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 - Algeria

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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 (Algeria) 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.

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	(6) Herslund et al. 2018; Kundu et al. 2018 ; Sixt, Klerkx, y Griffin 2018; Suleiman 2021 ; Helgegren et al. 2021 ; Pakizer et al. 2023

		entrenched in daily institutional practices and logics.	
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	(6) Werbeloff et al. 2017; Wutich et al. 2020; Ampe et al. 2021;

		and to steer towards regulatory framework change.	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 Algeria

In this section, we aim to analyze the barriers and drivers identified for the case of Algeria. 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: Weak Coordination and Lack of Institutional Support

In Algeria, stakeholder relationships in the water sector are marked by poor communication and weak collaboration, creating significant intersectoral barriers. While synergies exist, conflicts frequently arise due to diverging interests and priorities, particularly regarding the adoption of new technologies for non-conventional water use (NCW). Technical and collective collaboration is rare, often limited to isolated initiatives that lack continuity and long-term planning.

A major structural issue is the limited capacity to form and sustain water user associations, which significantly impacts the management of collective water infrastructure. In many cases, associations responsible for infrastructure receive insufficient state support, making it difficult to maintain irrigation systems and prevent their degradation. This has resulted in persistent water losses, including infiltration through traditional irrigation channels (Seguía), excessive irrigation doses, and network leaks.

Water scarcity has led farmers to individually and collectively modify existing water systems to meet their needs. While this has enabled localized solutions, it has also contributed to fragmented governance and uneven access to water resources. The adoption of circular agricultural practices could improve water sustainability, but state intervention is necessary to provide regulatory guidance and financial support.

Another key issue is the lack of bilateral cooperation between Tunisia and Algeria for transboundary aquifer management. While several North African countries have made efforts to protect shared aquifers, there is no official treaty or agreement between Algeria and Tunisia to coordinate watershed governance and prevent overexploitation. This absence of cross-border policies results in uncoordinated water extraction, leading to aquifer depletion, soil degradation, and conflicts over groundwater use.

In summary, Algeria's intersectoral barriers are characterized by weak institutional coordination, lack of formal collaboration frameworks, and insufficient government support for infrastructure management. Without stronger cooperation at both national and transboundary levels, NCW solutions will continue to face fragmented implementation and sustainability challenges.

Political Barrier: Lack of Local Support and Misalignment with International Policies

In Algeria, political support for NCW, particularly aquifer recharge, is weak, limiting its effective implementation. There is no clear national strategy or strong governmental backing for local initiatives, which prevents long-term planning and funding for NCW projects.

A major limitation is the lack of mechanisms for local participation in water governance. Decisions regarding water management are often made at the central level, without meaningful engagement from local communities. As a result, the specific needs of different regions are not adequately considered, leading to poorly adapted policies and ineffective interventions.

Additionally, international funding priorities do not always align with local realities. Many donor-supported water management projects follow global frameworks that do not consider the region's climatic, socio-economic, and environmental characteristics. For example, some irrigation policies based on Western models overlook Algeria's arid climate and water scarcity challenges, making them less effective or unsustainable in the long run .

At the same time, modern large-scale water projects have contributed to significant environmental changes, such as aquifer depletion and the disappearance of traditional water sources. Traditional hydraulic techniques, such as rainwater collection, floodwater spreading, and aquifer recharge through small and medium-sized structures like tabias and jessour, are gradually being abandoned due to the lack of state support. However, these low-cost, decentralized solutions could help address droughts if they were properly integrated into national policies.

Overall, Algeria's political barriers are characterized by weak governmental commitment to NCW, exclusion of local stakeholders from decision-making, and a misalignment between international funding priorities and local water needs. Without stronger local participation and more context-specific water policies, NCW initiatives will continue to struggle with ineffective implementation and limited impact.

Institutional Barrier: Fragmentation, Lack of Coordination, and Resistance to Change

In Algeria, institutional fragmentation and poor coordination between different agencies slow the adoption of non-conventional water use (NCW) solutions, particularly aquifer recharge. The absence of a unified governance framework leads to delays, inefficiencies, and competing institutional interests, making it difficult to implement innovative water management strategies.

