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# Legal and Policy Frameworks for Water Sustainability in the Maghreb region: A Comparative Analysis of Algeria, Morocco, and Tunisia

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**Abstract.** Ensuring water sustainability in the Maghreb requires robust legal and policy frameworks. This article provides a comparative, interdisciplinary analysis of water law and governance in Algeria, Morocco, and Tunisia. Drawing on national laws, constitutional provisions, and international agreements, we examine how each country's legal framework addresses water scarcity, quality, and equitable access. The analysis uses a descriptive–comparative methodology to highlight strengths, gaps, and opportunities in existing regimes. We find that while Maghreb nations have established comprehensive water codes and enshrined water rights in their constitutions, enforcement challenges and policy fragmentation persist. Regional initiatives for the North-West Sahara Aquifer System and joint programs under Maghreb institutions demonstrate the potential for cooperation. We conclude with recommendations: modernizing legal instruments to meet contemporary challenges (e.g. climate change), integrating water policy with other sectors, and strengthening regional coordination. These insights aim to guide policymakers and scholars interested in sustainable water management in arid regions (United Nations, 2023; Belhassan, 2022; Kuzma et al., 2023).

## 1. INTRODUCTION

Water resources are foundational to human health, economic development, and environmental sustainability. In 2015 the United Nations recognized the human right to water and sanitation in the 2030 Agenda (SDG 6) – underscoring that "access to safe water, sanitation and hygiene is the most basic human need" (United Nations, 2023). Yet rapid population growth, urbanization, and climate change are increasing the demand on scarce supplies. Worldwide, highly water-stressed regions include the Middle East and North Africa, where 83% of people already face "extremely high-water stress," and projections suggest nearly 100% of the Maghreb population will be under extreme water stress by 2050.

North Africa's Maghreb is one of the world's most water-stressed regions. Recent data show that per capita freshwater availability is far below the commonly cited "water poverty" threshold of 1,000 m³/person-year (FAO, 2023). The Maghreb (primarily Algeria, Morocco, and Tunisia) lies mostly within arid and semi-arid zones. Its water scarcity is driven by low rainfall and high evapotranspiration, compounded by population growth, urban expansion, climate change, and pollution. Many of the world's water bodies are already under pressure: for example, Northern Africa has recorded critical water stress levels, exceeding 100% withdrawal of available renewable resources. Against this background, legal and policy measures are vital to manage demand, protect quality, and allocate water equitably. Effective water governance aligns with sustainable development goals and climate adaptation strategies.

This study compares the legal frameworks governing water in Algeria, Morocco, and Tunisia, with attention to recent reforms (e.g. constitutional amendments enshrining water rights). We ask whether existing laws comprehensively protect water resources and adapt to emerging challenges. In particular, we analyze: (1) each country's statutes, regulations, and institutions for water protection; (2) compliance with international standards (e.g. human-rights law, transboundary treaties); (3) implementation gaps and enforcement issues; and (4) regional cooperation mechanisms among Maghreb states. By identifying best practices and shortcomings, this analysis informs how Maghreb nations can update laws to ensure long-term water security.

### 1.1. Climate Change and Water Resource Pressures in the Maghreb

North Africa is among the world's most water-stressed regions, where renewable freshwater resources are extremely limited and unevenly distributed. Rapid population growth, agricultural expansion, and urbanization have intensified pressure on scarce water supplies, while recurrent droughts and rising temperatures linked to climate change further aggravate the crisis. Countries such as Algeria, Tunisia and Morocco already withdraw more than 80 % of their available renewable water each year, a threshold considered "extremely high stress." This chronic scarcity threatens food security, economic stability, and ecosystem health, calling for urgent reforms in water governance, investment in non-conventional resources such as desalination and wastewater reuse, and stronger regional cooperation for shared aquifer management (SIWI, 2023; WRI, 2019).

The Maghreb region is among the world's most water-stressed zones, facing converging threats from climate change, rising demand, and hydrological degradation. All three countries fall below the absolute water scarcity threshold of 500 m³ per capita per year (FAO, 2021). Morocco averages 620 m³, Tunisia 420 m³, and Algeria approximately 300 m³, with downward trends as populations grow and precipitation declines (FAO, 2021; World Bank, 2022).

