Water Governance as a Pathway to Agricultural Sustainability in Arab Countries: An Institutional Analysis and an Indicator-Based Approach with a Case Study of Algeria

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Abstract:

Arab countries face growing water challenges that stem not only from natural scarcity, but also from weaknesses in water governance systems, particularly in the agricultural sector, which remains the largest consumer of water resources in the region. This study examines the role of water governance in achieving agricultural sustainability in Arab countries through an institutional, indicator-based analytical approach, with Algeria as a case study. The study adopts a descriptive-analytical methodology grounded in the New Institutional Economics framework, using selected indicators related to water governance, agricultural water stress, and technical and institutional efficiency. The findings reveal that weak institutional coordination, limited stakeholder participation, and the absence of effective agricultural water pricing mechanisms significantly undermine water-use efficiency and exacerbate the vulnerability of agricultural systems. The Algerian case further demonstrates that improving water governance indicators is a prerequisite for enhancing water productivity and ensuring the long-term sustainability of agricultural activities. The study concludes that adopting an integrated water governance approach based on institutional reform, enhanced transparency and accountability, and stronger policy coherence between water and agriculture constitutes a strategic pathway toward agricultural sustainability and food security in Arab countries.

Key words: Water governance, Agricultural sustainability, Water security, Institutional economics, Arab countries.

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1. INTRODUCTION

The water crisis is fundamentally a governance crisis, as achieving water security requires effective governance frameworks that recognize the economic, social, and environmental value of water resources. Today, Arab countries face mounting challenges in the water sector due to the interaction of natural, human, and institutional factors, most notably limited water availability, climate change, rapid population growth, and increasing water demand for agricultural, industrial, and urban uses. These pressures are further exacerbated by institutional shortcomings, including fragmented mandates, weak accountability mechanisms, and the dominance of inefficient considerations in water resource management.

As a result, inadequate water performance can no longer be explained solely by natural scarcity; rather, it has become increasingly associated with weak governance arrangements, poor institutional coordination, limited community participation, and deficiencies in decision-making processes. In this context, water governance emerges as a critical prerequisite for achieving water security and for shifting from traditional water management approaches toward more efficient and sustainable governance-based models. Such a transition is essential for developing innovative strategies to address water scarcity, improving the quality of available water resources, and strengthening investments in water infrastructure.

Through effective water management, it is possible to conserve water resources, reduce pollution, and ensure equitable allocation across sectors particularly agriculture, which remains the largest water-consuming sector in Arab countries, accounting on average for more than 80% of total water withdrawals. This reality places agricultural water management at the core of strategies aimed at achieving agricultural sustainability and food security. Consequently, water-related issues have become central to Arab policy agendas, reflecting the strategic importance of water resources, especially under

contemporary environmental and socio-economic transformations. This situation calls for a more comprehensive policy perspective that expands the concept of water security beyond purely technical solutions toward an integrated structural vision of water management, encompassing technology, governance, education, and the empowerment of local communities.

Research Objectives

This study aims to clarify the conceptual and theoretical framework of water governance and agricultural sustainability, while analyzing the current state of water governance in Arab countries and identifying its major institutional shortcomings. It further seeks to examine the relationship between the quality of water governance and the level of agricultural sustainability, and to propose a set of mechanisms and institutional frameworks that can support the adoption and effective implementation of water governance principles. In this regard, the study considers water governance as a strategic option capable of generating positive impacts on the financial, technical, and administrative management of water services, in addition to informing policy measures aimed at strengthening water governance in Arab countries.

Research Problem

The central research problem emerging from these objectives and which confers particular importance on water governance as a pathway to agricultural sustainability in Arab countries lies in the fact that this issue has become increasingly critical within Arab economies. This growing importance stems from the complex nature of the challenge, which intertwines limited natural water resources, mounting demographic pressures, and rising agricultural water demand. Nevertheless, inadequate water performance in Arab countries can no longer be attributed solely to natural scarcity; rather, it is fundamentally linked to the efficiency and effectiveness of

existing water governance systems, including institutional arrangements, legal frameworks, and decision-making mechanisms. Within this context, the core research question can be articulated as follows:

To what extent can water governance policies and practices enhance agricultural sustainability and ensure the optimal use of water resources in the face of persistent structural and institutional challenges in Arab countries?

