

Promoting Food security in some Maghrebi countries: the current situation and future prospects of water resources

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Abstract: This study examines the current situation and future prospects of water resources in selected Maghrebi countries and their relationship with food security. It adopts a comparative analytical approach based on official reports, international data, and previous studies. The research highlights the major challenges affecting water security in the region, including climate change, drought, population growth, and increasing agricultural demand. The findings show that water resources play a key role in achieving food security, while inefficient water management and groundwater depletion continue to threaten agricultural sustainability. The study concludes that improving water governance, modernizing irrigation systems, expanding non-conventional water resources, and strengthening regional cooperation are essential for achieving sustainable water and food security in the Maghreb region.

Keywords : Water resources, Maghreb countries, food security

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Introduction:

Water scarcity has become one of the most pressing environmental and developmental challenges facing the Maghreb region. In recent decades, climate change, recurrent droughts, population growth, and increasing economic activity have intensified pressure on available water resources in countries such as Algeria, Morocco, Libya, and Mauritania. These challenges directly affect agricultural production and threaten food security, particularly because agriculture remains the largest consumer of water resources in the region.

The Maghreb countries are characterized by arid and semi-arid climatic conditions, irregular rainfall, and increasing temperatures. According to several international reports, the region is among the most water-stressed areas in the world, with some countries approaching the threshold of absolute water scarcity. This situation has serious economic, environmental, and social implications, especially in light of the growing demand for food and water resulting from demographic expansion and urbanization.

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Water resources in the Maghreb region are distributed unevenly and include both conventional sources, such as rainfall, surface water, and groundwater, and non-conventional sources, including desalinated seawater and treated wastewater. Although governments in the region have invested heavily in dams, desalination plants, and irrigation infrastructure, water shortages continue to intensify due to climate variability, inefficient management, groundwater overexploitation, and rising consumption levels.

In this context, achieving food security has become closely linked to the sustainable management of water resources. Food production in the Maghreb countries depends heavily on irrigation and climate conditions, making agriculture particularly vulnerable to water scarcity and environmental degradation. Consequently, improving water governance and increasing water-use efficiency have become strategic priorities for ensuring long-term agricultural sustainability and reducing dependence on food imports.

Based on these challenges, this study seeks to answer the following research questions:

- What is the current situation of water resources in selected Maghrebi countries?
- What are the main challenges affecting water security in the region?
- To what extent can effective water resource management contribute to strengthening food security in the Maghreb countries?

The study is based on the hypothesis that improving the management and governance of water resources, particularly in the agricultural sector, can significantly contribute to enhancing food security and reducing the vulnerability of Maghrebi countries to future environmental and food crises.

This study aims to:

- analyse the current situation and future prospects of water resources in the Maghreb region;
- examine the relationship between water scarcity and food security;
- compare the major water-related challenges facing Algeria, Morocco, Libya, and Mauritania;
- evaluate the role of water management policies in supporting agricultural sustainability and food security.

Methodology

This study adopts a comparative analytical approach to examine water resources and their relationship to food security in selected Maghrebi countries, namely Algeria, Morocco, Libya, and Mauritania. The research is based on both qualitative and quantitative data collected from official national reports, international organizations, and previous academic studies.

The study relies on comparative indicators related to water availability, agricultural water consumption, desalination capacity, groundwater use, and projected water demand. It also analyses the impact of climate change and water scarcity on agricultural production and food security in the region.

In addition to descriptive analysis, the study adopts a comparative perspective in order to identify similarities and differences among the selected countries regarding water challenges, management strategies, and future policy responses.

Review of Existing Literature

The relationship between water resources and food security has received increasing attention in economic, environmental, and agricultural research, particularly in arid and semi-arid regions. Previous studies have emphasized that water scarcity represents one of the main obstacles to achieving sustainable food security in North Africa and the Arab region.

Sidjilali and Nasser (2023) argued that weak coordination between water and agricultural policies in Arab countries contributes to increasing food insecurity under climate change conditions. In the Algerian context, Ben Issa (2022) highlighted the limitations of current water policies in achieving agricultural self-sufficiency despite major investments in water infrastructure.

At the international level, the International Water Management Institute (IWMI, 2018) stressed that improving agricultural water management is essential for ensuring global food security, particularly because agriculture remains the largest consumer of freshwater resources worldwide. Similarly, UNESCO's World Water Development Report (2023) emphasized that climate change and unsustainable groundwater exploitation threaten long-term water and food security in several arid regions.

Despite the richness of previous literature, most existing studies have focused either on global trends or on individual country cases. Few studies have comparatively examined the Maghreb region as an integrated geographical and environmental space facing common water and food security challenges. Therefore, this study seeks to contribute to the existing literature by providing a comparative analysis of water resources, water use, and food security challenges in selected Maghrebi countries.