One of the key obstacles is that existing institutions operate within rigid, traditional frameworks, creating bureaucratic inertia and resistance to change. Many decision-making structures are deeply entrenched in conventional water management approaches, making it challenging to introduce new models for NCW, even when technical solutions exist.

Institutional challenges are further compounded by unclear responsibilities among different governmental bodies, causing overlapping mandates and conflicts in water resource management. This results in delays in project approval, inefficient allocation of resources, and difficulties in enforcing water conservation policies. Additionally, the lack of collaboration between research institutions and government agencies prevents the integration of scientific advancements into policy and practice, limiting the effectiveness of NCW implementation.

Overall, Algeria's institutional barriers are driven by weak inter-agency coordination, bureaucratic resistance to innovation, and a lack of integration between research and policy-making. Without structural reforms to enhance collaboration, streamline decision-making, and foster institutional adaptability, the expansion of NCW solutions will remain slow and inconsistent.

Economic Barrier: High Costs, Uncertain Viability, and Decline of Traditional Practices

In Algeria, the financial viability of NCW solutions, particularly artificial aquifer recharge, is often perceived as uncertain. Compared to traditional water management systems, which are seen as more reliable and cost-effective in the short term, NCW solutions face skepticism regarding their long-term benefits and economic feasibility. A primary concern is the high cost of implementation, especially given uncertainties in regional water demand. The investment required for building and maintaining recharge infrastructure may seem disproportionate, particularly when water availability and usage needs fluctuate. This financial unpredictability discourages both public and private investment, slowing the expansion of NCW solutions (Living Lab responses).

In parallel, modern large-scale hydraulic projects—designed to provide more water—have had unintended environmental and economic consequences. While these projects have increased agricultural yields, they have also led to the depletion of aquifers, the disappearance of water sources, and a shift from collective to individual irrigation practices. This transition has resulted in the erosion of traditional water-sharing systems and the decline of historical conservation techniques that once played a key role in water sustainability.

Traditional rainwater recovery, floodwater spreading, and groundwater recharge techniques—once widely practiced—are now being abandoned due to deteriorating infrastructure, lack of financial support, and limited time for farmers to maintain these systems. Many farmers have switched to wells, often resorting to unregulated water extraction, further exacerbating resource depletion and economic disparities.

Overall, Algeria’s economic barriers to NCW adoption stem from high implementation costs, uncertainty in long-term viability, and the decline of traditional water management practices. Without financial incentives, investment in maintenance, and policies to integrate NCW into regional development strategies, these solutions will remain financially unattractive and underutilized.

Normative Barrier: Outdated Legal Frameworks and Slow Regulatory Updates

In Algeria, outdated or poorly defined legal frameworks create regulatory obstacles to the adoption of non-conventional water use (NCW), particularly for aquifer recharge. The lack of clear laws or delays in updating existing regulations limits the ability to introduce innovative models for water management.

There are no reported issues with the interpretation of current laws, but the absence of specific regulatory provisions for NCW makes its implementation more complex. Without a well-defined legal framework, projects related to aquifer recharge and other NCW solutions face delays and administrative barriers.

The slow pace of regulatory adaptation remains a key challenge. As NCW practices evolve, legal updates are necessary to establish clear guidelines and ensure structured implementation that aligns with national water management strategies.

Technical Barrier: Inadequate Infrastructure and Challenges in Technology Adaptation

In Algeria, the current infrastructure is often inadequate to support artificial aquifer recharge models. There is a lack of specialized facilities and irrigation networks, which reduces the effectiveness of NCW projects. One of the main technical challenges is the difficulty in adapting artificial recharge technologies to local conditions. Essential data, such as permeability and hydraulic conductivity, are often missing due to the lack of piezometers to measure these parameters. Additionally, maintenance of equipment and integration with existing water systems remain problematic.