This question opens the way for a critical analysis of the relationship between governance quality and agricultural sustainability efficiency, while highlighting the urgent need for well-designed institutional and strategic reforms to secure the long-term sustainability of the agricultural sector. Accordingly, several sub-questions arise from this main problem:

- What is meant by water governance, and how does it differ from traditional water resource management?
- What is the current state of water governance in Arab countries?
- How does weak water governance affect water-use efficiency in the agricultural sector?
- What mechanisms can be adopted to strengthen water governance in support of agricultural sustainability objectives?

Significance of the Study

The significance of this study emerges from the theoretical and applied issues it addresses at both the conceptual and practical levels.

Scientific and theoretical significance:

This study contributes to the enrichment of the scholarly literature on water governance, agricultural sustainability, and the institutional and political economy of water resources. It enhances theoretical understanding of the relationship between institutional effectiveness, governance mechanisms, and water-use efficiency, particularly in water-scarce regions. From a policy-oriented perspective, the study

provides decision-makers with analytically grounded insights that can support the design of more effective policies and practices for agricultural water management. These include implementable institutional and strategic recommendations, such as improving intersectoral coordination, enhancing irrigation efficiency, strengthening community participation, and linking agricultural support policies to water-use efficiency, while emphasizing the importance of raising water awareness.

Developmental and social significance:

Water constitutes a vital pillar for achieving food security and ensuring social stability in Arab societies. Accordingly, improving water governance directly contributes to sustaining agricultural production, conserving natural resources for future generations, and reducing poverty and vulnerability in rural communities.

Regional and Arab significance:

The study offers an analytical assessment of water governance performance in Arab countries, thereby facilitating the identification of best practices and the transfer of experiences among countries in the region. Given that water resources represent a strategic asset for economic, social, and food-related development, the study also underscores the importance of strengthening regional cooperation to address shared challenges and environmental transformations, including water scarcity, water pollution, and climate change.

Methodology

This study adopts a multi-level analytical approach that combines institutional theoretical analysis with a case study methodology. On the one hand, it draws on the analytical tools of New Institutional Economics and environmental economics to examine the non-technical dimensions of water resource management, particularly those related to the role of institutions, incentive structures, and the distribution of authority within the water sector.

2. Theoretical and Institutional Framework of Water Governance and Agricultural Sustainability

2.1 Water Governance: Conceptual and Institutional Framework

The concept of water governance is rooted in the transformations that have characterized the literature on natural resource management since the 1990s, which marked a shift away from an exclusive focus on technical and engineering solutions toward emphasizing the decisive role of institutions, rules, and decision-making mechanisms in achieving efficient and equitable water use. In this context, water governance is defined as the set of formal and informal rules, institutions, processes, and actors that determine how decisions related to water management are made, implemented, and monitored (OECD, 2015).

The water governance approach is grounded in a fundamental premise: water scarcity is not necessarily an inevitable outcome of natural factors, but in many cases results from institutional failures and weak governance arrangements, such as poor coordination among relevant authorities, overlapping mandates, weak accountability mechanisms, and limited participation of end users particularly farmers (Pahl-Wostl, 2010).

From the perspective of New Institutional Economics, water is regarded as a strategic economic resource whose performance is shaped by institutional design, incentive systems, and the allocation of rights and responsibilities. The clearer and more effective these institutions are, the lower the transaction costs, the more efficient resource allocation becomes, and the greater the prospects for sustainability (Saleth & Dinar, 2004). Accordingly, water governance extends beyond supply demand management to encompass the political, economic, and social dimensions that regulate access to and use of water resources.

Moreover, the political economy of water emphasizes that patterns of water allocation, pricing, and investment often reflect power relations

and the interests of specific institutional and economic actors. This dynamic may lead to the reproduction of structural imbalances and water inequities, particularly in water-intensive sectors such as agriculture (Molle, 2009).

2.2 Agricultural Sustainability: Dimensions and the Relationship with Water Resources

Agricultural sustainability is defined as the capacity of agricultural systems to achieve stable and economically viable food production while conserving natural resources and ensuring social equity between present and future generations. It rests on three interrelated dimensions: the economic, environmental, and social dimensions (FAO, 2017).