II. Water resources in the Maghreb countries

Water resources in the Maghreb countries come from both traditional and non-traditional sources. Traditional resources include naturally available water such as rainfall, surface water, and groundwater, while non-traditional resources mainly refer to treated or desalinated water. Due to increasing water stress and climate change, Maghrebi countries are becoming increasingly dependent on non-conventional water resources to meet agricultural and domestic needs.

2.1 Natural water sources

2.1.1 Rainwater

Rainfall remains one of the main natural water sources in the Maghreb region. However, precipitation levels are highly irregular across seasons and from one year to another. In some cases, heavy rainfall occurs within short periods, causing floods that damage infrastructure and agricultural lands. At the same time, long periods of drought reduce water availability and negatively affect agricultural production.

Most annual rainfall occurs during autumn and winter, representing nearly 75–85% of total yearly precipitation. In contrast, spring rainfall remains limited, while summer is extremely dry, with temperatures often exceeding 40°C. Climate projections indicate that the region may experience a temperature increase of between 2 and 4°C by 2100, accompanied by a decline in rainfall and rising sea levels (Didouh, 2021). These changes are expected to intensify pressure on water resources and increase the vulnerability of food systems, particularly in countries that depend heavily on rain-fed agriculture.

Although Maghrebi countries share similar climatic conditions, the impact of rainfall variability differs from one country to another according to storage capacity, irrigation infrastructure, and water management policies. Morocco, for example, has invested significantly in dam infrastructure, while other countries continue to face difficulties in capturing and storing seasonal rainfall.

2.1.2 Surface water

Surface water resources are unevenly distributed across the Maghreb region. The region can generally be divided into three geographical zones.

The first zone includes the arid desert areas located in southern Algeria, Morocco, and Tunisia, in addition to most parts of Libya and Mauritania. These regions receive very limited rainfall, and rivers or wadis flow only during short periods of intense precipitation.

The second zone is the semi-humid area situated north of the Atlas Mountains in Algeria, Morocco, and Tunisia. This area contains more than 80% of the region's surface water resources and represents the main agricultural zone in the Maghreb.

The third important source is the Senegal River in southern Mauritania. The river is shared between Mauritania, Senegal, Mali, and Guinea, with annual flows estimated between 4 and 8 billion cubic meters. This shared resource plays an important role in supporting agriculture and food production in Mauritania.

The unequal distribution of surface water explains the differences in agricultural potential between Maghrebi countries. Countries with relatively better access to surface water resources

are generally more capable of supporting irrigated agriculture and reducing food import dependency.

2.1.3 Groundwater

Groundwater represents a strategic water resource for all Maghrebi countries, especially in areas affected by drought and irregular rainfall. In recent decades, dependence on groundwater has increased significantly due to population growth, agricultural expansion, and industrial activities.

However, excessive extraction and weak regulation have contributed to the depletion of renewable groundwater reserves. Several environmental problems have emerged, including falling water tables, drying wells, and increasing salinity in coastal aquifers as a result of seawater intrusion.

Groundwater resources in the Maghreb are estimated at approximately 17 billion cubic meters, around 40% of which consists of non-renewable fossil water located in desert aquifers shared mainly between Algeria, Tunisia, and Libya. These aquifers contain enormous reserves accumulated over thousands of years.

Libya is among the countries most dependent on groundwater extraction, particularly for agricultural and industrial uses. Algeria and Libya also consume large quantities of non-renewable groundwater in petroleum-related activities. This growing pressure on shared aquifers may create future tensions between neighboring countries if extraction policies remain uncoordinated. (Didouh, 2021, p. 170)

In response to these challenges, several Maghrebi countries have launched programs aimed at improving groundwater management, including water sustainability projects and investments in efficient irrigation systems. Nevertheless, the long-term sustainability of groundwater remains uncertain under current climate and consumption patterns.

2.2 Non-natural water resources:

The increasing scarcity of freshwater resources has encouraged Maghrebi countries to develop alternative water sources, particularly in urban and coastal areas.

2.2.1 Wastewater:

Urban growth and rising water consumption have increased the volume of wastewater generated in the region. Untreated wastewater creates serious environmental and health problems, which has pushed many countries to invest in wastewater treatment and recycling.

Although treatment technologies remain costly, treated wastewater has become an important alternative source for irrigating green spaces, forests, fodder crops, and certain industrial activities. Reusing treated water also reduces pressure on conventional freshwater resources.

2.2.2 Agricultural wastewater:

Traditional irrigation methods often lead to water losses and soil salinization. In many irrigated areas, excess agricultural water raises groundwater levels and damages soil quality. For this reason, drainage systems are increasingly used to collect and redirect agricultural wastewater.

After appropriate treatment, this water can be reused in selected industrial or agricultural activities. Improving irrigation efficiency remains essential for reducing water waste and protecting agricultural productivity in the region.