In a broader context, large irrigation infrastructure and irrigation systems are already in poor condition. Challenges such as reservoir silting, defective irrigation systems, and water losses due to infiltration into sandy soils further complicate NCW implementation. Traditional hydraulic techniques for soil and water conservation, including floodwater spreading and groundwater recharge, are gradually being abandoned, due to infrastructure deterioration, lack of resources, and limited time for maintenance. Farmers are increasingly turning to alternative water sources, such as wells, including illegal ones, further exacerbating water management difficulties .

Overall, technical barriers in Algeria stem from inadequate infrastructure, lack of key data for recharge models, and challenges in maintaining both traditional and modern water management systems. Without investment in technical capacity, infrastructure improvements, and enhanced monitoring tools, NCW solutions will remain difficult to scale and sustain.

Cognitive Barrier: Limited Technical Knowledge and Need for Specialized Training

In Algeria, there is a lack of sufficient knowledge and training among stakeholders regarding the use and maintenance of non-conventional water use (NCW) technologies. The absence of specific technical skills in areas such as artificial aquifer recharge is a major obstacle to the effective implementation and long-term sustainability of these solutions.

To address this gap, targeted training programs are needed in key areas, including hydrogeological data acquisition, maintenance of recharge equipment, and the use of modeling tools for groundwater management. Additionally, ongoing training on emerging practices and technologies is essential to ensure that stakeholders can adapt to evolving NCW methods and optimize their performance over time. Without structured capacity-building initiatives and continuous technical education, the adoption and effectiveness of NCW solutions in Algeria will remain limited, as stakeholders lack the necessary expertise to manage and maintain these systems efficiently.

Behavioral Barrier: Influence of Local Practices and Weak Integration of Social Factors

In Algeria, local practices, habits, and beliefs play a critical role in the success of NCW initiatives, particularly in aquifer recharge. Communities are more likely to support technologies and innovations that align with their existing cultural and social practices, making these factors essential for successful adoption. However, these social dimensions have often been insufficiently considered in NCW projects. In many cases, new water management innovations have been introduced without taking into account local customs and realities, leading to resistance or only partial adoption by communities.

Historically, farmers in Algeria have relied on traditional hydraulic techniques, such as rainwater harvesting, floodwater spreading, and groundwater recharge, which require collaboration for maintenance and water sharing. However, these practices are being abandoned due to infrastructure deterioration, lack of financial resources, and time constraints. As a result, many farmers are shifting to individual water sources, such as wells, which are sometimes unregulated or illegally constructed.

The lack of social integration in NCW strategies contributes to adoption challenges. Without greater alignment between new technologies and local water management traditions, as well as more inclusive decision-making processes, efforts to implement NCW solutions will likely face continued skepticism and limited community engagement.

Table 4. Main Barriers to water transition in Algeria

	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.	Weak coordination and lack of collaboration between stakeholders. Institutional fragmentation and absence of cross-border cooperation with Tunisia hinder transboundary aquifer management.
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.	Limited political support for local NCW initiatives, particularly aquifer recharge. Centralized decision-making excludes local communities, and international funding priorities do not align with regional needs
3	Institutional barrier	Institutional fragmentation and internal coordination problems, strong institutionalization of the existing sociotechnical regime entrenched in daily institutional practices and logics.	Institutional fragmentation and poor coordination slow NCW adoption. Resistance to change within governmental structures and lack of integration of scientific research further hinder implementation.
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 implementation costs and uncertainty about long-term viability discourage investment. Traditional water-sharing practices are being abandoned due to financial and logistical constraints
5	Normative barrier	Regulatory obstacles produced by legal frameworks or poor definition of laws leading to interpretation issues.	Outdated or poorly defined legal frameworks create regulatory uncertainty for NCW adoption. The slow pace of regulatory updates limits structured implementation and long-term planning.
6	Technical barrier	Inadequate infrastructure, difficulties in use or malfunction of the innovation.	Inadequate infrastructure to support artificial recharge models. Lack of key hydrogeological data, poor equipment maintenance, and deteriorating irrigation infrastructure reduce effectiveness.
7	Cognitive barrier	Lack of knowledge to use or maintain new technologies.	Insufficient knowledge and technical training among stakeholders. Limited capacity-building efforts hinder the ability to manage and maintain NCW technologies effectively.