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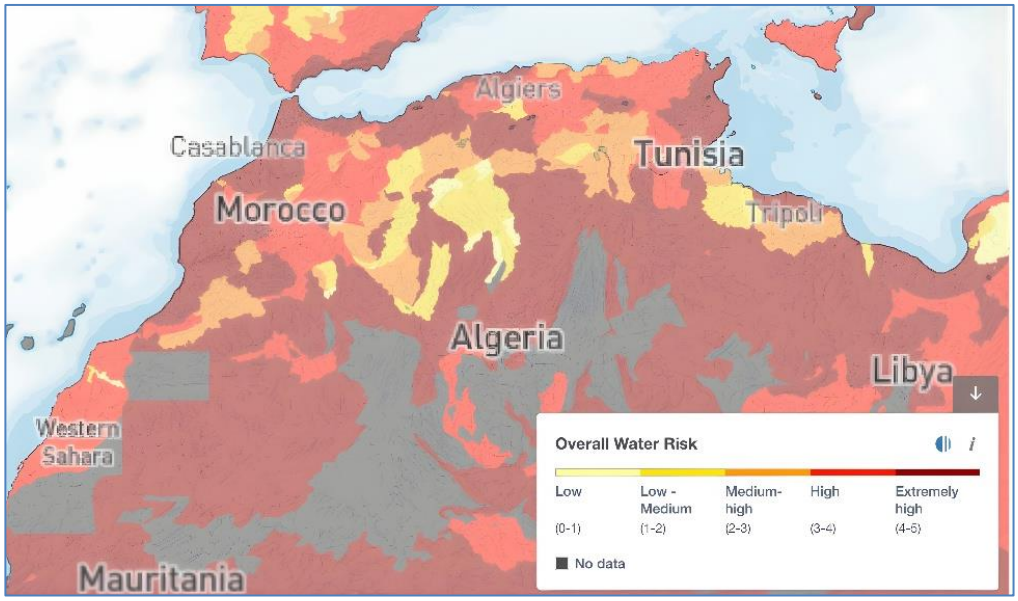


Figure 1. Spatial Distribution of Overall Water Stress in North Africa (WRI, 2019; SIWI, 2023).

Over the past four decades, North Africa has warmed at approximately 0.2–0.3 °C per decade—faster than the global average. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2021), the Mediterranean basin is a hotspot for climate change, with projected warming of 2–4 °C by 2100 under moderate emissions scenarios (Cramer et al., 2018). Tunisia's southern interior and Morocco's arid plains are particularly exposed to heat extremes and aridification (Schilling et al., 2020). Regional climate models project a decline in annual precipitation between 10–30% by mid-century, with significant increases in drought duration and intensity (Knutson et al., 2021).

The freshwater supply in the Maghreb is increasingly insufficient to meet rising demand. All three countries rely on variable rainfall and vulnerable aquifers. According to AQUASTAT (FAO, 2021), renewable internal freshwater resources per capita declined by over 65% in Algeria and Tunisia between 1990 and 2020. Groundwater overdraft is widespread: Tunisia's aquifers are exploited at over 125% of sustainable yield, particularly in regions like Kairouan and Gabès (Benabdallah et al., 2020). In Morocco, aquifer depletion in the Souss-Massa basin has led to government-imposed restrictions on agricultural groundwater use (Lejars et al., 2017).

Large reservoirs, once a backbone of supply, are increasingly unreliable. Morocco's Al Massira and Bin El Ouidane dams operated at less than 30% capacity during consecutive drought years between 2021–2023. Algeria's dam network, managed by ANBT, has also suffered declining inflows due to erratic rainfall, while Tunisia's Sidi Salem reservoir reached historical lows in 2022 (World Bank, 2022).

## 1.2. Data Analysis

To assess the effectiveness of legal-institutional frameworks, we compiled recent water resource and use data for Algeria, Morocco, and Tunisia. Table 1 summarizes indicators of renewable supply and stress for each country.