2.2.3 Industrial water:

Industrial activities such as mining, chemicals, textiles, and leather production consume considerable quantities of water and often generate highly polluting waste. To reduce environmental pressure and limit freshwater consumption, industries are increasingly encouraged to treat and reuse industrial water several times before disposal.

This approach contributes not only to water conservation but also to reducing pollution and improving the availability of freshwater resources for drinking and agriculture.

2.2.4 Saltwater:

Desalinated water is becoming an increasingly important resource in the Maghreb region, particularly in coastal countries facing severe water shortages. Seawater desalination provides an alternative solution for drinking water and industrial use, especially where conventional water resources are insufficient.

Despite its strategic importance, desalination remains expensive and energy-intensive, which limits its use in agriculture. However, technological progress and the expansion of renewable energy projects may reduce costs in the future and strengthen the role of desalination in regional water security strategies.

III. The current situation and future of water resources in the Maghreb countries:

Maghrebi countries are currently facing growing water stress as a result of climate change, recurrent droughts, population growth, and increasing agricultural demand. Although these countries share similar climatic constraints, the severity of water scarcity and the capacity to address it vary according to economic resources, infrastructure, and water governance strategies. This section analyses the current situation of water resources in Algeria, Morocco, Libya, and Mauritania, while highlighting future challenges and policy responses.

The following table presents a comparative overview of the main water resource indicators in selected Maghrebi countries:

Table 3.1. Comparative Indicators of Water Resources in Selected Maghreb Countries

Indicator	Algeria	Morocco	Libya	Mauritania
Per capita water availability	440 m ³ /year	<650 m ³ /year	310 m ³ /year (projected)	1460 m ³ /year
Main water source	Groundwater and dams	Dams and desalination	Fossil groundwater	Senegal River
Agricultural water consumption	>70%	~85%	~80%	High
Dependence on desalination	Increasing	Strategic priority	Limited	Very limited
Main water challenge	Drought and overexploitation	Climate variability and declining rainfall	Groundwater depletion	Weak infrastructure and rainfall scarcity

Source: Prepared by researchers based on FAO AQUASTAT (2016), World Bank (2018), and national water reports.

The table highlights significant disparities in water resource availability and management among Maghrebi countries. Algeria and Morocco have diversified their water strategies through dams and desalination projects, while Libya remains heavily dependent on non-renewable groundwater reserves. Mauritania, despite relatively higher per capita water availability, continues to face structural challenges related to weak infrastructure and irregular rainfall. The table also shows that agriculture remains the largest consumer of water resources across the region, increasing pressure on long-term water sustainability and food security.

3.1 Water resources in Algeria:

In recent years, Algeria has experienced increasing pressure on its water resources due to declining rainfall and rising temperatures. These climatic changes have significantly affected dam storage levels and freshwater availability, especially in densely populated northern regions. According to international indicators, Algeria is among the countries most exposed to water stress, with annual per capita water availability falling to nearly 440 m³, well below the international water poverty threshold of 1,000 m³ per year.

Algeria's water resources consist of both conventional and non-conventional sources. Surface water resources are mainly concentrated in the northern regions, while southern Algeria contains vast groundwater reserves shared with Libya and Tunisia. (Yennoun, 2016, p. 111). . These transboundary aquifers are considered strategically important for the future of agriculture and water security in the region.

However, heavy dependence on groundwater extraction raises serious sustainability concerns. Excessive use of fossil groundwater, particularly in agriculture and petroleum activities, may accelerate depletion and increase the risk of regional tensions over shared water reserves. Similar concerns have been highlighted by the United Nations World Water Development Report (UNESCO, 2023), which warned that unsustainable groundwater extraction in arid regions could threaten long-term food production and regional stability.

To strengthen water security, Algeria has expanded investments in dams, desalination plants, wastewater treatment facilities, and water transfer systems. By 2024, desalinated seawater accounted for nearly 42% of drinking water supply, and this share is expected to increase significantly by 2030. Algeria's strategy reflects a gradual shift toward non-conventional water resources in response to climate uncertainty and growing urban demand.

At the same time, the government has encouraged wastewater reuse in agriculture and promoted more efficient irrigation methods in order to reduce pressure on groundwater reserves. These measures are particularly important because agriculture remains one of the largest consumers of water in the country (Taha Derbal, 18 January 2025)

The national dam fill rate in 2023 and 2024 was distributed by region as follows:

Table 3.2. Regional Distribution of Dam Fill Rates in Algeria (2023–2024)

Region	2023	2024
East Algeria	60.12%	53.45%
West Algeria	17.88%	43.76%
Central Algeria	16.96%	16.96%
National Average	35.40%	35.40%

Source: Prepared by the researchers based on official data from the Algerian Ministry of Hydraulics for the period 2023–2024.

