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RESEARCH ARTICLE

MANAGING WATER SCARCITY THROUGH POLICY AND INSTITUTIONAL REFORM: THE EVOLUTION OF WATER GOVERNANCE IN JORDAN

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ABSTRACT

Jordan faces a critical water shortage driven by rapid and uncontrolled population growth, regional instability, and the escalating impacts of climate change. Over the past century, the country has undergone a profound transformation in water resources management. This paper examines the evolution of Jordan's water policy from a management and sustainability perspective, emphasizing its alignment with the United Nations Sustainable Development Goal 6 (SDG 6): ensuring availability and sustainable management of water and sanitation for all. Through a qualitative review of legislative documents, national strategies, and academic sources, the study traces key milestones, including the establishment of the Central Water Authority, the Water Authority of Jordan, and the Ministry of Water and Irrigation. The analysis reveals how adaptive management, integrated water resources management (IWRM) principles, and policy innovation have transitioned Jordan from fragmented to collaborative governance. Despite persistent scarcity, these reforms have strengthened institutional capacity, governance efficiency, and stakeholder coordination, advancing national progress toward SDG 6 and offering valuable insights for policymakers in other arid regions facing similar water security challenges.

KEYWORDS

Water policy, policy reform, governance, integrated water resources management (IWRM), resilience.

1. INTRODUCTION

Water scarcity in Jordan is a critical and well-documented issue that continues to worsen due to a combination of factors, including rapid population growth, repeated waves of refugees, increasing economic development demands, more frequent droughts, and the escalating impacts of climate change, (figure 1). One of the most significant demographic shifts occurred between 2004 and 2015, when Jordan's population surged from 5.6 million to 9.6 million with an annual growth rate of 4.9%. This sharp increase was primarily driven by the influx of refugees from regional conflicts, particularly the Syrian civil war, as well as instability in Iraq and Libya following the Arab Spring. As of April 2025, the population has reached approximately 11.8 million, with a current annual growth rate of 2.1%. Jordan received its first wave of refugees in the early 20th century, who settled near vital water resources. The second wave of refugees came when hundreds of thousands of Palestinians were forcibly displaced from their homeland during the war between Israel and Palestine in 1948. A third wave occurred after the Arab-Israeli war in 1967, followed by a fourth wave during the Gulf crisis after the invasion of Kuwait in 1990. The fifth wave came after the American attack on Iraq in 2003, and the most recent and influential influx occurred after the outbreak of the Syrian conflict in 2011. These subsequent waves of displacement have resulted in a vast refugee presence in Jordan, putting significant pressure on the country's limited water resources. This pressure, however, extends far beyond water scarcity; it intensifies the demand on all natural resources, infrastructure, and the labour market.

The rapid increase in the need for housing, employment, food, energy, and public services has deeply impacted Jordan's economic resilience. Notably, the pressure on water and energy systems has become increasingly critical, posing serious challenges to the nation's capacity to meet basic needs and ensure sustainable long-term development (DoS Department of Statistics of Jordan, 2025) (Odeh et al., 2019) (Mohammad et al., 2021).

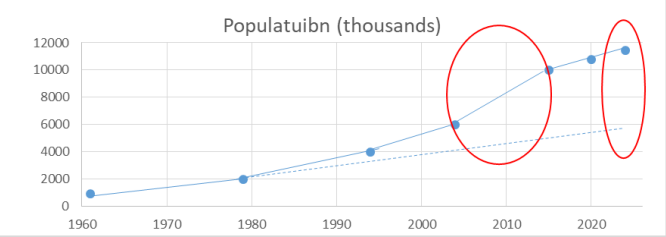

Figure 1: Population Growth schemes in Jordan, (Department of Statistics of Jordan, 2025)

Over the past few decades, Jordan has experienced a decline in rainfall and increased variability, heightening the pressure on water availability, distribution, and affordability for both the government and its citizens. This problem has also led to prioritizing the freshwater use for domestic needs. Multiple studies and projections indicate that drought conditions

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are expected to worsen, with the potential for future droughts to occur every three to four years. However, Jordan's renewable water resources are minimal and drop far short of meeting national demand. Signs of overexploitation are increasingly evident across many watersheds and aquifers. The country's annual per capita share of freshwater has drastically declined, from 500 cubic meters in 1975 to just 61 cubic meters in 2023, which is well below the global threshold for severe water scarcity, defined as 500 cubic meters per capita. This alarming trend highlights the critical challenges facing Jordan's water sector.

The Jordanian government has developed multiple policies, strategies, and plans aimed at promoting the sustainable development, management, and utilization of water resources. These efforts are designed to address current needs and prepare for the growing challenges that will impact the country's water sector in the future. Jordan's existing water resources are hardly adequate to meet current demands across various water-consuming sectors, including the explicit needs of the environment, and will actually become scarcer in the future. This fact calls for frequent and strategic adjustments in water demand management. While mainstream measures have helped address scarcity in the past, they are unlikely to provide sustainable long-term solutions. National water resources and the overall water balance are under increasing pressure due to growing demand, over-abstraction of supplies, and the mounting impacts of climate change. An exponential increase in water demand is causing intense competition among socioeconomic sectors. Balancing the needs for domestic consumption, agriculture, industry, and environmental protection, alongside concerns over deteriorating water quality and the management of waterborne diseases, presents a critical sustainability challenge (El-Nasser, 2014) (Mohammad et al., 2020). Further, the economic growth of the past decades has placed additional stress on both groundwater and surface water quality. The challenge ahead lies in meeting the country's growing water needs over the medium and long term. This demands the adoption of alternative resource management strategies and enhanced water-use efficiency to optimize the use of Jordan's limited water resources. This paper aims to examine the historical evolution of water policy and law in Jordan, analyzing institutional transformations and their implications for resilience, integrated water resources management (IWRM), and sustainable development.