Table 1. Water resource statistics for Maghreb countries (Belhassan, 2022; World Bank, 2022).

| Indicator | Algeria | Morocco | Tunisia |
|---|---|---|---|
| Renewable freshwater (km³/yr) | 12.0 (2017) | 29.5 (2017) | 5.0 (2017) |
| Pop. (million, 2023) | 45.5 | 37.7 | 12.4 |
| Water per cap (m³/yr) | 270 | 828 | 360 |
| Water stress (% withdrawal) | 65–75% | 70–80% | >85% |
| % Withdrawals – Agriculture | 80% | 88% | 80% |
| Irrigated area (% of cropland) | 54% (2019) | 38% (2017) | 35% (2017) |
| Major dams (total cap., km³) | 15 | 18 | 4 |
| Desalination capacity (m³/day) | 1.7 million (2024) | 0.5 million (2023) | 0.2 (2024) |

These data highlight the dire situation. All three countries fall well below the 1,000 m³/year "water stress" threshold, with Tunisia especially low (≈360 m³). By WRI classification, Tunisia is already in extreme stress (>80% withdrawal of supply) whereas Morocco and Algeria are in the high-stress category. Agricultural use dominates (approaching 90% in Morocco), reflecting outdated irrigation practices. Per capita water has halved or more since independence: e.g. Algeria's 1960 value (~1500 m³) is now <300 m³.

The establishment of basin agencies, drinking water reforms, and recent codal changes. Notable entries include Morocco's 1995 Water Law (implemented 2016), Algeria's 2005 law, and Tunisia's 2014 basin reform. This visualization (derived from legal documents) shows that while all three countries accelerated reforms post-2000, follow-through has been uneven (e.g. Tunisia's new law still in draft).

## 2. METHODOLOGY

This study adopts a descriptive, analytical, comparative approach, reviewing legal texts, policy documents, and scholarly analyses to extract information on each country's water governance. This method, supported by cross-national research design principles, enables systematic comparison of statutes and institutional arrangements. Our sources include water codes, environmental laws, constitutional provisions, governmental reports, and academic literature. We synthesize qualitative data on

regulatory principles (e.g. sustainability, access rights) and administrative structures (e.g. water agencies, user committees) for each country. By comparing the Maghreb states side-by-side, we highlight how historical, political, and socioeconomic factors shape differing legal strategies for water sustainability.

## 2.1. National Legal Framework Overview

Algeria has long recognized the centrality of water to development. In 2005 it enacted a comprehensive Water Resources Law (Law No. 05-12), later amended by Laws No. 08-03 (2008) and Order No. 09-02 (2009) to refine implementation procedures. The 2005 law establishes core principles such as solidarity, equitable allocation, and environmental protection. It sets priorities for water uses, pollution control standards, and pricing mechanisms to encourage efficiency. A series of ministerial decrees elaborate technical rules (e.g. wastewater reuse for irrigation) and create institutions for river-basin management. In practice, Algeria's approach is integrated, with regional basin agencies overseeing supplies at the watershed level.

Notably, Algeria's 2020 constitutional amendment explicitly constitutionalized the right to water, stating that "the state shall ensure that the citizen has access to drinking water and shall work to preserve it for future generations" (Algerian Constitution, Art. 13, 2020). This enshrines water as a fundamental right and mandates government responsibility. In parallel, a specialized water police force was established to monitor compliance with water laws and combat pollution. Together, these developments affirm the government's commitment to water protection. Nevertheless, scholars note that enforcement has lagged behind legislation (Drouiche et al., 2012). For example, rural areas still face infrastructure deficits, and groundwater overuse remains a concern (Drouiche et al., 2020). In sum, Algeria's legal framework is among the most detailed in the region, but its real-world efficacy depends on improved implementation and funding for water management agencies.

Morocco has also developed an extensive legal regime for water. Its modern framework traces back to Water Law No. 10.95 (1995), which established river basin agencies (RBAs) and set broad objectives: guaranteeing urban drinking water, meeting irrigation needs, and safeguarding quality. The law embodies the principle of participation, imposing user fees and penalties for violations. For instance, noncompliance with pollution standards may incur fines or imprisonment, and many implementing decrees target wastewater treatment and protected zones. In response to new challenges, Morocco updated this regime with Law No. 36-15 (2016), expanding regulatory scope. Key enhancements include explicit recognition of citizens' right to sufficient water of good quality and legal provisions for non-conventional sources (desalination and treated wastewater). The 2011 Moroccan constitution similarly affirms water as a shared public responsibility: Article 31 requires the state and local authorities to "mobilize all available means to facilitate citizens' equal access to water" and protect the environment.