The table shows important regional disparities in water availability. Eastern Algeria recorded the highest dam filling rates due to relatively higher rainfall and better storage conditions, while central regions continued to experience severe pressure on water resources. These differences illustrate the unequal spatial distribution of water resources within the country and underline the importance of integrated water transfer policies.

3.2 Water Resources in Morocco

Morocco is considered one of the most vulnerable countries in the Maghreb region to future water scarcity. Although the country possesses relatively diversified water resources, climate change and repeated droughts have significantly reduced water availability during the last decade.

Rainfall levels declined sharply in recent years, reaching historically low levels in 2022. Snowfall areas in the Atlas Mountains also decreased considerably, reducing natural water reserves that traditionally supply rivers and dams. As a result, per capita water availability has fallen below 650 m³ annually and is expected to decrease further in the coming years.

Unlike Algeria, Morocco has relied heavily on large-scale dam policies since the 1960s. This strategy enabled the country to build substantial storage infrastructure and support irrigated agriculture. Nevertheless, prolonged drought has reduced dam filling rates and exposed the limits of conventional water policies under changing climatic conditions.

To address these challenges, Morocco has accelerated investment in desalination plants, wastewater treatment, and irrigation modernization. The country has also expanded drip irrigation systems, which currently irrigate nearly 700,000 hectares and save significant quantities of water annually.

Despite these efforts, agriculture continues to consume approximately 85% of national water resources. This has generated criticism regarding the sustainability of certain export-oriented agricultural products requiring large amounts of water, especially watermelons and citrus crops. Several researchers have argued that Morocco's agricultural strategy should be reconsidered in order to balance export revenues with long-term water security (Bank., 2022)

Morocco's recent water strategy increasingly emphasizes renewable energy-powered desalination, groundwater protection, and institutional reforms aimed at improving water governance and reducing losses in distribution networks.

3.2 Water resources in Libya:

Libya faces one of the most severe water crises in the region due to its extremely arid climate and limited renewable water resources. The country depends almost entirely on groundwater, which supplies approximately 97% of total water demand.

The Great Man-Made River project remains the backbone of Libya's water system, transporting fossil groundwater from southern aquifers to coastal cities where most of the population is concentrated. Although this project has supported agricultural and urban development for decades, its sustainability remains highly uncertain because it relies mainly on non-renewable groundwater reserves.

Water demand in Libya has increased rapidly due to population growth, urban expansion, and inefficient consumption patterns. At the same time, political instability and armed conflict since 2011 have weakened infrastructure maintenance and disrupted water management systems. Repeated attacks on water infrastructure have further reduced water availability in several regions.

Libya also records extremely high levels of water consumption compared to neighboring countries. Excessive groundwater extraction has contributed to declining aquifer levels and increasing salinity, particularly in coastal areas. These developments directly threaten agricultural productivity and food security.

Although seawater desalination could reduce pressure on groundwater resources, the sector remains underdeveloped because of high costs, poor maintenance, and limited institutional capacity. According to FAO (2016), most desalination plants operate below their production capacity, while wastewater treatment remains insufficient.

The Libyan case demonstrates how political instability can intensify environmental vulnerability and weaken water security, even in countries possessing significant groundwater reserves. (Nations, 2005).

3.4 Water resources in Mauritania

Mauritania faces major water challenges due to its desert climate, low rainfall, and limited surface water infrastructure. Unlike Algeria and Libya, Mauritania depends heavily on seasonal rivers and rainfall concentrated in short periods.

The Senegal River represents the country's most important surface water resource and plays a key role in supporting irrigation and agricultural activities. Several dams, including the Diama Dam and Fom Ghalita Dam, contribute to irrigation and water storage. However, the country still loses substantial quantities of rainwater because of insufficient storage infrastructure.

Rapid population growth, weak water management, and pollution have increased pressure on available resources. Agriculture remains highly vulnerable to climatic fluctuations, particularly because irrigation infrastructure remains limited in many rural areas.

In response, Mauritania has launched ambitious programmes to construct dams and water reservoirs aimed at improving water storage and supporting agriculture and livestock production. The country's water strategy for 2030 also emphasizes sustainable groundwater management, improved sanitation, and increased investment in water infrastructure.

Compared with other Maghrebi countries, Mauritania possesses fewer financial and technological resources to address water scarcity. Nevertheless, its relatively lower population density and access to the Senegal River provide important opportunities for improving agricultural water management in the future. (Nations(FAO), 2016)

IV. Water use in the Maghreb countries

Water use in the Maghreb countries is distributed across several sectors, mainly agriculture, industry, tourism, and domestic consumption. However, the agricultural sector remains by far the largest consumer of water resources in the region. The growing imbalance between water

availability and water demand has become one of the major challenges affecting sustainable development and food security in North Africa.