2. Material And Methods

This study involves a qualitative, document-based research strategy embedded in policy and institutional analysis. The purpose is to discuss how Jordan's water governance developed through administrative reforms, legislative implementations, and strategic management decisions over the past century. To achieve this, a combination of historical review, policy analysis, and institutional mapping was employed. Primary data were drawn from Jordanian legislative records, including official water laws, bylaws, and royal decrees dating back to 1921. Secondary sources contained annual reports from the Ministry of Water and Irrigation (MWI), the Water Authority of Jordan (WAJ), and the Jordan Valley Authority (JVA), in addition to national strategies and policy documents such as the (Water Strategy, 1997), the (National Water Strategy, 2016–2025), and the (National Water Strategy, 2023–2040). Further, the paper analyzed many academic literature and technical reports published by international agencies, including the FAO, WHO, and World Bank, to review local developments within global water governance trends.

The methodological framework for this paper involved three stages, namely: Recorded structuring, this organized the reforms by historical period to trace the institutional origions of water management practice in Jordan; Thematic analysis, which identified regular governance principles in water sector, such as centralization, integration, and resilience, and Comparative structure, which evaluated how Jordan's policy revolution aligns with integrated water resources management (IWRM) frameworks, and public administration theories of adaptive governance. This approach leads to an interdisciplinary understanding that links water resource management with public administration and institutional reform, offering understandings relevant for policymakers in governance.

Over the past few decades, Jordan has experienced a decline in rainfall and increased variability, heightening the pressure on water availability, distribution, and affordability for both the government and its citizens. This problem has also led to prioritizing the freshwater use for domestic needs. Multiple studies and projections indicate that drought conditions are expected to worsen, with the potential for future droughts to occur every three to four years. However, Jordan's renewable water resources are minimal and drop far short of meeting national demand. The Jordanian government has developed multiple policies, strategies, and plans aimed at promoting the sustainable development, management, and utilization of water resources. These efforts are designed to address current needs and prepare for the growing challenges that will impact the country's water sector in the future. Jordan's existing water resources are hardly adequate to meet current demands across various water-consuming sectors, including the explicit needs of the environment, and will actually become scarcer in the future. This fact calls for frequent and strategic adjustments in water demand management. While mainstream measures have helped address scarcity in the past, they are unlikely to provide sustainable long-term solutions. National water resources and the overall water balance are under increasing pressure due to growing demand, over-abstraction of supplies, and the mounting impacts of climate change. An exponential increase in water demand is causing intense competition among socioeconomic sectors. Balancing the needs for domestic consumption, agriculture, industry, and environmental protection, alongside concerns over deteriorating water quality and the management of waterborne diseases, presents a critical sustainability challenge (El-Nasser, 2014). Further, the economic growth of the past decades has placed additional stress on both groundwater and surface water quality. The challenge ahead lies in meeting the country's growing water needs over the medium and long term. This demands the adoption of alternative resource management strategies and enhanced water-use efficiency to optimize the use of Jordan's limited water resources.

Jordan renewable freshwater availability of only about 61 cubic meters per capita in 2021 (Ministry of Water and Irrigation, 2023). Over half the population receives water once a week or less (WHO, 2022). In 2023, the country's available water resources reached 1,202 MCM, an increase of 71 MCM from the previous year. The long-term annual average rainfall is approximately 8,184 MCM. In comparison, rainfall in 2022/2023 was approximately 8,508 MCM, about 4% above the long-term average (1937–2023). The total effective recharge reached 304 MCM, representing about 4.5%, while the surface runoff was estimated at 174.6 MCM, or 2.4%. In contrast, water use reached 683 MCM, a 24 MCM increase from 2022, primarily due to increased reliance on both renewable and non-renewable groundwater, especially in the industrial sector. Agricultural water use was constrained by limited surface water availability. Overall, Jordan's available water resources remain at about 1.2 billion MCM, highlighting the essential need to expand non-conventional water sources urgently (Ministry of Water and Irrigation, 2023).

According the 2023 annual report of MWI, Jordan's total available water resources amounted to approximately 1,202 million cubic meters (MCM), marking an increase of 71 MCM compared to 2022. This rise is attributed to improved water management and increased rainfall. The country's water balance remains heavily reliant on groundwater extraction, which accounted for 418 MCM, with significant contributions from surface water (351 MCM) and regional water sources (136.6 MCM). Additionally, non-traditional water sources, including treated wastewater (215.4 MCM) and desalinated water (2.25 MCM), played an increasingly important role in meeting water demands. Water consumption patterns indicate that the municipal sector utilised 526.4 MCM (44%), agriculture 623.4 MCM (52%), and industry and tourism collectively 52.3 MCM (4%). Jordan's 14 major dams have a total storage capacity of 357 MCM, of which 35% was utilised in 2023. Despite these efforts, water scarcity challenges persist, exacerbated by over-extraction of groundwater, climate variability, and rising demand. To address these issues, strategic measures are recommended, including enhancing groundwater conservation, expanding wastewater reuse, improving regional water cooperation, upgrading water infrastructure, and investing in desalination projects. These efforts aim to ensure long-term water security and sustainability in Jordan.

Groundwater remains the primary source of water supply in Jordan, accounting for approximately 57% of total water use, primarily for drinking and basic domestic purposes. Surface water is the second most important source, concentrated primarily in the Jordan Valley, where it is used for both municipal and agricultural purposes, accounting for approximately 27% of total use. The remaining share is supplied by non-conventional resources, particularly treated wastewater and desalinated water, which have become increasingly significant in supporting municipal and agricultural demand, figure 2 (Ministry of Water and Irrigation, 2023).

