual Driver: Absence of Key Promoters

In Italy, there are no identified key promoters or influential figures actively championing the shift toward the installation of new NCW solutions. This is mainly because reservoirs are not considered an innovative solution, as they have been widely used in the past. Due to this lack of leadership, there is no significant individual influence on regulatory framework changes or targeted efforts to overcome barriers in the process. Instead, the expansion or restoration of reservoirs relies on institutional mechanisms and broader agricultural policies rather than individual advocacy.

Networks Driver: Stakeholder Collaboration and Advocacy

In Italy, farmers' associations have actively networked with other stakeholders, such as the reclamation consortium, to lobby regional authorities for the creation of new reservoirs. These networks have played a role in raising awareness and advocating for increased support for water storage solutions.

Despite these efforts, the installation of new reservoirs has not yet seen significant policy changes or increased funding. Recent droughts have been the main catalyst for triggering responses and increasing public and institutional awareness of the issue. Although these networks have requested legal reforms and greater financial support, these demands remain unmet.

Collaboration across local, regional, and national levels can be effective when there is a shared political will and available economic resources. However, no specific examples of successful multilevel collaboration have been observed in Val d’Orcia.

Political Driver: Policy Frameworks and Institutional Support for NCW

In Italy, state actors provide some political support for the installation of new reservoirs, but policies and regulations remain outdated, unclear, and in need of improvement. Although there are national planning documents that address water infrastructure and drought management—such as the Piano Invasi, PNISI, and the Decreto Siccità—there is no fully aligned, comprehensive policy framework to effectively support NCW implementation (LL).

At the regional level, the watershed authority has issued a new Water Management Plan, which represents an effort to regulate and plan water resources. Additionally, there is ongoing consideration of creating public reservoirs that can be shared by multiple small farms, helping those who lack the land or financial resources for private infrastructure. However, proper regulations are needed to ensure fair distribution and avoid conflicts in such shared-use scenarios (Deliverable 4.1.).

The European Union's funding orientation could play a role in supporting water infrastructure projects, but its alignment with Italy's specific needs is unclear. Overall, while policy initiatives exist, the lack of clear regulatory frameworks, insufficient funding, and slow implementation processes remain significant challenges to advancing NCW solutions at scale.

Normative Driver: Regulatory Barriers to NCW Implementation

In Italy, there is no clear legal support to facilitate the installation of new non-conventional water (NCW) solutions, such as reservoirs. The legal procedures are highly complex, and the regulatory compliance process is lengthy and costly, creating significant barriers to implementation (LLs).

Rather than facilitating NCW adoption, current regulations primarily create obstacles for stakeholders seeking to install new reservoirs. The only exceptions to these barriers are specific cases where regulatory exemptions or special provisions apply, but these are limited in scope. Overall, the regulatory framework does not actively assist stakeholders in correctly applying NCW innovations. Instead, the bureaucratic and financial burdens associated with legal compliance hinder the widespread adoption of these solutions (LLs).

Economic Driver: Limited Financial Support for NCW Implementation

In Italy, some financial support is available at the regional, national, and European levels to back the installation of new NCW solutions, such as reservoirs . However, these funds are limited and insufficient compared to the total investment needed for reservoir creation and management (LLs).

The market demand for reservoirs is high, as they are essential to meeting crop water needs during increasingly dry summers (LLs). However, the financial constraints and administrative complexity in accessing funds remain major challenges for implementation.

Regarding economic incentives, some funding has been provided by regional governments, national programs, and EU institutions. However, these resources are often difficult to obtain and do not fully cover the costs necessary to develop and maintain reservoirs (LLs).

Table 5. Main Drivers to water transition in Italy

	Drivers	**Definition**	**Description**
1	Shared vision driver	The existence of a common vision that shifts collective perception towards a new regime or widespread adoption of innovation.	Most stakeholders recognize the need for reservoirs due to climate change impacts, but there are no recent large-scale mobilizations.