4.1 Water use in agriculture

Agriculture is the backbone of water consumption in all Maghrebi countries, accounting for approximately 70–85% of total water use depending on the country (Nations(FAO), 2016) This high dependence is mainly explained by arid climatic conditions, irregular rainfall, and the expansion of irrigated agriculture aimed at increasing food production and reducing dependence on food imports.

Countries such as Morocco and Algeria have invested heavily in irrigation infrastructure, dams, and groundwater extraction to support agricultural production. However, the rapid expansion of irrigation has also intensified pressure on water resources, particularly groundwater reserves. Excessive pumping, illegal well drilling, and inefficient irrigation methods have contributed to falling groundwater levels, increasing salinity, and land degradation in several agricultural regions.

The challenge facing Maghrebi countries today is not only the scarcity of water resources, but also the efficiency of water use in agriculture. Traditional irrigation methods, especially flood irrigation, continue to cause considerable water losses through evaporation and seepage. According to the World Bank (2022), improving irrigation efficiency could significantly reduce agricultural water consumption while maintaining productivity levels.

In response, many countries in the region have adopted modern irrigation technologies such as drip irrigation, sprinkler systems, and pivot irrigation. These techniques allow more precise water distribution and can reduce water losses by 30–40% compared to conventional irrigation methods. Morocco, in particular, has expanded drip irrigation systems within the framework of its Green Morocco Plan, while Algeria has encouraged the use of water-saving technologies in southern agricultural projects.

Despite these efforts, important challenges remain. In several areas, water-intensive crops continue to be cultivated despite severe water shortages. This situation raises questions about the long-term sustainability of current agricultural policies, especially in countries seeking to expand agricultural exports while facing increasing climate pressures.

The relationship between water management and food security is therefore becoming increasingly complex. Improving agricultural productivity can no longer depend solely on increasing water extraction, but rather on achieving greater efficiency, promoting climate-smart agriculture, and adopting sustainable cropping systems.

4.2 Water use in industry:

Industrial water consumption in the Maghreb region remains lower than agricultural consumption, but it has increased steadily in recent years due to industrial expansion, urbanization, and economic diversification policies.

Industries such as mining, chemicals, textiles, food processing, oil refining, and construction materials require large quantities of water during production processes. In countries such as Algeria and Libya, the energy sector also consumes significant amounts of water, particularly in petroleum extraction and refining activities.

One of the major concerns associated with industrial water use is pollution. Industrial wastewater often contains chemical substances and heavy metals that threaten both surface water and groundwater quality. Inadequate treatment of industrial wastewater increases environmental degradation and reduces the availability of safe water for agriculture and human consumption.

To address these challenges, several Maghrebi countries have introduced regulations encouraging industries to recycle and reuse treated wastewater. Morocco and Tunisia, for example, have developed wastewater treatment programmes aimed at reducing industrial pollution and improving water sustainability.

Nevertheless, industrial water management in the region still faces important institutional and technological constraints, including limited treatment infrastructure, weak monitoring systems, and insufficient investment in water-efficient technologies. ((FAO), AQUASTAT Country Profile – Maghreb countries. FAO, 2016)

4.3 Water use in tourism

Tourism represents an increasingly important source of water consumption in several Maghrebi countries, especially Morocco and Tunisia. Tourist facilities such as hotels, resorts, swimming pools, golf courses, and green recreational spaces require large quantities of water, particularly during the summer season when water demand is already high.

Studies show that water consumption per tourist can be more than double the average domestic consumption of local populations. This situation creates additional pressure on water resources in coastal and desert areas where freshwater availability is already limited.

The expansion of tourism infrastructure in water-stressed regions raises important sustainability concerns. In some cases, competition between tourism, agriculture, and domestic consumption may intensify during drought periods.

For this reason, sustainable tourism policies are becoming increasingly necessary in the Maghreb region. Several countries have started promoting water-saving technologies in hotels,

wastewater reuse for landscape irrigation, and desalination projects to support tourist areas. However, further efforts are needed to integrate water sustainability into tourism development strategies.

Overall, the future of water security in the Maghreb countries will depend largely on improving water governance and increasing efficiency across all sectors, particularly agriculture, which remains the key factor linking water resources to food security.

V. Water Needs and Their Relationship to Food Security in the Maghreb region

Water security and food security are closely interconnected in the Maghreb region. Increasing pressure on water resources due to climate change, population growth, urban expansion, and agricultural demand has made water scarcity one of the most serious development challenges facing North African countries. In this context, ensuring sufficient and sustainable water supplies has become a strategic priority directly linked to economic stability, agricultural productivity, and national security.

Maghrebi countries are increasingly aware that achieving food security cannot rely solely on expanding agricultural production. It also depends on the efficient management of water resources, particularly because agriculture remains the largest consumer of water in the region. Consequently, several countries have begun adopting integrated water management strategies focused on desalination, wastewater reuse, irrigation modernization, and climate adaptation policies.