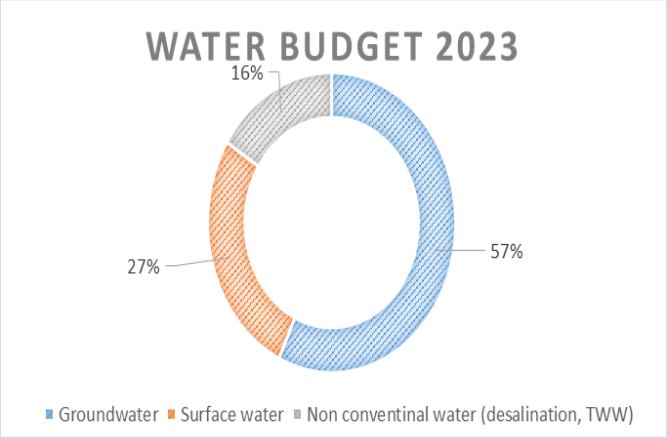

Figure 2 : Water Budget for Jordan, 2023 (Ministry of Water and Irrigation, 2023)

Groundwater forms the backbone of water supply in the country, yet it is being overexploited at almost double the safe yield rates of the aquifers. This unsustainable abstraction has led to significant declines in groundwater levels, the progressive depletion of aquifers, and a deterioration in water quality. As groundwater is a non-renewable resource in many areas, its depletion reflects long-term threats to domestic, economic, and agricultural supplies (Figure 3).

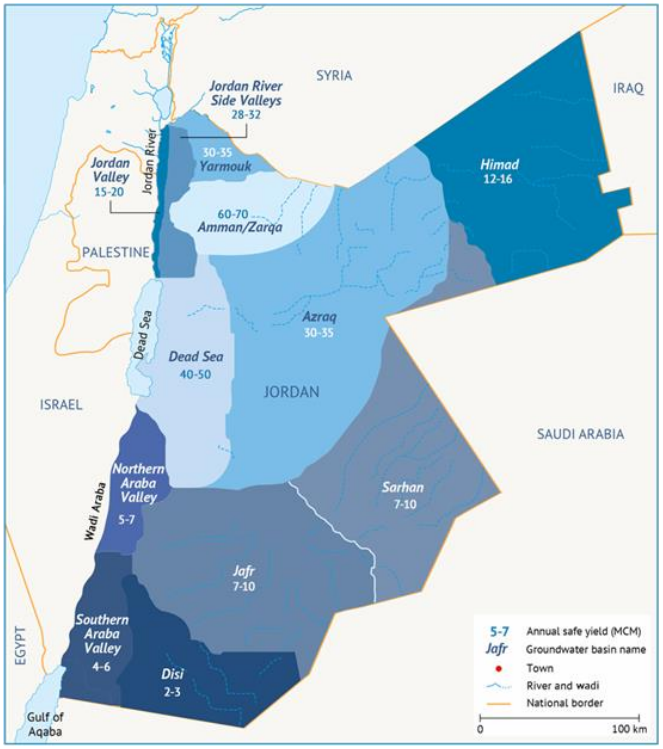

Figure 3 : Groundwater basins in Jordan, with the annual yields (Ministry of Water and Irrigation, 2023)

On the other hand, Surface water resources, while essential, are highly variable and unreliable. Their availability is closely connected to rainfall patterns, which have become increasingly irregular under the influence of climate change. Jordan's 13 principal dams provide a combined storage capacity of about 280 million cubic meters (MCM). However, the progressive accumulation of sediment within these reservoirs is highly reducing their effective storage capacity, reducing their efficiency in water supply, flood control, and agricultural irrigation (Figure 4) (Ministry of Water and Irrigation, 2024). Approximately one-quarter of Jordan's renewable freshwater resources develop outside its national borders, primarily from transboundary aquifers and shared river basins. Due to the country's topographical nature, Jordan is situated downstream of these basins, which adds more pressure to securing its water rights and shares. This natural dependence on inflows from neighbouring countries stresses the geopolitical extent of Jordan's water security. The Yarmouk River, for example, is a vital source shared with Syria, while the Jordan River system involves complex regional dependencies with upstream use by numerous riparian conditions. Likewise, several of Jordan's groundwater basins spread across political boundaries, making their sustainable management dependent upon regional cooperation. Such factors heighten Jordan's vulnerability to upstream abstractions, unilateral water development projects, and broader political tensions. Therefore, ensuring water security in Jordan is not only a matter of internal resource management but also demands practical transboundary governance, bilateral and multilateral agreements, and adaptive strategies to mitigate risks associated with regional variability and competing demands.

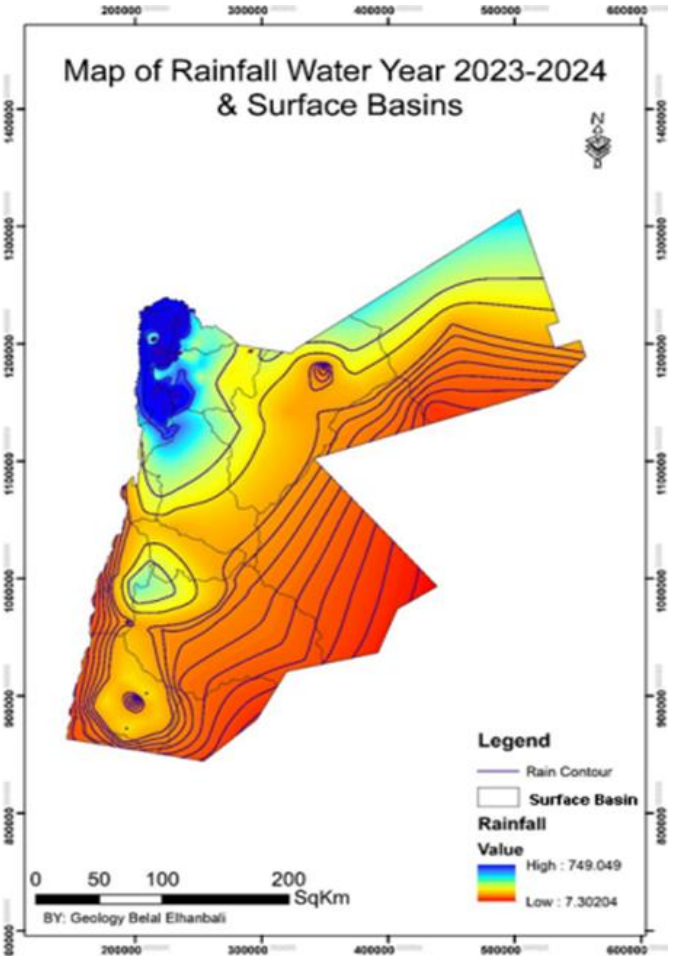

Figure 4 : Surface water basins and rainfall amounts for the year 2023-2024 (Ministry of Water and Irrigation, 2024)