Morocco's reforms also emphasize climate adaptation and participation. The 2016 law mandates drought management planning and integrates climate resilience into basin planning. It simplifies licensing to encourage decentralized water governance and promotes gender equity in water committees. Observers note that Morocco's approach is progressive, especially in conceptualizing water as an economic and social right (Tazi Sadeq, 2020). However, water scarcity remains severe in some regions. For example, studies find that rainfall variability and rising demand have strained supply despite these laws (Del Vecchio & Barone, 2018). Ensuring compliance with water use restrictions and improving infrastructure (e.g. small-scale irrigation) are ongoing policy priorities.

Tunisia's water governance builds on a unified Water Code originally passed in 1975 and amended through 2001. The Code established water as a public domain resource and set rules for abstraction, distribution, and pollution control. Major amendments in 1987, 1988, 1994, and 2001 expanded the framework; for example, the 2001 amendment proclaimed water a "national wealth" to be protected and sustainably used. Over time, Tunisia strengthened its institutional capacity: the National Water Distribution Utility (SONEDE) and the National Sanitation Office (ONAS) manage drinking water and sewage, while the General Directorate of Water Resources grants licenses and monitors quality. These agencies operate under detailed regulations (e.g. quality standards at observation stations).

In 2014 Tunisia became the first MENA country to explicitly enshrine the right to water in its constitution. Article 44 states: "The right to water is guaranteed. The conservation of water and the rationalization of its use is a duty of the state and society". This constitutional guarantee reinforces the existing statutory regime. Tunisian law also addresses climate risks: recent policies emphasize demand management and reuse of treated wastewater (particularly in agriculture). Nevertheless, like its neighbors, Tunisia struggles with implementation gaps. Reports cite insufficient rural services and over-exploited aquifers (Jebari & Berndtsson, 2013; Bachta & Ben Nasr, 2020). Continued investment in monitoring networks and regulatory enforcement is needed to ensure that the legal framework achieves its sustainability goals.

# 3. RESULTS

## 3.1. Comparative Analysis with International Standards

All three Maghreb countries have acceded to key international water agreements and committed to the UN's human-rights framework (General Comment No. 15 and GA Resolution 64/292 on water and sanitation). In practice, however, the alignment between national laws and international norms varies. Algeria and Morocco have, for example, expressed support for principles of Integrated Water Resources Management (IWRM) – Morocco's RBAs are modeled on the IWRM concept. Morocco hosted UN events (the 1997 World Water Forum; COP22 in 2016) that signal its international engagement (Del Vecchio & Barone, 2018). Tunisia ratified the UN Watercourses Convention (1997) and the Paris Agreement, illustrating its formal compliance with transboundary and climate regimes (Tanzi et al., 2015).

Yet challenges remain. National plans often set ambitious targets (e.g. universal sanitation, 100% reuse of treated wastewater by a target date) that outpace current capacity. Funding constraints and bureaucratic bottlenecks can delay implementation of international commitments. For example, Algeria participates in the EU-funded PRIMA program on water reuse and agriculture, but domestic coordination of such initiatives is still emerging. On shared aquifers, Algeria and Tunisia have a 2002 agreement for joint management of the North-West Sahara Aquifer System, but fuller operationalization is incomplete (Drouiche, 2020). Overall, Maghreb countries "show divergence" between their stated commitments to international water norms and on-the-ground application. This gap underscores the need to adapt global water policy frameworks to local realities, and to strengthen cross-border cooperation under bodies like the Arab Maghreb Union and the Sahara-Sahel Observatory (OSS).