5.1 Current and future water resource needs in the Maghreb countries

The Maghreb region is classified among the most water-stressed regions worldwide. Future projections indicate that water demand will continue to rise significantly due to demographic growth and economic expansion, while renewable freshwater resources are expected to decline because of climate change and recurrent droughts.

This growing imbalance between supply and demand threatens not only water security but also agricultural sustainability and food production capacity. According to the World Bank several Maghrebi countries may face critical water shortages by 2030 if current consumption patterns continue without substantial reforms in water governance and agricultural management (Bank, 2018).

The following table summarizes the projected evolution of water demand in selected Maghrebi countries:

Table 5.1 Projected Water Demand in Selected Maghreb Countries

Country	Water Demand in 2000	Projected Demand in 2025/2030	Projected Demand in 2050
Algeria	7.4 billion m ³	Increasing demand due to population growth	Continued increase expected
Morocco	—	14.198 billion m ³ by 2030	Severe water stress expected
Libya	5.58 billion m ³	7.63 billion m ³ by 2025	10.09 billion m ³
Mauritania	5.13 billion m ³	Increasing demand with demographic growth	Continued pressure on resources

Source: Compiled by the researchers based on World Bank (2018), FAO AQUASTAT (2016), and national statistics.

The table demonstrates the rapid growth in water demand across the Maghreb region. Libya is expected to witness one of the sharpest increases in water demand despite its extremely limited renewable water resources. Morocco also faces growing pressure due to climate change and population growth. These projections indicate that future food security in the region will largely depend on improving water governance, reducing waste, and increasing the efficiency of agricultural water use.

5.1.1 Water Needs in Algeria

Algeria possesses relatively important water resources compared to some neighboring countries, estimated at approximately 20 billion m³ annually. However, rapid demographic growth and increasing agricultural demand have intensified pressure on available resources.

Agriculture alone consumes more than 70% of total water use, reflecting the country's heavy dependence on irrigation for food production. At the same time, domestic and industrial demand continues to rise, especially in urban areas.

To reduce pressure on conventional water resources, Algeria has expanded investments in desalination and wastewater treatment. Desalination plants currently represent an increasingly important component of national water policy, particularly for supplying coastal and northern regions.

Nevertheless, the sustainability of Algeria's water strategy remains closely linked to improving irrigation efficiency and reducing groundwater overexploitation. Expanding agricultural production without rationalizing water use could increase future water deficits despite the country's investments in infrastructure (Nations, AQUASTAT Country Profile – Algeria. FAO, 2016)

5.1.2 Water Needs in Morocco

Morocco is expected to face significant water deficits in the coming decades due to declining rainfall, population growth, and the expansion of agricultural and industrial activities. Domestic water demand alone is projected to increase substantially by 2030.

The agricultural sector remains the dominant consumer of water resources, particularly because Morocco relies heavily on irrigated agriculture for both domestic consumption and agricultural exports. Although the country has implemented major reforms in irrigation systems, water-intensive crops continue to create pressure on limited water reserves.

One of Morocco's main challenges lies in balancing agricultural export policies with long-term water sustainability. Several studies have criticized the expansion of crops requiring high water consumption in drought-prone regions, arguing that this model may threaten future food and water security. (Bank, 2018) (Conseil Économique, 2019)

In response, Moroccan authorities have increased investments in desalination plants, wastewater reuse, and renewable-energy-powered water infrastructure. These policies aim to diversify water sources and reduce dependence on rainfall.

5.1.3 Water Needs in Libya

Libya faces one of the most critical water situations in the Maghreb region because of its extremely limited renewable water resources and heavy dependence on fossil groundwater reserves.

Water demand in Libya is expected to increase dramatically by 2050, while per capita water availability is projected to decline sharply. Agriculture remains the main consumer of water, accounting for nearly 80% of total use. This dependence is particularly problematic because most irrigation water comes from non-renewable groundwater sources.

The country's long-term food security is therefore highly vulnerable to groundwater depletion. Continued overexploitation of aquifers may reduce agricultural productivity and increase dependence on food imports in the future.

Political instability has further complicated water management in Libya by weakening infrastructure maintenance and limiting investment in desalination and wastewater treatment projects. As a result, the country faces both environmental and institutional challenges in achieving sustainable water security ((BGR), 2013)

5.1.4 Water Needs in Mauritania

Mauritania's water challenges are mainly related to low rainfall, limited infrastructure, and the heavy dependence of agriculture on climatic conditions. Although the country possesses

significant agricultural potential along the Senegal River basin, large areas of farmland remain dependent on seasonal rainfall.

Population growth is expected to increase pressure on available water resources in the coming decades, while per capita water availability is projected to decline steadily.