Reclaimed water is considered a vital component of Jordan's water management strategy. Since 2008, advancements in wastewater treatment technologies have led to an increase in the use of reclaimed water for irrigation. Currently, more than 90% of treated wastewater is reused, primarily in agriculture, thereby offsetting some of the pressure on freshwater resources and contributing to water sustainability. Taken together, these sources define the complicated and fragile nature of Jordan's water sector. Over-abstraction, climatic variability, unstable political situation around the country, and infrastructure constraints underscore the urgent need for integrated water resource management

strategies to secure Jordan's health, economy, and food security in the face of increasing scarcity, figure 5, (Ministry of Water and Irrigation, 2023)

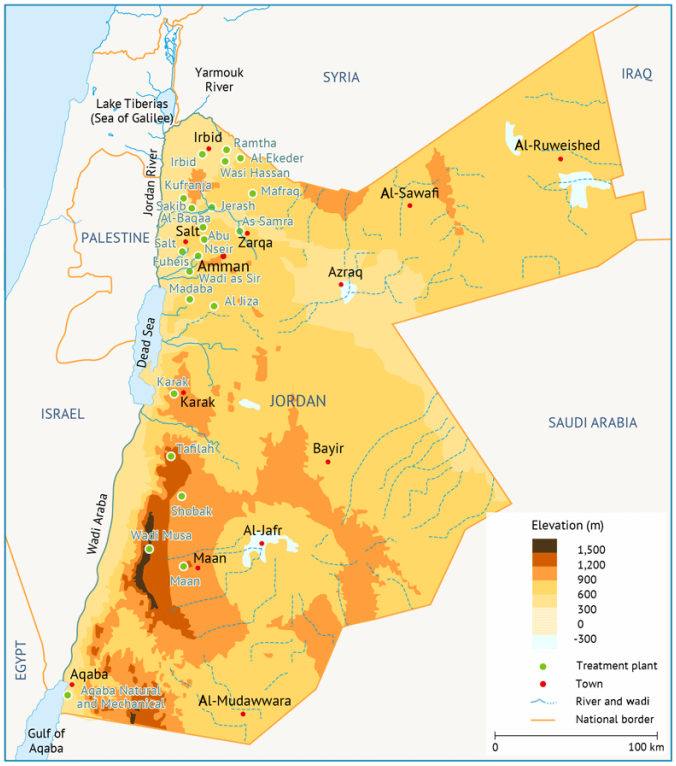

Figure 5 : Distribution of wastewater treatment in Jordan (Ministry of Water and Irrigation, 2023)

3. Results And Discussion

3.1 Early Water Legislation (1921–1959)

During the years of the establishment of the Emirate of the East Jordan (1921–1946), the foundations of modern statehood gradually emerged. The administration initially established an Executive Council, which an elected Legislative Council later complemented, while the judiciary maintained independence through a formal court system (Salameh, 2001). Financial and technical assistance from Britain played an important role in supporting the developing state, with British civil and military administrators providing advisory and institutional guidance (Falah, 1999). Legislation during this period reflected a hybrid legal framework, combining the continuation of Ottoman-era laws governing daily life with new legal codes adapted from Palestine, which was under the British Mandate (Bocco, 2003). Water administration in the emirate was primarily concerned with municipal supply. Within towns, responsibility for water provision was assigned to municipal councils. In contrast, the central government's role was largely facilitative, ensuring project implementation, enacting regulatory legislation, and securing loans for infrastructure development (Salameh, 2001). In rural areas without formal councils, communities relied primarily on gravity wells that collected rainwater or on natural springs as their primary water sources (Shatanawi and Al-Momani, 2006; Pappe, 2011).

By the mid of 1930s, water policy in the emirate developed to contain groundwater and irrigation management, mainly in response to regional political developments, particularly the Palestinian revolution of 1936–1937 against Jewish immigration into Palestine (Pappe, 2011) (Gleick, 1993) (Haddadin, 2001). During this period, groundwater and surface waters of the Jordan Basin became focal points of competition, with the Jewish Agency targeting these resources for development (Gleick, 1993). In response, two laws were enacted in Palestine to strengthen government authority over water resource management and investigation, which were later adopted and implemented by the Emirate (Bocco, 2003). Between 1946 and 1957, responsibility for water resources in Jordan was led by the Projects Department, which operated under the Department of Lands and Surveys within the Ministry of Finance. Regulation and management of these resources were exercised by the Director of Lands and Surveys, with support from the Manager of the Projects Department. During this period, water rights for irrigation were closely linked to land ownership, with the right to use water for agricultural purposes generally attending the rights to the irrigated land (Haddadin, M. 2001). The influx of Palestinian refugees to Jordan during the late 1940s and early 1950s added significant pressure on jobs and livelihoods. Jordan's economy was weak, making foreign aid essential to support development initiatives and job creation, with water resources playing a critical role in the process. In response to these urgent needs, the Jordanian government founded a department devoted to the development of water resources, staffed by both American and Jordanian experts.