### 3.2. Challenges and Gaps in Implementation

Despite comprehensive legal codes, the Maghreb faces persistent obstacles in making laws effective. Key challenges include:

- Law enforcement: Political instability and limited budgets undermine enforcement of water regulations. In all three countries, monitoring agencies lack resources to track withdrawals or pollution in real time. The absence of clear community participation mandates (SDG 6.b) also weakens implementation of water laws.
- Monitoring and compliance: Robust enforcement requires data on water quality and quantity. However, many Maghreb states have sparse monitoring networks. Without real-time data, illegal drilling and contamination can go undetected. Efforts to install observation stations (as done in Tunisia) help, but broader network coverage is needed.
- Financial constraints: Upgrading water infrastructure (dams, treatment plants, pipelines) and funding agencies remain challenging under tight national budgets. This is especially acute in rural areas and informal settlements. Cost-recovery mechanisms (fees, tariffs) exist on paper but are not always sufficient or equitably applied.
- Policy integration: Water issues are cross-sectoral by nature. However, coordination between water ministries and agriculture, energy, or urban planning is uneven. For example, in some regions irrigation needs are not well balanced with urban supply demands. Integrating water policy with climate adaptation, energy policy (e.g. desalination), and food security strategies is still a work in progress.
- Climate change impacts: Increasing frequency of droughts and extreme weather events strains existing systems. All Maghreb states face projected declines in runoff and recharge. Legal frameworks have begun to address this (through drought contingency plans and flexible allocation rules), but adaptive management will require continual updating of laws and greater use of non-conventional sources.
- Technological and infrastructural gaps: Investments in new technologies like advanced desalination and wastewater reuse are at early stages. The region's reliance on traditional groundwater and surface sources leaves it vulnerable. Building capacity in innovative water-saving techniques (e.g. drip irrigation, water recycling) is needed to fulfill the intent of sustainability laws.

### 3.3. Regional Cooperation in the Maghreb

Water in the Maghreb is transboundary by necessity. Recognizing this, Algeria, Morocco, and Tunisia have participated in regional initiatives. Under the Sahara-Sahel Observatory (OSS), the three countries agreed in 2002 to jointly manage the North-West Sahara Aquifer System (NWSAS). This mechanism establishes joint studies and a consultative framework to monitor the aquifer and share data. Although implementation has been slow, it lays a foundation for multilateral water planning.

Other regional cooperative projects include:

- CREM (Maghreb Sustainable Water Management): A technical cooperation platform that promotes knowledge-sharing and harmonized policies among Algeria, Morocco, and Tunisia. It focuses on capacity-building and joint research, acknowledging that shared hydrological features (drought, aquifers) require coordinated responses.
- Regional Initiative on Water Scarcity (NENA): A broader Arab/MENA program addressing drought resilience, in which Maghreb states participate. This initiative assists with developing comprehensive drought strategies and policy guidelines.
- Maghreb Environmental Protection Charter: A multilateral agreement (under the Arab Maghreb Union) that integrates water conservation into broader environmental goals. It provides a policy framework for collective action on resource management (Oualkacha et al., 2017).
- Non-Conventional Water Dialogue: Cooperative efforts to explore desalination and reuse. For instance, Morocco and Algeria have exchanged best practices on wastewater treatment technology. These dialogues aim to increase regional capacity for alternative water sources (Sebri, 2017).

Despite these efforts, cooperation is impeded by political and economic factors. Tensions within the Maghreb (e.g. between Morocco and Algeria) have often stymied deeper institutional integration. Divergent policy priorities and investment capabilities mean that strategies (like desalination) are pursued at different paces. There is also a lack of a supra-national authority for water: unlike Europe's River Basin Districts, the Maghreb has no equivalent to enforce regional water law. As one expert notes, stronger political will and a dedicated regional water commission could transform these multilateral agreements into effective projects.