Agriculture remains the main water-consuming sector, but irrigation infrastructure is still relatively limited compared to other Maghrebi countries. Most agricultural production depends on cereals and traditional farming systems that remain highly vulnerable to drought and rainfall fluctuations.

Despite these constraints, Mauritania possesses important opportunities for improving food security through better water storage infrastructure, irrigation expansion, and integrated management of Senegal River resources. (Nations(FAO), 2016)

5.2 Comparative Analysis of Water Needs in the Maghreb Region

Although Maghrebi countries share similar climatic pressures, their water challenges differ in terms of severity, management capacity, and available resources.

Algeria and Morocco have invested heavily in desalination, dams, and irrigation modernization, while Libya remains highly dependent on non-renewable groundwater. Mauritania, on the other hand, faces structural limitations related to infrastructure and rainfall variability.

However, a common feature across all countries is the dominant role of agriculture in water consumption. This highlights the urgent need to improve agricultural water efficiency and adopt more sustainable food production systems.

Future food security in the Maghreb region will therefore depend not only on increasing water supply, but also on improving governance, reducing waste, promoting regional cooperation, and adapting agricultural policies to climate realities.

VI. The relationship between water resources and food security in the Maghreb countries

The relationship between water resources and food security has become increasingly critical in the Maghreb region due to climate change, demographic growth, and rising food demand. Although the Maghreb covers a vast geographical area estimated at more than 5.7 million km², only a limited proportion of land is suitable for agriculture. In addition, agricultural production remains highly dependent on water availability, making water security a fundamental condition for achieving food security in the region ((AOAD), 2016)

Food security is no longer limited to the availability of food products alone. It also involves the ability of countries to maintain sustainable agricultural production systems capable of meeting domestic demand under changing environmental and economic conditions. In this context,

efficient water management plays a decisive role in improving agricultural productivity, reducing food imports, and strengthening economic stability.

Historically, several Maghrebi countries have relied heavily on food imports to meet growing domestic demand, particularly for cereals, vegetable oils, sugar, and dairy products. This dependence has increased the vulnerability of these countries to global market fluctuations and international supply crises. The food crisis triggered by global economic disruptions and climate-related shocks has further demonstrated the strategic importance of strengthening local agricultural production.

However, achieving food self-sufficiency in the Maghreb region remains difficult because of structural challenges affecting both water and agricultural sectors. One of the main constraints is that nearly 78% of agricultural production depends on rainfall, while irrigated agriculture represents only a limited share of cultivated land. As a result, agricultural output fluctuates significantly from year to year depending on climatic conditions.

The increasing scarcity of water resources also threatens the sustainability of current agricultural systems. Excessive groundwater extraction, soil salinization, drought, and desertification have reduced the productivity of agricultural land in several regions. In addition, population growth and urban expansion continue to increase competition over limited water resources between agriculture, industry, tourism, and domestic consumption.

For this reason, many experts argue that improving food security in the Maghreb countries requires a transition toward more sustainable and water-efficient agricultural models. According to FAO (2018), modern agricultural strategies should focus on increasing productivity while reducing pressure on natural resources ((FAO), Organic Agriculture and Agribusiness in the North Africa Region: Opportunities and Challenges. FAO, 2018)

Several approaches are increasingly being promoted in the region, including:

- smart agriculture based on digital technologies and climate monitoring;
- drip irrigation and water-saving irrigation systems;
- greenhouse and protected agriculture;
- vertical farming and hydroponic systems;
- organic agriculture and environmentally sustainable farming practices.

These approaches can contribute to improving water efficiency and increasing agricultural productivity under conditions of limited water availability. Some studies have shown that sustainable agricultural practices may improve productivity while reducing environmental degradation and water waste.

At the same time, improving food security in the Maghreb region requires stronger integration between agricultural, water, industrial, and environmental policies. Water governance should

therefore be considered a strategic component of long-term economic planning rather than a purely environmental issue.

The following table compares the main water-related challenges affecting food security in selected Maghrebi countries and highlights the main policy responses adopted by each country:

Table 6.1. Main Water and Food Security Challenges in Selected Maghreb Countries

Country	Main Water Challenge	Impact on Food Security	Main Government Response
Algeria	Drought and groundwater overuse	Pressure on irrigated agriculture	Desalination and wastewater reuse
Morocco	Declining rainfall and water stress	Dependence on food imports	Irrigation modernization and dams
Libya	Fossil groundwater depletion	Reduced agricultural sustainability	Great Man-Made River and desalination
Mauritania	Rainfall variability and weak infrastructure	Low agricultural productivity	Dam construction and irrigation expansion

Source: Prepared by the researchers based on FAO (2016), World Bank (2018), and UNESCO Water Report (2023).