The ownership and use of water resources, such as springs, perennial streams, ponds, and river flows, were often unclear and poorly documented. To address this, the government launched a systematic update of land ownership records and introduced modern surveying techniques to replace outdated Ottoman methods. Lands already irrigated using water from springs, streams, or rivers were required to be designated accordingly in new title deeds issued by the Department of Lands and Surveys, replacing the Ottoman-era deeds. In addition, the amount of water required for irrigation had to be clearly specified. To formalize these procedures, the first water law in the kingdom was enacted in 1946 as Law No. 38, the Law of Settlement of Water Rights. This legislation outlined the procedures for settling water rights and authorized the Prime Minister, upon recommendation of the Director of the Department of Lands and Surveys, to designate any area requiring formal water rights settlement as an "irrigation area." The law authorized the department to adopt existing irrigation systems or develop new ones and authorized the Director to create, operate, and maintain irrigation projects in designated areas. It also established the collection of water charges from beneficiaries. By centralizing the management of water resources under government authority, the law aimed to control local conflicts among farmers and ensure fair allocation, reflecting an early effort to regularize water governance in the emerging Jordanian state (El-Nasser, 2014) (Salameh, 2001) (Shatanawi and Al-Momani, 2006) (Gleick, 1993). Since irrigation was the primary consumer of water resources, the formulation of water rights was linked to the ownership of irrigable land. To formalize this connection, the government enacted Law No. 40 in 1952, the Law of Settlement of Land and Water Rights, which integrated land ownership with associated irrigation water rights. In addition to this key regulatory framework, the Director of the Department of Lands and Surveys, supported by the Projects Department, was tasked under Law No. 31 of 1953, the Water Supervision Law, with the construction and management of irrigation projects, with landowners contributing two-thirds of the capital costs. Michael Ionides drafted this law before he departed for military service (Ionides, 1946). To address groundwater development, the well-drilling department was established within the Ministry of Public Works. The private sector at the time lacked the technical capacity to introduce modern drilling technologies, making government-led initiatives essential. Jordan desired technical assistance from friendly countries to explore and assess its groundwater resources. Given the hydrological connections between groundwater and wadi base flow, which are dependent on farmers, careful planning was required to ensure that new well-drilling activities would not negatively affect existing agricultural water uses. This approach reflected the government's early recognition of the integrated management of surface and groundwater resources as a foundation for sustainable irrigation development (Salameh, 2001: Shatanawi and Al-Momani, 2006;Pappe, 2011).

3.2 Institutional Consolidation (1959–1977)

Legislation in the late 1950s observed a new phase in Jordan's water policy, reflecting both institutional innovation and socio-economic objectives. Law No. 14 of 1959, the East Ghor Canal Law, established the first independent water authority in Jordan, the East Ghor Canal Authority (EGCA), headed by a board of directors. A second significant law created a central water authority to coordinate national water management efforts. The East Ghor Canal Law embodied a novel approach to irrigated-land reform. It was drafted with USAID support, the legislation defined that the land to be irrigated would be subdivided into farm units of three to four hectares, to redistribute irrigated land to both landowners and landless farmers. For the Jordanian government, the law offered a mechanism of land reform in a politically sensitive regional context. Under the law, land within the irrigation project area was seized, its value assessed, and recorded as an asset of the fund for the owner. Following project implementation, the land was subdivided into farm units of three to four hectares. Owners with smaller than four hectares retained land equal to the estimated value of their original property. Larger holdings were allocated in descending percentages, such that larger pre-project holdings resulted in a smaller proportion retained post-project. Land previously developed with perennial tree plantations alongside wadis could be entirely retained, subject to approval by the Council of Ministers. Remaining land, including surplus areas and state lands within the project zone, was allocated to landless farmers.

Experience from the initial implementation of the East Ghor Canal Law led to legislative adjustments. Laws No. 13 and 31 of 1962 amended specific provisions to address practical challenges and refine land allocation procedures, ensuring more effective application of the policy on the ground (Salameh, 2001) (Shatanawi and Al-Momani, 2006). A second significant legislative development in Jordan's evolving water policy extended beyond a specific region to encompass the entire kingdom. Law No. 51 of 1959 established the Central Water Authority (CWA), an independent government agency tasked with reorganizing the management of national water resources. The CWA reduced multiple previously separate entities, including the Department of Irrigation, the Drilling Department within the Ministry of Public Works, the Department of Water Resources Development under the Office of Consolidated Services (later merged with the Jordan Development Board), and all operational water projects managed by other departments. The CWA was responsible for all water-related matters across the kingdom, except for the East Ghor Canal Project in the Jordan Valley and municipal water supply networks. The establishment of the CWA was observed as a significant advance in Jordan's water governance, enabling a professional and systematic approach to the sector with particular emphasis on resource surveys and exploration. Its activities included documenting water resources, measuring flows and quality parameters, conducting groundwater investigations, and supplying municipal water to underserved cities. This level of centralized, autonomous management was unprecedented in the region; neighbouring countries typically had multiple ministries overseeing water affairs, often with overlapping responsibilities, whereas Jordan's model enabled greater efficiency (Shatanawi and Al-Momani, 2006; Gleick, 1993; Haddadin, 2001).

By the mid-1960s, it became evident that integrating government departments responsible for natural resources, including water, was required to improve coordination and efficiency. In response, Law No. 37 of 1966 established the Natural Resources Authority (NRA), clearly defining its responsibilities and authorities. The NRA merged the East Ghor Canal Authority, the Central Water Authority, and the Department of Mining, which had previously operated under the Ministry of National Economy. The new authority was also assigned to develop water distribution networks across all population centres in the kingdom, except Amman (Haddadin, 2001). Shortly after the NRA's establishment, the June 1967 war erupted, severely limiting the agency's activities to the operation and maintenance of projects inherited from its institutions. Among the limited development initiatives pursued, the NRA constructed the East Ghor Canal for 8 kilometres, from station 70 to station 78. However, broader development efforts were stalled mainly due to regional instability following Israel's occupation of Arab territories, including the West Bank. Retaliatory actions by Israel depopulated significant portions of the valley, effectively halting agricultural activities and constraining the NRA's capacity to implement new projects (Shatanawi and Al-Momani, 2006).