In arid and semi-arid regions such as most Arab countries water constitutes the primary limiting factor for the sustainability of agricultural activities. Agriculture depends directly on the availability of water resources and the efficiency of their management, whether in terms of quantities used, resource quality, or irrigation technologies applied.

Weak agricultural water management leads to declining water productivity, land degradation, and the overexploitation of groundwater resources, thereby threatening the long-term sustainability of the agricultural sector and food security (World Bank, 2018).

Consequently, agricultural sustainability cannot be achieved in isolation from water policies; rather, it requires close integration between agricultural, water, and environmental policies, within an institutional framework capable of balancing economic efficiency, natural resource protection, and social equity.

2.3 The Relationship between Water Governance and Agricultural Sustainability

Contemporary literature demonstrates a strong relationship between the quality of water governance and the level of agricultural sustainability. Good governance arrangements based on transparency, accountability, participation, and intersectoral coordination contribute to improving water-use efficiency, reducing losses, and promoting the adoption of modern irrigation technologies, thereby enhancing agricultural productivity and environmental sustainability (Van Oel et al., 2019).

By contrast, weak water governance results in distorted price signals, the persistence of inefficient irrigation practices, and the intensification of water resource depletion particularly in agriculture, which often benefits from unconditional water subsidies that undermine economic incentives for conservation (OECD, 2015).

Accordingly, water governance constitutes a strategic entry point for achieving agricultural sustainability, not only through improved water resource management, but also through institutional restructuring, enhanced community participation, linking agricultural support to water-use efficiency criteria, and activating accountability and regulatory mechanisms.

3. The Current State of Water Governance in Arab Countries

Water resource conditions in Arab countries reflect some of the most severe levels of water stress globally, as the majority of these countries are located in arid and semi-arid regions, with per capita water availability far below the internationally recognized water poverty threshold. However, this situation cannot be explained solely by natural and climatic factors; rather, it is closely linked to the characteristics of prevailing water governance systems, which in most cases suffer from institutional and structural deficiencies that constrain the efficiency of water resource management, particularly in the agricultural sector. In this context, this section focuses on analyzing

the current state of water governance in Arab countries by diagnosing key institutional shortcomings and decision-making mechanisms, and by highlighting their implications for water resource management and agricultural performance, as outlined below.

3.1 Institutional Framework and Overlapping Mandates

Water governance in Arab countries is characterized by pronounced institutional fragmentation, whereby multiple governmental entities share responsibilities for planning, implementation, and regulation within the water sector, often in the absence of effective coordination mechanisms.

This overlap in mandates results in higher transaction costs, unclear allocation of responsibilities, and delays in policy implementation, all of which negatively affect the efficiency of water management particularly in agriculture, which requires close coordination between water and agricultural policies (World Bank, 2018). In many cases, agricultural water management remains subject to administrative centralization, limiting local-level decision-making flexibility and reducing institutional capacity to adapt to the environmental and social specificities of different agricultural regions.

3.2 Weak Participation and Limited Participatory Governance

One of the defining features of water governance in Arab countries is the limited involvement of end users, especially farmers, in water planning and management processes. Despite growing recognition in international literature of the importance of participatory approaches, decision-making in the water sector remains largely top-down, undermining policy compliance and reducing overall effectiveness (OECD, 2015).

The absence of effective participation contributes to:

- weak adoption of modern irrigation technologies;
- persistence of inefficient water-use practices; and
- limited collective responsibility toward water resources.

These dynamics exacerbate problems of water waste and resource depletion, particularly in shared and stressed water basins.

3. 3 Distortions in Water Pricing and Economic Incentives

Most Arab countries suffer from inefficient pricing systems for agricultural water, where water is often provided at subsidized or quasi-free rates, without reflecting production costs or the true economic and environmental value of the resource.

According to Saleth and Dinar (2004), such conditions lead to:

- distorted price signals;
- weakened economic incentives for water conservation; and
- limited improvements in water-use efficiency in agriculture.