2	Cognitive driver	The creation and assimilation of knowledge to enhance policy orientation; the presence of professional knowledge to support innovation; individual and social learning to change practices.	General awareness exists, but no significant efforts are in place to support professional learning or changes in practices
3	Institutional driver	The existence of formal and informal institutions to drive experimentation, a coherent and flexible framework, and multiple institutional mechanisms to facilitate regime change and support this transition.	Some consultants promote improved water practices, but there is no specific experimentation phase for reservoirs. Regional funding exists but is limited
4	Individual driver	The presence of a promoter who uses their influential power to support the transition, particularly from the beginning of the process and to steer towards regulatory framework change.	No key individual promoters or leadership figures have emerged to drive reservoir implementation
5	Networks drivers	The existence of networks with actors located at other scales to support innovations, their diffusion, or scaling up.	Farmer associations and reclamation consortia advocate for more funding and policy changes, but their efforts have not yet led to significant changes
6	Political driver	Political support from state actors and coherence of public policy instruments to support the transition.	There are some national policies (e.g., Piano Invasi, decreto siccità) and regional management plans, but they are complex and not fully aligned with local needs
7	Normative driver	Legal support through the presence of clear and strict regulatory measures, and assistance to stakeholders for their proper implementation.	Legal procedures for installing reservoirs are complex, costly, and time-consuming, creating obstacles rather than support for implementation

8	Economic driver	The existence of financial support from various stakeholders and demand or market to support the innovation.	Limited regional, national, and EU financial support exists, but it is insufficient compared to the funds required for reservoir creation and maintenance

Conclusions: Challenges and Opportunities for the Development of NCW in Italy

Persistent Governance Fragmentation and Institutional Misalignment: Structural Barriers to NCW Implementation

The analysis of NCW implementation in Italy reveals a set of deeply rooted barriers that hinder the upscaling of water storage solutions, particularly reservoirs. Central among these is the fragmentation of governance and the lack of effective coordination across sectors and institutional levels. Water management responsibilities are distributed among multiple actors—from local municipalities to regional departments and national agencies—with overlapping mandates and divergent priorities. This complexity contributes to bureaucratic delays, regulatory ambiguity, and limited strategic alignment, as illustrated by the case of the San Piero in Campo dam and the protracted approval processes described throughout the report.

Moreover, the regulatory environment is marked by inconsistent interpretation of environmental laws, especially regarding sediment management and land use. While intended to ensure environmental protection, these regulations often generate legal uncertainty and financial burdens for stakeholders. Farmers face restrictive conditions that classify sediments as waste, limiting the reuse of excavated materials and inflating compliance costs. The procedures for obtaining authorization are not only time-consuming but also fraught with ambiguities that result in caution and delay from public officials.

Economic barriers further complicate implementation. While reservoirs are recognized as essential to adapting to climate-induced water stress, the high initial costs, particularly for small and mid-sized farms, and the lack of financial predictability constrain broader adoption. Available regional, national, and EU funds are considered insufficient, and the procedures to access them are perceived as complex and misaligned with local agricultural realities. This is especially problematic in areas such as Val d'Orcia, where irrigation is increasingly needed, but remains difficult to expand due to these structural constraints.

Additionally, technical and operational barriers—including the deterioration of existing reservoirs, limited availability of suitable land for new installations, and gaps in technical services—exacerbate these issues. Although engineering solutions exist and are accessible,

a disconnect remains between technical consultancy and regulatory updates. On the cognitive and behavioral fronts, while there is general awareness of the need for water conservation practices, their adoption is uneven. Farmers tend to rely on traditional approaches, and the absence of demonstration projects and targeted support further limits the diffusion of improved practices.

These barriers reflect a systemic inertia, where existing institutional logics, legal frameworks, and resource constraints converge to stall innovation, even when social and environmental needs are well recognized. Overcoming them will require coordinated reform efforts that cut across administrative boundaries and align regulatory, financial, and technical instruments with the evolving demands of water governance in Italy.

Potential Enablers for NCW Upscaling: Shared Recognition, Stakeholder Advocacy, and Policy Windows

Despite these structural challenges, several drivers offer opportunities to strengthen the implementation of NCW strategies in Italy. Foremost among them is a shared recognition among stakeholders—especially in the agricultural sector—of the urgent need to expand water storage capacity to confront seasonal droughts and climate variability. This consensus supports the social acceptability of reservoirs and legitimizes demands for policy change, even if it has not yet translated into broad-based mobilization or sustained political pressure.