Following the restoration of law and order after the 1967 war, the government of Jordan prioritized the resumption of economic and social development in early 1971. Development initiatives had been largely inactive for about four years, and urgent efforts were needed to make up for lost time and design new projects. This period also marked a significant shift in water policy, developing the sector's perspective to include municipal wastewater services alongside traditional water supply. The central government increasingly carried responsibility for providing municipal water and wastewater services, reflecting the growing importance of urban water management (Haddadin, 2001).

In the capital, Amman, challenges in water supply and wastewater disposal, previously managed by the municipality, stressed the need for institutional reform. Although Law No. 1 of 1965 established a municipal department to construct and operate wastewater collection and treatment services, and Law No. 14 of 1965 (the Amman Water Law) empowered another department to manage municipal water projects, these arrangements proved insufficient to meet the city's growing demands. In response, the government adopted a more autonomous and specialized approach to urban water management by establishing the Amman Water and Sewerage Authority (AWSA) under Law No. 19 of 1973. AWSA was responsible for managing the city's integrated water and wastewater services and was empowered to secure water from remote sources in coordination with the NRA. For the rest of the country, municipal water projects, previously under the NRA, were transferred to a newly created agency, the Domestic Water Supply Corporation (DWSC), under Law No. 56 of 1973. This agency assumed responsibility for distribution networks across towns and villages, excluding Amman. Wastewater services outside Amman were assigned to the Ministry of Municipal and Rural Affairs under Law No. 12 of 1977. Despite these structural reforms, the fragmentation of water administration proved less effective than intended. Chronic urban and rural water shortages, limited financial resources for feasibility studies, and insufficient project preparation contributed to delays and highlighted the challenges of managing an increasingly complex water sector (Shatanawi and Al-Momani, 2006) (Haddadin, 2001). In the Jordan Valley, government policy experienced a significant shift in water resource management and in its broader development perspective. The valley had been severely affected by paramilitary and military conflicts following the June 1967 war. More than half of the village's houses were destroyed, and the population declined from approximately 63,000 to just 5,000. Following the rehabilitation of law and order in 1971, the rehabilitation and development of the Jordan Valley became a national priority. The government adopted an integrated social and economic development approach, with irrigated agriculture serving as the backbone of the strategy (Haddadin, 2001). To implement this vision, a dedicated agency with a clear mandate was established. Law No. 2 of 1973 created the Jordan Valley Commission (JVC), tasked with planning and executing projects for the valley's rehabilitation and development. Upon project completion, the JVC would hand over operations and maintenance responsibilities to the relevant government agencies.

3.3 Expansion and Integration (1977–1988)

In 1977, the policy framework was further refined with the establishment of the Jordan Valley Authority (JVA) under Law No. 18 of 1977. The JVA succeeded the JVC, the Jordan River Tributaries Regional Corporation, and the relevant sections of the Natural Resources Authority and Domestic Water Supply Corporation operating in the valley. The authority's jurisdiction was simultaneously extended southward to the Gulf of Aqaba on the Red Sea. The JVA was granted broad powers to develop and implement integrated social and economic plans for the Jordan Valley. Its mandate contained water resource development and management, social infrastructure, public utilities, transportation, housing, organization of farmers, municipal development, and support for agricultural activities. The authority was also empowered to secure funding from friendly countries and contract loans with the approval of the Council of Ministers. This comprehensive, integrated approach proved highly effective, restoring development momentum in the Jordan Valley and significantly improving residents' standard of living (Shatanawi and Al-Momani, 2006). Around the same period, Amman faced increasing water demand, prompting the city's first significant transfer of water from remote sources. At a high-level meeting chaired by the King, it was decided to convey water from the Azraq aquifer, located approximately 72 km northeast of Amman, and from the East Ghor Canal in the Jordan Valley. In the absence of a dam on the Yarmouk River, however, the East Ghor Canal alone could not completely meet both agricultural requirements in the valley and municipal water needs in Amman, especially during the dry season. To address this shortfall, irrigation water in the Jordan Valley was rationed, and a formal policy was adopted to reuse treated wastewater for agricultural purposes. This action partially compensated for the water shifted from the canal to supply the capital, reflecting an early integration of water reuse into Jordan's water management strategy (Haddadin, 2001).

A comprehensive assessment of municipal water supply and demand for Jordan was first launched in 1978. At that time, no single agency managed municipal water supplies nationwide. In response, the government pressed Syria to approve the construction of the Maqarin Dam on the Yarmouk River, an international watercourse, and enacted domestic legislation to support the project. The United States also appropriated $150 million for dam construction. By 1980, however, Syria's delays, compounded by strained Jordan–Syria relations over the Iraq–Iran War, obstructed progress. Jordan then approached Iraq to close the municipal water supply gap by transferring water from the Euphrates River. A feasibility study by Howard Humphrey and Partners indicated the project's cost per cubic meter would be prohibitively high, and the plan was shelved in 1984. Fortunately, groundwater discoveries in the Yarmouk Gorge and Wadi Arab enabled municipal water supply to Irbid and the surrounding areas. The growing water shortages in urban and rural areas, particularly in Amman and Irbid, highlighted the limitations of the Domestic Water Supply Corporation (DWSC) and the AWSA. To address urgent needs, municipal water supplies from the Jordan Valley were entrusted to the Jordan Valley Authority (JVA) in 1982, building on the authority's proven track record in project implementation. Subsequently, Law No. 34 of 1983 established the Water Authority of Jordan (WAJ), a comprehensive water agency that assumed responsibility for the distribution networks formerly managed by local councils nationwide. WAJ also became the legal successor to AWSA, DWSC, and the NRA's water-related components. Initial jurisdictional overlaps between WAJ and JVA were resolved after seven months, reinstating a dual-authority system reminiscent of the EGCA and CWA arrangement between 1959 and 1966. In 1988, this structure was formalized with the creation

of the Ministry of Water and Irrigation, under which both authorities remained autonomous, supervised by boards of directors chaired by the minister, and with minor legal amendments reflecting the new organizational arrangement (Shatanawi and Al-Momani, 2006).