The table shows that although Maghrebi countries share similar environmental pressures, the nature of water-related challenges and policy responses differs from one country to another. Algeria and Morocco have focused on technological and infrastructural solutions, while Libya continues to rely heavily on groundwater extraction. Mauritania remains constrained by weak infrastructure and climatic variability. These differences directly affect each country's capacity to achieve sustainable food security.

The experiences of Maghrebi countries also show important differences in their capacity to address food and water challenges. Morocco and Algeria have invested heavily in irrigation modernization and desalination projects, while Libya continues to face serious institutional and political constraints affecting water management. Mauritania, on the other hand, remains highly vulnerable to rainfall variability despite its agricultural potential along the Senegal River basin.

The following table summarizes the main effects of water scarcity on agricultural production and food security in the Maghreb region.

Table 6.2. Impact of Water Scarcity on Food Security in the Maghreb Region

Water-related Challenge	Impact on Agriculture	Impact on Food Security
Drought and declining rainfall	Reduced crop yields	Increased dependence on food imports
Groundwater depletion	Decline in irrigated agriculture	Instability in food production
Soil salinization	Loss of fertile agricultural land	Lower agricultural productivity
Climate change	Irregular agricultural seasons	Higher vulnerability to food shortages
Water pollution	Decline in water quality for irrigation	Reduced food quality and safety

Source: Prepared by the researchers based on FAO (2016), UNESCO World Water Development Report (2023), and Cambridge Prisms: Water (2025).

The table shows that water scarcity directly affects agricultural productivity and therefore threatens food security in the Maghreb region. Climate change and groundwater depletion are among the most critical challenges because they reduce the availability of water for irrigation and increase the vulnerability of agricultural systems. These findings confirm that improving water management policies is essential for achieving sustainable food security in North Africa.

Overall, the relationship between water resources and food security in the Maghreb region is characterized by strong interdependence. Sustainable food production cannot be achieved without securing sufficient and well-managed water resources. Likewise, future water strategies in the region must take into account the growing pressures generated by agricultural demand, climate change, and demographic expansion.

VII. Conclusion

This study has shown that water resources and food security are deeply interconnected in the Maghreb region. The growing pressure on water resources caused by climate change, population growth, urban expansion, and agricultural demand has transformed water scarcity into one of the most serious challenges facing sustainable development in North Africa.

The findings reveal that all Maghrebi countries are experiencing increasing water stress, although the severity and nature of the crisis differ from one country to another. Algeria and Morocco have expanded investments in dams, desalination plants, and irrigation modernization, while Libya remains heavily dependent on non-renewable groundwater resources. Mauritania, despite its agricultural potential, continues to face major structural and climatic constraints affecting water availability and agricultural productivity.

The study also demonstrates that agriculture remains the largest consumer of water resources in the region, accounting for between 70% and 85% of total water use. However, the continued reliance on traditional irrigation methods, excessive groundwater extraction, weak infrastructure, and poor water governance has increased pressure on already limited resources.

Climate change has further aggravated the situation through declining rainfall, rising temperatures, and increasing drought frequency, negatively affecting agricultural production and food security.

Despite significant investments in water infrastructure, several challenges remain unresolved, including water losses in distribution networks, groundwater depletion, pollution, and the lack of integrated regional water strategies. These challenges indicate that improving water availability alone is not sufficient; sustainable management and efficient use of water resources are equally important for ensuring long-term food security.

The study further confirms that future food security in the Maghreb region will depend on the transition toward more sustainable agricultural and water management models. Modern irrigation systems, wastewater reuse, desalination technologies powered by renewable energy, smart agriculture, and digital water monitoring systems can contribute significantly to reducing water stress and improving agricultural productivity.

International experiences have shown that innovative water policies and technological solutions can improve both water efficiency and agricultural sustainability. Therefore, adapting successful international practices to the specific environmental and economic conditions of the Maghreb region could help strengthen regional resilience to future water and food crises.

Based on these findings, the study proposes the following recommendations:

- Strengthening regional cooperation among Maghrebi countries in the management of shared water resources and the development of water infrastructure projects;
- Promoting integrated water governance policies that combine environmental, agricultural, economic, and social dimensions;
- Expanding the use of non-conventional water resources, particularly seawater desalination and treated wastewater reuse;
- Encouraging water-saving agricultural practices through modern irrigation systems, smart agriculture, and climate-resilient farming techniques;
- Reducing dependence on highly water-intensive crops and promoting more sustainable agricultural production systems;
- Increasing investment in renewable energy technologies to reduce the cost of desalination and improve water sustainability;
- Enhancing public awareness campaigns aimed at rationalizing water consumption and protecting water resources;

- Expanding the use of digital technologies and artificial intelligence in monitoring water quality, consumption, and irrigation efficiency.

Overall, ensuring water security has become a strategic necessity for achieving sustainable food security in the Maghreb region. Without effective and coordinated water management policies, the region may face increasing environmental, economic, and social vulnerabilities in the coming decades.

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