Stakeholder networks, particularly farmer associations and reclamation consortia, play an active role in articulating demands, lobbying for funding, and proposing regulatory adjustments. These networks have proved essential in giving visibility to NCW needs and advocating for regional support. However, their efforts are still constrained by the institutional and regulatory barriers outlined above, and no transformative breakthroughs have yet been achieved.

At the institutional level, there are relevant but limited initiatives, such as Tuscany's Regional Rural Development Program (PSR), which includes measures to co-fund water storage projects. While these programs offer a starting point, stakeholders consider them underfunded and insufficiently strategic to trigger large-scale transitions. National policy instruments like *Piano Invasi*, *PNIISSI*, and the *Decreto Siccità* indicate a growing awareness of water infrastructure needs, but policy implementation remains slow and fragmented, and often lacks the legal and financial mechanisms needed for scale.

In terms of political drivers, there is growing attention to shared reservoirs for multiple small farms, which could democratize access to water infrastructure. However, no strong leadership or prominent policy entrepreneurs have emerged to champion these initiatives and bridge the gap between technical feasibility and regulatory practice. Similarly, cognitive drivers—such as knowledge sharing and peer learning—are not systematically fostered, although some consultants are beginning to fill this gap.

In sum, while Italy's NCW landscape is still shaped more by structural inertia than by strategic coordination, these emerging drivers—social consensus, stakeholder advocacy,

and modest institutional initiatives—provide entry points for change. Leveraging them will require targeted investment, leadership, and regulatory reforms capable of translating diffuse awareness into actionable, large-scale solutions.

References

Acheampong, Ernest Nti, Mark Swilling, y Kevin Urama. 2016. “Sustainable Urban Water System Transitions Through Management Reforms in Ghana”. *Water Resources Management* 30 (5): 1835-49. https://doi.org/10.1007/s11269-016-1256-3.

Afghani, Nof, Johannes Hamhaber, y Jos Frijns. 2022. “An Integrated Assessment Framework for Transition to Water Circularity”. *Sustainability* 14 (14): 8533. https://doi.org/10.3390/su14148533.

Ampe, Kasper, Erik Paredis, Lotte Asveld, Patricia Osseweijer, y Thomas Block. 2021. “Incumbents’ enabling role in niche-innovation: Power dynamics in a wastewater project”. *Environmental Innovation and Societal Transitions* 39 (junio): 73–85. https://doi.org/10.1016/j.eist.2021.03.004.

Baigorrotegui, Gloria, Cristian Parker, y Fernando Estenssoro. 2014. “Insights into Sociotechnical Transitions towards Patterns of Sustainable Consumption in Water and Energy in South-American Mining—Two Argentinean Controversies”. *Sociologias* 16 (diciembre): 72–111. https://doi.org/10.1590/15174522-016003704.

Binz, Christian, Sasha Harris-Lovett, Michael Kiparsky, David L. Sedlak, y Bernhard Truffer. 2016. «The thorny road to technology legitimation—Institutional work for potable water reuse in California». *Technological Forecasting and Social Change* 103 (febrero): 249-63. https://doi.org/10.1016/j.techfore.2015.10.005.

Blomkvist, Pär, David Nilsson, Benard Juma, y Lewis Sitoki. 2020. «Bridging the critical interface: Ambidextrous innovation for water provision in Nairobi’s informal settlements». *Technology in Society* 60 (febrero): 101221. https://doi.org/10.1016/j.techsoc.2019.101221.

Criqui, L. 2020. Sociotechnical alternatives and controversies in extending water and sanitation networks in Lima, Peru. Water Alternatives 13(1): 160-181

Dobre, Catalina Codruta, Joanne Vinke-de Kruijf, Luisa Moretto, y Marco Ranzato. 2018. « Stormwater management in transition: The influence of technical and governance attributes in the case of Brussels, Belgium ». *Environmental Science & Policy* 85 (julio) : 1-10. https://doi.org/10.1016/j.envsci.2018.03.015.