3.4 Policy Reform and Modernization (1990s–2016)

With the initiation of the Middle East peace process in October 1991, the Ministry of Water and Irrigation in Jordan established Bylaw No. 54 of 1992, which created a third branch within the ministry, operating under the Secretary General, to focus on long-term planning and strategic water management (Haddadin, 2001). Building on this policy, Jordan successfully negotiated the recovery of its water share from Israel. The treaty, signed on October 26, 1994, and enacted on November 11, established the Joint Water Committee to manage all bilateral water matters and implement the provisions of the Water Annexe. The Jordanian delegation to the committee is drawn from the Ministry of Water and Irrigation and chaired by the Secretary General of the Jordan Valley Authority. Coordination between the two parties has generally been satisfactory, and further improvements are expected as broader regional peace facilitates the inclusion of additional riparian stakeholders (Shatanawi and Al-Momani, 2006).

By 2000, WAJ's centralized management of distribution networks across all population centres had become administratively burdensome. Experience suggested that municipal water services are better managed at the provincial or city level, particularly following the consolidation of smaller municipal councils. In Amman, the largest city, operations and maintenance of water and wastewater systems were awarded to a private-sector joint venture combining local and foreign expertise, which continues to manage these services. This management contract approach was strongly influenced by donor agencies, especially the World Bank, to introduce advanced private-sector participation in Jordan's water sector. However, premature privatization of water resources, as occasionally advocated by donors, remains a high-risk strategy given Jordan's prevailing social, economic, and political conditions (Shatanawi and Al-Momani, 2006; Haddadin, 2001). In April 1997, the Ministry of Water and Irrigation (MWI) developed a formal national water strategy, which was officially approved by the Council of Ministers on May 3, 1997 (MWI Ministry of Water and Irrigation, 1997). The strategy established long-term objectives for water resources management and was supported by four complementary policies formulated to achieve these goals. While the strategy itself is fixed, the associated policies are designed to respond dynamically to changing needs and are amended as required. A central factor shaping the strategy and its policies was the ongoing imbalance between population growth and available water resources, which had resulted in significant deficits. To address this challenge, the strategy aimed to maximize efficiency in water conveyance, distribution, and use, while augmenting available resources through measures such as brackish water desalination and treated wastewater reuse. Efficiency improvements were promoted through both supply- and demand-side management measures, including modernizing irrigation systems, replacing ageing water networks, and adjusting water tariffs. Agricultural credit programs, administered by government institutions, were also extended to encourage the adoption of advanced irrigation technologies. Meanwhile, the Ministry of Water and Irrigation is the principal authority responsible for the development, distribution, and management of water resources in Jordan, except for green water (rainfall absorbed by the soil). International donors' support for the water sector has been substantial. The World Bank, for instance, highlighted the importance of cost-recovery policies as early as the 1960s when it financed projects such as the Beit Sahur–Jerusalem water project using International Development Association (IDA) funds. In 1974, the bank conditioned financing for the Northeast Ghor Irrigation Project on recovering operation and maintenance costs, along with a portion of capital costs. In response, the Jordanian government adopted a policy aimed at recovering whole operation and maintenance costs and part of the capital costs, though achieving complete irrigation cost recovery has remained a challenge. Other donors followed this precedent. For example, the Kreditanstalt für Wiederaufbau (KfW) of Germany initially refused to provide further loans for municipal water projects in 1997 due to insufficient cost-recovery measures. After the government adjusted the water tariffs to recover whole operation and maintenance costs, KfW extended two loans: one to rehabilitate part of Amman's municipal water network, and another to double the capacity of water transmission from the Zai treatment plant to the Daboug Reservoir in Amman. These interventions highlight the interplay between domestic policy, donor conditions, and infrastructure development in the evolution of Jordan's water sector.

Between 1995 and 1999, the Ministry of Water and Irrigation (MWI) developed a national water strategy emphasizing sustainable water resource management (MWI Ministry of Water and Irrigation, 1997). The strategy prioritized maximizing efficiency in water conveyance, distribution, and use while protecting water resources from pollution and depletion. It called for fully exploiting surface and groundwater resources, exploring the potential of treated wastewater for agricultural and non-domestic purposes, groundwater recharge, and desalination of brackish and seawater sources. A clear allocation hierarchy was established, prioritizing basic human needs (100 liters per capita per day), followed by tourism and industrial uses, and lastly irrigation, which was to be minimized through technological innovations and cultivation of water-efficient crops. The strategy promoted a dual approach combining demand- and supply-management measures, human resource development in the water sector, and regional cooperation to secure Jordan's fair share of shared water resources, while recognizing that full-cost recovery was financially burdensome for households, where water expenditures accounted for approximately 4.6% of income. The Water Utility Policy, issued in 1997, identified the depletion of groundwater aquifers as a major threat to the sustainability of irrigation in both highlands and desert regions and proposed legal and financial measures to gradually reduce groundwater withdrawals to the safe yield level, while allocating fossil groundwater for municipal and industrial uses. Wastewater was acknowledged as a strategic resource, with guidelines for environmentally sound reuse, and brackish water was recognized as the highest potential non-conventional resource, usable directly or after desalination. The policy also highlighted inadequate investments in distribution systems and lower operational efficiency relative to other sectors. The Groundwater Management Policy of 1998 emphasized that Jordan's twelve water basins were being over-pumped, with abstraction rates exceeding safe yields by 146% in minor aquifers and 235% in major aquifers (MWI, 1998a). It called for reducing abstraction to match annual recharge levels by 2005 and prioritizing non-renewable groundwater, including Disi water, for municipal and industrial uses rather than agriculture. The strategic use of treated wastewater (Irrigation Water Policy 1998). It restricted fresh water allocation to irrigation only after municipal and industrial demands were conditioning agricultural water use on the sustainability of groundwater resources and preventing pollution (MWI, 1998b). Free leaching water from surplus surface water was provided during the wet season, particularly for farmers using treated wastewater in the dry season. The (Wastewater Management Policy, 1998) addressed wastewater salinity, organic loads, and treatment coverage treated effluent with fresher water and utilizing non-renewable sources such as Disi water and desalinated water to improve effluent quality for safe agricultural reuse (MWI, 1998c). In 1998, the Government of Jordan adopted a comprehensive National Water Strategy to address severe water scarcity, optimize resource use, improve efficiency, and promote conservation across sectors (MWI, 2000) (MWI, 2002a).