8	Behavioral barrier	Failure to consider contexts (practices, habits, beliefs) in developing innovation and the economic, social, and environmental benefits it can provide.	Local habits and beliefs strongly influence NCW adoption. Poor integration of social and cultural factors into new initiatives leads to resistance and limited acceptance by communities.

Drivers

Shared Vision Driver: The Absence of a Common Strategy Limits NCW Adoption

In Algeria, there is no clear and widely shared vision supporting the transition to new water management models focused on aquifer recharge. This lack of a unified perspective limits the effectiveness of collective efforts and results in fragmented perceptions among stakeholders, reducing engagement and slowing down the adoption of NCW technologies.

According to field contributions, the absence of a common vision has led to a lack of coordinated initiatives, making it difficult to mobilize different actors around NCW solutions. Although no structured collaboration has been identified, some localized efforts have emerged in response to water scarcity. Farmers, particularly in oasis regions, have adapted traditional water harvesting and irrigation techniques to their needs, implementing circular practices such as rainwater collection, aquifer recharge, and improved drainage systems. These practices enable water reuse and efficiency at the local level.

However, these adaptations remain independent initiatives rather than part of an integrated national strategy. The existing fragmentation prevents broader cooperation and limits the large-scale development of NCW solutions.

Cognitive Driver: Limited Knowledge Integration and Professional Learning Hinder NCW Expansion

The creation and assimilation of knowledge on artificial aquifer recharge in Algeria are primarily supported through local case studies, collaborative research projects, and awareness initiatives. However, despite these efforts, the integration of this knowledge into national policies remains slow, limiting its impact on the financing and expansion of NCW solutions.

There are currently no significant efforts to support professional learning or promote changes in practices related to artificial recharge. This gap restricts the dissemination of necessary knowledge and technical skills, creating obstacles to the effective implementation of NCW technologies.

At the local level, individual and social learning processes play an important role in raising awareness among stakeholders about the potential benefits of artificial recharge. These processes facilitate the exchange of practical knowledge and encourage broader adoption of NCW methods. However, without structured professional training and policy alignment, these learning efforts remain scattered and do not translate into widespread, sustainable adoption.

Institutional Driver: The Role of the Hydrographic Basin Agency in Supporting NCW Innovation

In Algeria, the Hydrographic Basin Agency (ABH) serves as a key formal institution facilitating experimentation and innovation in water management. It plays a central role in coordinating initiatives related to artificial aquifer recharge and in implementing pilot projects aimed at enhancing NCW solutions.

While ABH provides a structured institutional mechanism to support the adoption of NCW technologies, no additional mechanisms were identified that actively promote their large-scale installation. The agency's efforts remain focused on pilot projects rather than comprehensive national programs, limiting the widespread adoption of NCW solutions. Strengthening institutional frameworks and expanding support mechanisms could enhance the scalability of artificial recharge initiatives across the country.

Individual Driver: Lack of Key Promoters of NCW

In Algeria, there are no key promoters or influential figures who have actively championed the transition toward artificial recharge models. The absence of strong leadership has limited the momentum necessary for advancing NCW solutions, leaving efforts largely fragmented and lacking coordinated direction.

Without influential individuals advocating for change, there has been little impact on the regulatory framework or on mobilizing institutional and financial support for artificial recharge. Leadership plays a crucial role in overcoming initial barriers, yet in this case, there are no documented examples of individuals driving progress or pushing for policy reforms to facilitate NCW implementation.

The lack of centralized leadership and advocacy has contributed to slow adoption rates and weak institutional backing. Establishing key figures—whether policymakers, researchers, or local water experts—to champion NCW initiatives could help bridge the gap between technical knowledge, political will, and practical implementation.