Domènech, Laia, Hug March, Maria Vallès, y David Saurí. 2015. “Learning processes during regime shifts: Empirical evidence from the diffusion of greywater recycling in Spain”. *Environmental Innovation and Societal Transitions* 15 (junio): 26–41. https://doi.org/10.1016/j.eist.2014.01.001.

Eggimann, Sven, Bernhard Truffer, Ulrike Feldmann, y Max Maurer. 2018. “Screening European market potentials for small modular wastewater treatment systems—an inroad to

sustainability transitions in urban water management?" *Land Use Policy* 78 (noviembre): 711-25. https://doi.org/10.1016/j.landusepol.2018.07.031.

Fam, Dena, Cynthia Mitchell, Kumi Abeysuriya, y Abby Mellick Lopes. 2014. "Emergence of decentralised water and sanitation systems in Melbourne, Australia". *International Journal of Water* 8 (2): 149-65. https://doi.org/10.1504/IJW.2014.060962.

García Soler, Natàlia, Timothy Moss, y Ourania Papasozomenou. 2018. «Rain and the city: Pathways to mainstreaming rainwater harvesting in Berlin». *Geoforum* 89 (febrero): 96-106. https://doi.org/10.1016/j.geoforum.2018.01.010.

Hartman, Preston, Travis Gliedt, Jeffrey Widener, y Rebecca W. Loraamm. 2017. "Dynamic capabilities for water system transitions in Oklahoma". *Environmental Innovation and Societal Transitions* 25 (diciembre): 64–81. https://doi.org/10.1016/j.eist.2016.12.004.

Heiberg, Jonas, Bernhard Truffer, y Christian Binz. 2022. « Assessing transitions through sociotechnical configuration analysis—a methodological framework and a case study in the water sector ». *Research Policy* 51 (1) : 104363. https://doi.org/10.1016/j.respol.2021.104363.

Helgegren, Ida, Jennifer McConville, Graciela Landaeta, y Sebastien Rauch. 2021. «A multiple regime analysis of the water and sanitation sectors in the Kanata metropolitan region, Bolivia». *Technological Forecasting and Social Change* 166 (mayo): 120638. https://doi.org/10.1016/j.techfore.2021.120638.

Herrfahrdt-Pähle, Elke, Maja Schlüter, Per Olsson, Carl Folke, Stefan Gelcich, y Claudia Pahl-Wostl. 2020. «Sustainability transformations: socio-political shocks as opportunities for governance transitions». *Global Environmental Change* 63 (july): 102097. https://doi.org/10.1016/j.gloenvcha.2020.102097.

Herslund, Lise, Antje Backhaus, Ole Fryd, Gertrud Jørgensen, Marina Bergen Jensen, Tatu Mtwangi Limbumba, Li Liu, et al. 2018. «Conditions and opportunities for green infrastructure—Aiming for green, water-resilient cities in Addis Ababa and Dar es Salaam». *Landscape and Urban Planning* 180 (diciembre): 319-27. https://doi.org/10.1016/j.landurbplan.2016.10.008.

Hess, David J., y Kate Pride Brown. 2018. "Water and the politics of sustainability transitions: from regime actor conflicts to system governance organizations". *Journal of Environmental Policy & Planning* 20 (2): 128-42. https://doi.org/10.1080/1523908X.2017.1341304.

Hoolohan, Claire, Iain Soutar, James Suckling, Angela Druckman, Alice Larkin, y Carly McLachlan. 2019. "Stepping-up Innovations in the Water—Energy—Food Nexus: A Case Study of Anaerobic Digestion in the UK". *The Geographical Journal* 185 (4): 391–405. https://doi.org/10.1111/geoj.12259.

Karimi, Nishtman, Hossein Azadi, y Kobe Boussauw. 2021. «The Water Management Regime in Western Iran: A Retrospective Analysis through a Hybrid Transitions Framework». *Sustainability* 13 (6): 3323. https://doi.org/10.3390/su13063323.

Kundu, Debasish Kumar, Aarti Gupta, Arthur P. J. Mol, Mohammad Moshiur Rahman, y Doris van Halem. 2018. «Experimenting with a novel technology for provision of safe drinking water in rural Bangladesh: The case of sub-surface arsenic removal (SAR)». *Technology in Society* 53 (mayo): 161-72. https://doi.org/10.1016/j.techsoc.2018.01.010.