Moreover, agricultural subsidy policies in many Arab countries remain disconnected from water-efficiency considerations, encouraging the cultivation of water-intensive crops in already water-scarce environments. This situation directly contradicts the objectives of agricultural sustainability and water security.

3.4 Data Gaps and Transparency Deficits

The limited availability of accurate and up-to-date water data constitutes a major challenge to improving water governance in Arab countries. The absence of integrated water information systems, combined with weak data sharing among institutions, constrains evidence-based policymaking and undermines monitoring and evaluation mechanisms (FAO, 2021).

These data gaps are closely associated with deficiencies in transparency and accountability, as information on water allocation, efficiency of use, and policy outcomes is often insufficient or inaccessible. This, in turn, weakens both institutional and societal oversight of water management practices.

These institutional and governance shortcomings have direct implications for agricultural performance in Arab countries, where low levels of water productivity persist, reliance on traditional irrigation techniques remains widespread, and groundwater depletion

continues to intensify particularly in arid and semi-arid areas (FAO, 2017).

Overall, the current state of water governance in Arab countries reveals a clear gap between escalating water-related challenges and the capacity of existing institutional frameworks to respond effectively. This underscores the urgent need for deep structural reforms in water governance systems as a prerequisite for transitioning toward more efficient and sustainable water management.

4. The Impact of Water Governance on Achieving Agricultural Sustainability

Contemporary literature highlights that the relationship between water governance and agricultural sustainability is both causal and direct, as the quality of institutional frameworks, decision-making mechanisms, and incentive systems plays a decisive role in determining the efficiency of agricultural water use and the capacity of agricultural systems to remain viable under increasing environmental and climatic pressures.

In this context, water governance is not viewed merely as a regulatory framework, but rather as a strategic instrumentfor redirecting water resource use toward more efficient and sustainable pathways. Accordingly, this section analyzes the impact of water governance on achieving agricultural sustainability by elucidating the relationship between institutional quality and water-use efficiency in the agricultural sector.

4.1 Water Governance and Water-Use Efficiency in Agriculture

Sound governance arrangements contribute to improving water allocation efficiency within the agricultural sector by:

- reducing water losses;
- enhancing compliance with water-use regulations; and

- encouraging the adoption of more efficient irrigation technologies.

Several studies indicate that clear institutional rules, along with effective monitoring and accountability mechanisms, reduce the overexploitation of water resources particularly groundwater and enhance crop water productivity (Saleth & Dinar, 2004; Van Oel et al., 2019). By contrast, weak water governance leads to the persistence of traditional irrigation practices, deterioration of water infrastructure, and higher levels of water losses, all of which undermine water-use efficiency in agriculture and compromise the foundations of long-term sustainability.

4.2 The Impact of Governance on the Adoption of Modern Agricultural Technologies

Water governance plays a pivotal role in creating an enabling institutional environment for the adoption of modern agricultural technologies, such as localized irrigation systems, the reuse of treated wastewater, and improved water demand management. The presence of clear policies, appropriate economic incentives, and targeted support mechanisms enhances farmers' capacity to invest in water-saving technologies and reduces the risks associated with technological transitions (FAO, 2017).

Under conditions of weak governance, however:

- poor coordination between agricultural and water policies; and
- the persistence of unconditional subsidies for water consumption

weaken economic incentives for innovation and lock the agricultural sector into low water-efficiency production pathways.

4.3 Governance, Water Pricing, and Economic Incentives

Agricultural water pricing constitutes one of the most influential governance tools for achieving agricultural sustainability. Pricing systems that reflect—at least partially—the economic and environmental value of water contribute to (OECD, 2015):

- demand management;
- improved water-use efficiency; and
- the reorientation of agricultural production toward less water-intensive crops.

In contrast, the absence of such mechanisms in most Arab countries distorts price signals and limits the role of markets as regulatory instruments, thereby exacerbating pressure on water resources and undermining the prospects for achieving genuine agricultural sustainability.

4.4 Participatory Governance and the Enhancement of Agricultural Sustainability

International experiences demonstrate that the effective participation of farmers and water users in planning and management processes contributes to:

- improved compliance with water policies;
- enhanced resource-use efficiency; and
- strengthened agricultural sustainability.