Networks Driver: Lack of Structured Networks

In Algeria, there are no structured networks involving stakeholders at different levels to support the dissemination or scaling of innovations in artificial aquifer recharge. Existing initiatives remain mostly local, lacking coordination at the regional or national level. This absence of well-established networks hinders the widespread adoption of NCW solutions, as knowledge sharing and coordinated efforts are minimal.

Due to the lack of strong network structures, the success of artificial recharge initiatives depends heavily on local engagement rather than on broader collaboration. Without organized stakeholder interaction, the diffusion of best practices, access to technical support, and financial mobilization remain limited.

While collaboration across different scales—local, regional, and national—could significantly improve the support for NCW solutions by promoting knowledge exchange, funding coordination, and pilot project expansion, such collaboration remains insufficient. Strengthening formal and informal networks could facilitate the adoption of NCW technologies by aligning efforts and resources across multiple levels.

Political Driver: Lack of National Policy and Regulatory Framework Hinders NCW Development in Algeria

In Algeria, political support for artificial aquifer recharge exists at the local level but remains limited to specific initiatives. However, at the national level, there is no structured support to drive a coordinated transition toward NCW solutions. The absence of a national strategy and aligned public policy instruments significantly impedes the effective implementation and scaling of artificial recharge models.

There is currently no regulatory framework specifically designed to support artificial recharge, nor have any significant policy actions been taken to promote its adoption. Existing initiatives depend mainly on the efforts of institutions like the Hydrographic Basin Agency (ABH) rather than on a broader government-led program.

While traditional hydraulic techniques such as rainwater collection, floodwater diversion, and aquifer recharge have historically been practiced, state support remains insufficient, particularly for small and medium-sized water conservation structures. Instead, most governmental funding is directed toward large-scale unconventional water projects, such as desalination, water transfers, and wastewater treatment, leaving artificial recharge largely unsupported.

A coherent national policy and dedicated regulatory framework would be necessary to facilitate the sustainable development of NCW technologies. Increased political commitment, strategic funding mechanisms, and policy alignment at all levels could enable broader adoption and integration of artificial recharge models into Algeria's water management system.

Normative Driver: Absence of Clear Legal Support for NCW Implementation in Algeria

In Algeria, there is no clear legal framework to facilitate the implementation of artificial aquifer recharge models. The current legal system lacks specific regulations to govern this practice, creating uncertainty and limiting the ability of stakeholders to adopt and implement NCW solutions effectively.

Regulatory measures do not provide adequate support for stakeholders involved in artificial recharge. The absence of clear standards and formal procedures makes it difficult for institutions, farmers, and water managers to integrate recharge techniques into existing water management strategies. Without a structured legal framework, the implementation of these solutions remains fragmented and dependent on local initiatives rather than being part of a coordinated national effort.

Additionally, the lack of regulatory assistance and technical guidelines prevents stakeholders from correctly applying artificial recharge methods. There are no official mechanisms to ensure proper implementation, monitor performance, or provide necessary adjustments to optimize the efficiency of recharge projects.

To advance NCW adoption in Algeria, developing a dedicated regulatory framework with clear legal guidelines, procedural support, and formalized standards would be essential. Such measures would help institutionalize artificial recharge and provide a stable foundation for its broader application across the country.

Economic Driver: Lack of Financial Support and Market Demand for NCW

In Algeria, there is no significant financial support from stakeholders to facilitate the widespread adoption of artificial recharge models. Projects lack structured funding mechanisms and rely on sporadic, uncoordinated financial sources, which limits their scalability and long-term sustainability.

Additionally, there is no well-established market or sufficient demand to drive the adoption of artificial recharge. The absence of institutional support and public awareness has contributed to the underdevelopment of this practice, preventing it from becoming a viable alternative within Algeria's broader water management strategies.

One of the few financial instruments available is the National Agricultural Development Fund (FNRDA), which has provided some funding for specific artificial recharge initiatives. However, its impact remains limited and insufficient to promote large-scale adoption or to serve as a comprehensive financial mechanism supporting NCW implementation.