## 4. DISCUSSION

### 4.1. Key Research Findings

Our comparative analysis yields several core insights:

- Existing Legislation: Algeria, Morocco, and Tunisia have all enacted detailed water laws and regulations. These cover allocation, quality standards, and penalties for misuse. Each has also established institutions (basin agencies, utilities) to implement these laws. National frameworks generally align with IWRM principles, at least on paper.
- Constitutional Rights: Morocco (2011) and Tunisia (2014) explicitly guarantee the right to water in their constitutions, with Algeria following in 2020. This elevates water access to a fundamental right and can empower civil society to demand accountability.
- Strengths: All three countries emphasize sustainability and pollution control. Newer laws explicitly address climate resilience, and significant reforms have introduced modern concepts (e.g. participatory management, gender equity in water committees). Some countries have also implemented economic instruments (tariffs, fines) to rationalize use.
- Weaknesses: Many legal provisions date to the late 20th century and have not kept pace with emerging issues. Enforcement is inconsistent, and penalties for violations are often not levied. Over-allocation of some water bodies (especially aquifers) continues due to outdated or insufficiently enforced licensing. Moreover, not all laws explicitly address ecosystem health (e.g. environmental water flows) despite rising concern.
- Regional Coordination: While bilateral and multilateral forums exist, the Maghreb lacks a fully harmonized regional water strategy. Unlike European or North American examples, there is no supranational water treaty among Maghreb states (aside from limited bilateral accords). This fragmentation means each country largely acts unilaterally, missing opportunities for joint infrastructure or data-sharing.

- Policy Integration: Where countries have linked water management to agriculture, environment, or energy policy, results are positive. For example, Morocco's National Water Plan aligns irrigation investments with climate adaptation. However, integration is uneven: some sectors (e.g. mining, tourism) still operate under legacy rules that do not reflect current scarcity challenges.

In summary, the Maghreb has a strong legal foundation for water protection, but implementation gaps and incomplete integration pose risks to sustainability. The region's considerable water stress – already among the highest globally – will only be managed if laws are rigorously applied and updated.

## 4.2. Conclusions and Recommendations

Water security in the Maghreb is at a critical juncture. Growing demand, climate variability, and pollution pressures mean that the robustness of legal frameworks and policies will determine future outcomes. Our analysis shows that while Algeria, Morocco, and Tunisia have made important strides (e.g. constitutional water rights, basin-level management), significant reforms are still needed to ensure enduring sustainability.

We offer the following recommendations for policy and law improvement:

- Modernize Water Legislation: Update outdated water codes to address contemporary issues such as climate change adaptation, pollution from new industrial activities, and the protection of aquatic ecosystems. Incorporate environmental water allocations (instream flows) and strengthen enforcement provisions. Drawing on international best practices (Salman & Bradlow, 2006), Maghreb countries should refine licensing and penalty systems to ensure compliance.
- Enhance Integrated Management: Promote genuine IWRM by aligning water law with agriculture, energy, and environmental policies. For example, integrate crop planning and water-saving mandates, and ensure energy-intensive sectors (like mining and desalination) operate under water conservation rules. Facilitating multi-sector committees can institutionalize cross-cutting decision-making.
- Invest in Monitoring and Infrastructure: Allocate resources to modernize water monitoring networks (remote sensing, telemetry) so that laws can be enforced in real time. Expand infrastructure for wastewater treatment, desalination, and rainwater harvesting. For instance, adopting advanced irrigation systems (drip, pivot) and reuse of treated effluent in agriculture can substantially reduce freshwater demand (Rebelo et al., 2020).
- Strengthen Institutions and Civil Participation: Ensure that water agencies have sufficient technical capacity and independence. Encourage public participation (e.g. as mandated by SDG 6) in water management decisions and oversight, perhaps through empowered Water Users Associations or advisory councils (as Algeria's National Advisory Council for Water). Transparent reporting and stakeholder engagement can improve legitimacy and compliance.
- Promote Regional Cooperation: Deepen Maghreb collaboration by revitalizing joint bodies (OSS, NWSAS Commission) and creating binding arrangements where feasible. For shared aquifers or rivers, negotiate clear joint management agreements. Consider convening a Maghreb Water Forum to share data and best practices. Leveraging common technologies (e.g. regional desalination centers) could achieve economies of scale. Political commitment to regional water issues should be elevated to match the urgency.

Ultimately, safeguarding water in the Maghreb will require harmonizing national laws with international norms and local realities. By refining legal frameworks and policies, and by fostering cooperation, Maghreb countries can improve resilience against water scarcity. This aligns with Sustainable Development Goal 6 ("clean water and sanitation for all") and supports the Maghreb's broader goals of stability, economic growth, and environmental protection.

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