Participatory approaches reduce water-related conflicts and improve the management of shared resources, particularly in water-scarce basins (Pahl-Wostl, 2010).

In the Arab context, however, weak participation remains one of the most significant constraints to agricultural sustainability, as decisions are often made without involving local stakeholders. This limits policy effectiveness due to their insufficient responsiveness to on-the-ground realities.

It is therefore evident that achieving agricultural sustainability in Arab countries cannot rely on isolated technical solutions alone. Rather, it requires a comprehensive reform of water governance systems, based on:

- improving institutional frameworks;
- strengthening transparency and accountability;

- integrating water and agricultural policies; and
- adopting effective economic instruments for managing water demand.

Such reforms would steer the agricultural sector toward more efficient and sustainable production pathways, thereby enhancing food security, conserving water resources, and ensuring the long-term viability of agricultural activities in Arab countries.

5. Algeria as a Case Study in the Context of Water Governance *(An Indicator-Based Approach)*

Building on the theoretical analysis and the diagnosis of water governance conditions in Arab countries, this section moves to the applied level through an examination of Algeria as a case study. Algeria represents an analytically significant case for the study of water governance in the Arab region, given the intensifying water stress, rising agricultural water demand, and increasing reliance on groundwater resources, all within an institutional context characterized by multiple stakeholders and a high degree of centralized decision-making.

These characteristics closely mirror the conditions observed in several Arab countries, rendering the Algerian experience a representative and illustrative model for analyzing the impact of water governance on agricultural sustainability. Accordingly, this section adopts an indicator-based approach aimed at assessing the level of water governance and its implications for agricultural sustainability, while highlighting the gap between technical efforts undertaken and the effectiveness of the institutional frameworks regulating water resource use, as outlined below.

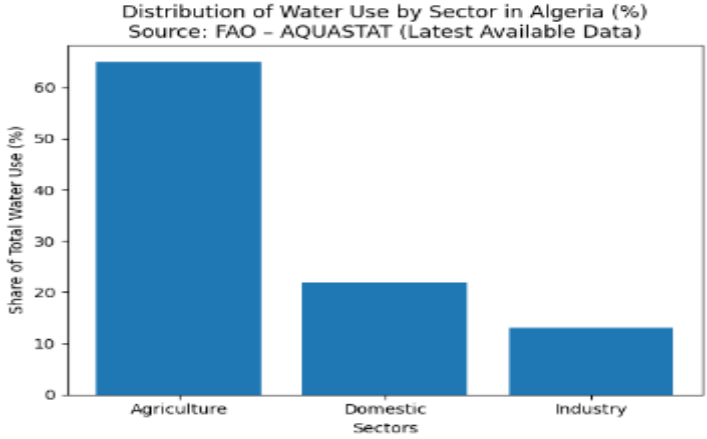
5.1 Indicators of Water Stress in the Agricultural Sector

Data from the Food and Agriculture Organization (FAO – AQUASTAT) indicate that the agricultural sector in Algeria accounts for more than 60–65% of total water withdrawals, making it the largest water-consuming sector compared to others (FAO, 2021). By

contrast, agriculture contributes only a relatively modest share to gross domestic product, reflecting the low water productivity of the agricultural sector.

To illustrate the structure of water demand in Algeria, Figure (1) presents the distribution of water use by sector, highlighting the dominant share of agriculture and its central role in exerting pressure on water resources.

Fig.1. Distribution of Water Use by Sector in Algeria (%)