Lennartsson, M.; McConville, J.; Kvarnström, E.; Hagman, M. and Kjerstadius, H. 2019. Investments in innovative, urban sanitation—Decision-making processes in Sweden. Water Alternatives 12(2): 588-608

Lieberherr, Eva, y Bernhard Truffer. 2015. «The impact of privatization on sustainability transitions: A comparative analysis of dynamic capabilities in three water utilities». *Environmental Innovation and Societal Transitions* 15 (junio): 101-22. https://doi.org/10.1016/j.eist.2013.12.002.

Liu, Li, y Marina Bergen Jensen. 2018. "Green infrastructure for sustainable urban water management: Practices of five forerunner cities". *Cities* 74 (abril): 126-33. https://doi.org/10.1016/j.cities.2017.11.013.

McConville, J. R., E. Kvarnström, M. Ahlström, y C. B. Niwagaba. 2022. «Possibilities for changing to resource recovery in Kampala's on-site sanitation regime». *Resources, Conservation and Recycling* 181 (junio): 106275. https://doi.org/10.1016/j.resconrec.2022.106275.

McConville, J. R., E. Kvarnström, H. Jönsson, E. Kärrman, y M. Johansson. 2017. «Source separation: Challenges & opportunities for transition in the swedish wastewater sector». *Resources, Conservation and Recycling* 120 (mayo): 144-56. https://doi.org/10.1016/j.resconrec.2016.12.004.

Mguni, Patience, Amber Abrams, Lise Byskov Herslund, Kirsty Carden, Jessica Fell, Neil Armitage, y Aa'isha Dollie. 2022. "Towards water resilience through Nature-based Solutions in the Global South? Scoping the prevailing conditions for Water Sensitive Design in Cape Town and Johannesburg". *Environmental Science & Policy* 136 (octubre): 147-56. https://doi.org/10.1016/j.envsci.2022.05.020.

Miörner, Johan, Jonas Heiberg, y Christian Binz. 2022. « How global regimes diffuse in space—Explaining a missed transition in San Diego's water sector ». *Environmental Innovation and Societal Transitions* 44 (septiembre) : 29-47. https://doi.org/10.1016/j.eist.2022.05.005.

Nastar, Maryam. 2014. "What drives the urban water regime? An analysis of water governance arrangements in Hyderabad, India". *Ecology and Society* 19 (2). https://www.jstor.org/stable/26269562.

Nilsson, David, y Pär Blomkvist. 2021. "Is the self-read water meter a pro-poor innovation? Evidence from a low-income settlement in Nairobi". *Utilities Policy* 68 (febrero): 101143. https://doi.org/10.1016/j.jup.2020.101143.

Novalia, Wikke, Briony C. Rogers, y Joannette J. Bos. 2021. “Incumbency and political compromises: Opportunity or threat to sustainability transitions?” *Environmental Innovation and Societal Transitions* 40 (septiembre): 680-98. https://doi.org/10.1016/j.eist.2021.05.002.

Pakizer, Katrin, Eva Lieberherr, Megan Farrelly, Peter M. Bach, David Saurí, Hug March, Miriam Hacker, y Christian Binz. 2023. “Policy sequencing for early-stage transition dynamics—A process model and comparative case study in the water sector”. *Environmental Innovation and Societal Transitions* 48 (septiembre): 100730. https://doi.org/10.1016/j.eist.2023.100730.

Savini, Federico, y Mendel Giezen. 2020. “Responsibility as a Field: The Circular Economy of Water, Waste, and Energy”. *Environment and Planning C: Politics and Space* 38 (5): 866-84. https://doi.org/10.1177/2399654420907622.

Silvestri, Giorgia, Julia M. Wittmayer, Karlijn Schipper, Robinah Kulabako, Sampson Oduro-Kwarteng, Philip Nyenje, Hans Komakech, y Roel Van Raak. 2018. «Transition Management for Improving the Sustainability of WASH Services in Informal Settlements in Sub-Saharan Africa—An Exploration». *Sustainability* 10 (11): 4052. https://doi.org/10.3390/su10114052.