To advance artificial recharge in Algeria, it would be necessary to develop stronger financial incentives, increase public and private investment, and integrate recharge models into national water management policies. Without these measures, the economic viability of NCW solutions will remain weak, hindering their long-term sustainability.

Table 4. Main Drivers to water transition in Algeria

	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.	No clear common vision for artificial recharge exists, leading to fragmented perceptions and low stakeholder engagement.

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.	Knowledge creation is supported through case studies and research projects, but policy integration and professional learning efforts remain limited.
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.	The Hydrographic Basin Agency (ABH) plays a role in facilitating innovation, but there are no widespread institutional mechanisms supporting NCW adoption.
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.	There are no key promoters or influential figures driving artificial recharge, which limits momentum for its implementation.
5	Networks drivers	The existence of networks with actors located at other scales to support innovations, their diffusion, or scaling up.	There are no structured networks at different levels to support diffusion or scaling of artificial recharge, resulting in local and uncoordinated initiatives.
6	Political driver	Political support from state actors and coherence of public policy instruments to support the transition.	Political support exists at the local level but is limited to specific initiatives. There is no structured national strategy or regulatory framework to facilitate NCW adoption.
7	Normative driver	Legal support through the presence of clear and strict regulatory measures, and assistance to stakeholders for their proper implementation.	No clear legal framework exists to regulate artificial recharge. The absence of standards and procedural guidelines makes implementation difficult for stakeholders.
8	Economic driver	The existence of financial support from various stakeholders and demand or market to support the innovation.	There is no significant financial support or structured funding mechanisms for artificial recharge. The National Agricultural Development Fund (FNRDA) provides limited financial

			assistance but is insufficient for large-scale adoption.

Conclusions: Challenges and Opportunities for NCW Development in Algeria

The implementation of non-conventional water (NCW) solutions in Algeria faces significant barriers but also presents key opportunities for development. Based on the analysis of both barriers and drivers, the main conclusions are as follows:

Persistent Barriers Hindering NCW Adoption

The intersectoral and institutional barriers remain major obstacles, with fragmented governance, lack of coordination between agencies, and limited collaboration between stakeholders. This fragmentation results in isolated initiatives rather than an integrated strategy for aquifer recharge and water management. Regulatory and political barriers further exacerbate the issue, as the absence of a clear legal framework and structured national policies prevents widespread adoption of artificial recharge models.

From an economic perspective, the lack of financial incentives, limited state support, and an undeveloped market for NCW solutions make large-scale implementation difficult. High initial investment costs combined with uncertainty in water demand discourage stakeholders from investing in these technologies. Additionally, technical barriers, such as inadequate infrastructure, lack of data collection mechanisms, and maintenance challenges, further hinder NCW expansion.

Drivers That Function as Opportunities for NCW Development

Among the identified drivers, only a few serve as genuine enablers of NCW rather than becoming additional barriers. Institutional mechanisms, such as the Hydrographic Basin Agency (ABH), have the potential to play a central role in facilitating experimentation and pilot projects. However, these efforts remain limited in scope and require stronger institutional backing and policy integration to become effective at a national level.

Local knowledge and adaptive practices provide another key opportunity. Despite the lack of a shared national vision, farmers and local actors have developed water-saving and recycling techniques, including artificial recharge and small-scale circular irrigation practices. These existing practices can serve as a foundation for expanding NCW adoption if properly supported through capacity-building programs and funding mechanisms.

The political driver, although weak at the national level, provides localized support for artificial recharge models. Local government initiatives and specific funding sources, such as the National Agricultural Development Fund (FNRDA), have supported some small-scale projects. However, scaling these initiatives will require a more structured national policy framework and dedicated funding mechanisms.

In summary, while significant structural and financial barriers persist, Algeria does have some key enabling factors, particularly at the local institutional level and within farmer-led initiatives. Moving forward, bridging the gap between local innovation and national policy support will be crucial for the successful scaling of NCW technologies.

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