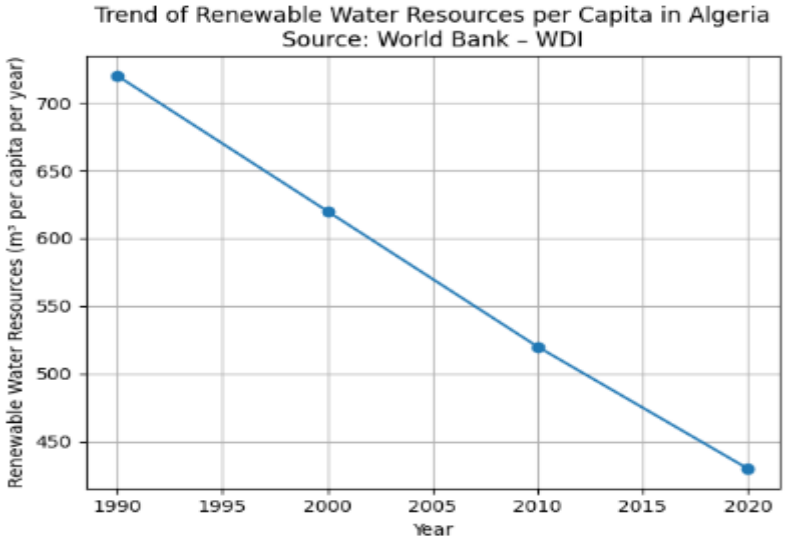
Source:FAO – AQUASTAT

It is also evident that the available data indicate a continuous decline in per capita renewable water resources, reaching levels that place Algeria among countries experiencing high water stress, below the internationally recognized water poverty threshold. At the same time, there has been an increasing reliance on groundwater

resources, particularly in southern regions, where abstraction rates in some aquifers exceed natural recharge levels, posing a serious threat to the long-term sustainability of these resources (FAO, 2021).

Within the context of assessing the degree of water stress, Figure (2) illustrates the trend in per capita renewable water resources in Algeria.

Fig.2. Trend in Per Capita Renewable Water Resources in Algeria (m³/person/year)



Source: World Bank – WDI

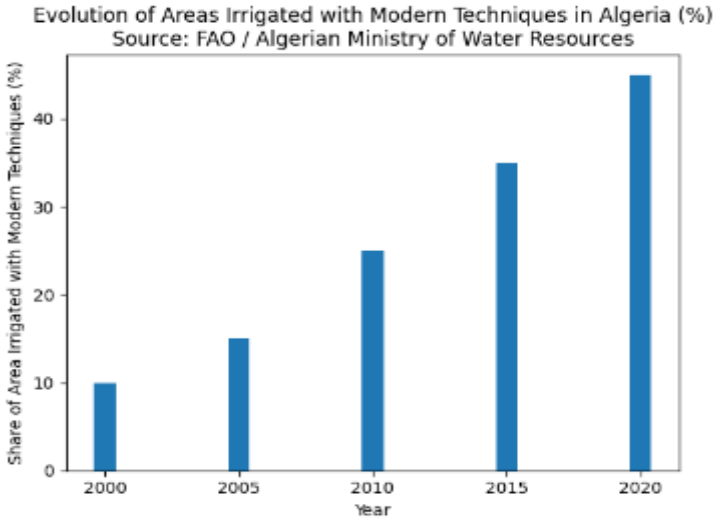
5.2 Indicators of Technical Efficiency in Agricultural Water Management

In recent years, Algeria has witnessed an expansion in the adoption of modern irrigation technologies, particularly drip irrigation, within the framework of policies aimed at rationalizing agricultural water use. However, FAO reports indicate that the performance of these technologies remains uneven, due to weak agricultural extension services, limited technical monitoring, and the lack of integration between financial support mechanisms and institutional guidance (FAO, 2017).

These indicators demonstrate that, despite their importance, technical improvements have not resulted in a substantial increase in water productivity, confirming that technical efficiency alone is insufficient

in the absence of effective water governance capable of coordinating policies and linking support measures to measurable outcomes. To illustrate the technical efforts undertaken to improve agricultural water-use efficiency, Figure (3) shows the evolution of areas irrigated with modern irrigation technologies in Algeria, allowing for an assessment of the impact of technical improvements within the existing institutional framework.

Figure .3. Evolution of Areas Irrigated with Modern Irrigation Technologies in Algeria (%)



Source:FAO / Algerian Ministry of Water Resources and Water Security

5.3 Indicators of Institutional Governance and Intersectoral Coordination

Reports by the World Bank and the United Nations Development Programme (UNDP) indicate that water management in Algeria is characterized by a multiplicity of actors and overlapping mandates across the water, agriculture, and environmental sectors. This institutional fragmentation results in weak coordination and higher transaction costs (World Bank, 2018; UNDP, 2019).