Sixt, Gregory N., Laurens Klerkx, y Timothy S. Griffin. 2018. “Transitions in water harvesting practices in Jordan’s rainfed agricultural systems: Systemic problems and blocking mechanisms in an emerging technological innovation system”. *Environmental Science & Policy* 84 (junio): 235-49. https://doi.org/10.1016/j.envsci.2017.08.010.

Suleiman, Lina. 2021. “Blue green infrastructure, from niche to mainstream: Challenges and opportunities for planning in Stockholm”. *Technological Forecasting and Social Change* 166 (mayo): 120528. https://doi.org/10.1016/j.techfore.2020.120528.

Suleiman, Lina, Bo Olofsson, David Saurí, Laura Palau-Rof, Natàlia García Soler, Ourania Papasozomenou, y Timothy Moss. 2020. «Diverse pathways—common phenomena: comparing transitions of urban rainwater harvesting systems in Stockholm, Berlin and Barcelona». *Journal of Environmental Planning and Management* 63 (2): 369-88. https://doi.org/10.1080/09640568.2019.1589432.

Sullivan, Abigail, Dave D. White, Kelli L. Larson, y Amber Wutich. 2017. “Towards Water Sensitive Cities in the Colorado River Basin: A Comparative Historical Analysis to Inform Future Urban Water Sustainability Transitions”. *Sustainability* 9 (5): 761. https://doi.org/10.3390/su9050761.

Travassos, Luciana, y Sandra Momm. 2022. “Urban River Interventions in São Paulo Municipality (Brazil): The Challenge of Ensuring Justice in Sociotechnical Transitions”. *Frontiers in Sustainable Cities* 3 (enero). https://doi.org/10.3389/frsc.2021.684109.

Van der Voorn, Tom, y Jaco Quist. 2018. « Analysing the Role of Visions, Agency, and Niches in Historical Transitions in Watershed Management in the Lower Mississippi River ». *Water* 10 (12) : 1845. https://doi.org/10.3390/w10121845.

Ward, Sarah, y David Butler. 2016. “Rainwater Harvesting and Social Networks: Visualising Interactions for Niche Governance, Resilience and Sustainability”. *Water* 8 (11): 526. https://doi.org/10.3390/w8110526.

Welie, Mara J. van, Pauline C. Cherunya, Bernhard Truffer, y James T. Murphy. 2018. «Analysing transition pathways in developing cities: The case of Nairobi’s splintered sanitation regime». *Technological Forecasting and Social Change* 137 (diciembre): 259-71. https://doi.org/10.1016/j.techfore.2018.07.059.

Werbeloff, Lara, Rebekah Brown, y Chris Cocklin. 2017. “Institutional Change to Support Regime Transformation: Lessons from Australia’s Water Sector.” *Water Resources Research* 53 (7): 5845-59. https://doi.org/10.1002/2016WR020289.

White, Dave D., Eleanor K. Rauh, Abigail Sullivan, Kelli L. Larson, Amber Wutich, Danielle Linthicum, Veronica Horvath, y Krista L. Lawless. 2019. “Public Attitudes towards Urban Water Sustainability Transitions: A Multi-City Survey in the Western United States”. *Sustainability Science* 14 (6): 1469-83. https://doi.org/10.1007/s11625-019-00658-z.

Wutich, Amber, Christine Demyers, Julia C. Bausch, Dave D. White, y Abigail Sullivan. 2020. “Stakeholders and social influence in a shadow network: Implications for transitions towards urban water sustainability in the Colorado River basin”. *Ecology and Society* 25 (1). https://doi.org/10.5751/ES-11451-250128.

Xu, Guanghua, Xianli Xu, Wanbin Tang, Wen Liu, Jing Shi, Meixian Liu, y Kelin Wang. 2016. «Fighting against water crisis in China—A glimpse of water regime shift at county level». *Environmental Science & Policy* 61 (julio): 33-41. https://doi.org/10.1016/j.envsci.2016.03.021.

Yasmin, T., M. A. Farrelly, y B. C. Rogers. 2018. « Evolution of water governance in Bangladesh: An urban perspective ». *World Development* 109 (septiembre) : 386-400. https://doi.org/10.1016/j.worlddev.2018.05.003.