Moreover, decision-making processes remain largely centralized, with limited involvement of farmers and water users in planning and evaluation activities. This situation negatively affects the effectiveness of agricultural water policies and constrains their ability to respond to local environmental and socio-economic variations.

Table 1. Stakeholders Involved in Water Managem

Stakeholder / Institution	Main Role in Water Management	Level of Decision-Making
Ministry of Water Resources and Water Security	Strategic planning, water resource mobilization, and development of water infrastructure	Central
Ministry of Agriculture and Rural Development	Management of agricultural water use and irrigation systems	Central
Ministry of Environment and Renewable Energies	Environmental regulation, protection of water resources, and monitoring	Central
Provincial and Municipal Authorities	Local implementation of water policies and service delivery	Local (Executive)
Water Users Associations (Farmers)	Direct water use and limited participation in management processes	Local (Advisory)

Source: UNDP (2019); Algerian Ministry of Water Resources and Water Security.

5.4 Indicators of Water Pricing and Economic Incentives

According to international reports, agricultural water pricing in Algeria does not reflect its economic or environmental value, as water is provided at low or subsidized rates without linking consumption to levels of efficiency or productivity (Saleth & Dinar, 2004; OECD, 2015).

This situation has resulted and continues to result in distorted price signals, weakened economic incentives for water conservation, and the encouragement of water-intensive agricultural production patterns. Consequently, pressure on water resources has intensified, reducing the prospects for achieving agricultural sustainability.

The aforementioned indicators confirm that weak water governance in Algeria directly contributes to the fragility of agricultural systems through:

- declining water productivity;
- depletion of groundwater resources; and
- increased risks of unsustainability in the medium and long term.

Conversely, partial experiences aimed at improving institutional coordination and adopting more participatory approaches suggest that enhancing water governance indicators can have a positive impact on water-use efficiency and the sustainability of agricultural activities.

6. CONCLUSION

This study concludes that the agricultural water crisis in Arab countries should not be understood merely as a problem of natural resource scarcity; rather, it is fundamentally an institutional governance crisis, manifested in weak intersectoral coordination, limited stakeholder participation, distorted economic incentives, and the dominance of technical approaches at the expense of institutional reforms.

The indicator-based case study of Algeria demonstrates that improving the efficiency and sustainability of agricultural water use depends more critically on the quality of water governance systems than on resource availability or the adoption of technical solutions alone. Building on the results of the analysis, a set of strategic mechanisms for strengthening water governance in Arab countries can be identified, as outlined below:

- Restructuring the institutional framework for water management to ensure clear mandates, reduce overlapping roles among involved entities, and enhance coordination between water, agricultural, and environmental policies, thereby achieving institutional coherence and reducing transaction costs.
- Strengthening participatory approaches in water management by empowering local stakeholders particularly farmers and water user associations to engage effectively in the planning and evaluation of water policies. This would contribute to higher levels of policy compliance, improved water-use efficiency, and a stronger sense of collective responsibility toward water resources.
- Reforming agricultural water pricing systems by gradually linking prices to the economic and environmental value of water, while taking social considerations into account. Such reforms would help correct price signals, encourage the adoption of less water-intensive production patterns, and link agricultural subsidies to water-efficiency criteria.
- Enhancing water information systems and transparency through the development of accurate and integrated databases, improved inter-institutional data sharing, and the adoption of indicator-based monitoring and evaluation mechanisms. This would support evidence-based planning and strengthen institutional accountability.
- Integrating the institutional dimension into policies for technological innovation, so that modern irrigation technologies are not viewed as isolated solutions but as components of a comprehensive governance framework that combines economic incentives, institutional support, and capacity building. This integration is essential to ensure

tangible improvements in water productivity and agricultural sustainability.

In light of the above, the study emphasizes that adopting a comprehensive water governance approach, grounded in institutional reform, enhanced transparency and accountability, and policy integration, constitutes an indispensable strategic pathway for achieving agricultural sustainability and food security in Arab countries. It also underscores the importance of moving beyond the perception of water management as a purely technical sector toward recognizing it as a broader developmental and structural issue, requiring multi-level interventions that integrate policies, institutions, and local communities to ensure the rational and sustainable use of water resources in both the short and long term.

7. Appendices

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