The MWI oversaw overall water resources, while the Water Authority of Jordan (WAJ) and the Jordan Valley Authority (JVA) managed distribution, wastewater systems, and Jordan Rift Valley irrigation, respectively. Legislative and technological enhancements were emphasized to balance demand and supply. In 2000, water management in Amman was handed over to a private sector joint venture, influenced by international donors, particularly the World Bank, to enhance efficiency, although this step was considered risky given Jordan's social and political context. The Water Sector Action Plan (2002–2006) outlined sector challenges and scheduled interventions, emphasizing private sector participation, improved enforcement, agricultural tariffs, and limiting irrigated areas in the Jordan Valley to reduce agricultural water demand. It also promoted substituting fresh water with brackish and treated wastewater and storing Jordan River floodwaters for irrigation of salinity-tolerant crops, with a desalination plant at King Talal Reservoir proposed to reduce treated wastewater salinity (MWI, 2002b). Regulation No. 65 of 2004 set standards for wastewater treatment and reuse, particularly for agricultural and industrial applications, ensuring safe and sustainable practices. The Water Strategy 2008–2022 focused on ensuring safe, adequate, and secure water supplies; sustainably managing surface and groundwater; protecting aquatic ecosystems; promoting sustainable water use with cost-reflective tariffs; and adapting to population growth and economic development. It prioritized sustainable agriculture, established a single irrigation service provider, expanded desalination, improved the use of treated wastewater, and strengthened institutional reform. Regulation No. 85 of 2013 governed groundwater and surface water extraction and use, requiring licensing and imposing penalties to ensure compliance (Ministry of Environment, 2016) (Ministry of Water and Irrigation, 2023).

3.5 Contemporary Reforms and Resilience (2016–2040)

The Jordan National Water Strategy 2016–2025 focused on resilience, clean water access, integrated water resource management, climate

change adaptation, and the water-energy-food nexus, with progress monitored across financial sustainability, service enhancement, supply-demand balance, and resource protection. The National Water Strategy 2023–2040 addresses extreme water scarcity, overuse of resources, climate impacts, and population growth, with objectives including closing the supply-demand gap by 2030 through desalination, reuse, and leak reduction; increasing non-conventional water resources, targeting 60% of irrigation water from such sources by 2030; modernizing governance and legal frameworks; enhancing climate change resilience via IWRM and aquifer protection; promoting treated wastewater use and efficient irrigation practices; and increasing energy efficiency and renewable energy use within the water sector to ensure financial sustainability (MWI, 2002b ; Nature Reserves Law No. 47, 2025 ; Renewable Energy Law, 2025 ; Ministry of Environment, 2023; Ministry of Energy and Mineral Resources, 2020).

The National Water Strategy 2023–2040, issued by the MWI, represents Jordan's most comprehensive and forward-looking framework for achieving sustainable water security under extreme scarcity conditions. The strategy builds on previous national plans but introduces a stronger emphasis on integrated resource management, institutional efficiency, and financial sustainability. It envisions ensuring equitable and reliable access to water while safeguarding resources for future generations. Among its central goals is the reduction of non-revenue water; including leakage and illegal abstraction, from current levels of over 45% to 25% by 2040, with a consistent annual reduction of about 2%. It also calls for a substantial expansion in the use of non-conventional water resources, targeting that at least 60% of irrigation demand be met by treated wastewater, desalinated water, and brackish sources by 2030 (Renewable Energy Law, 2025 ; Ministry of Environment, 2023 ; Ministry of Agriculture, 2021 ; Waste Management Law No. 27, 2025 ; Wastewater Reuse Regulation, 2025 ; Water Authority Law No. 18, 2025). This shift is designed to alleviate the overexploitation of renewable groundwater, which remains a critical challenge for Jordan's water balance. Institutional reform forms another cornerstone of the new strategy. It seeks to enhance governance by empowering autonomous utilities, establishing an independent water regulator, and promoting transparency through improved data management and digital monitoring systems. Furthermore, the strategy emphasizes financial and operational sustainability, aiming to recover full operation and maintenance costs, reduce energy expenditure, and increase efficiency through advanced technology and smart infrastructure. It explicitly integrates the WEFE nexus approach, ensuring that water policy is coordinated with national energy and agricultural strategies. Climate resilience is embedded throughout the framework, focusing on groundwater protection, flood management, and drought adaptation. Collectively, these measures position the 2023–2040 strategy as a transformative roadmap that links technical management, institutional governance, and economic planning, making it a leading model of adaptive water policy for arid and politically complex regions such as Jordan (Ministry of Agriculture, 2021 ; Wastewater Reuse Regulation, 2025 ; Water Authority Law No. 18, 2025 ; Water Use Regulation No. 85, 2025 ; Biodiversity Law Draft, 2025).

3.6 Synthesis: Policy Evolution and Resilience

Over the past century, Jordan's water sector has expanded through a series of effecttive institutional, legal, and strategic milestones that collectively illustrate an adaptive model of resource management under severe scarcity. Early frameworks in the Emirate period focused primarily on regulating irrigation rights and municipal supply. However, by the mid-twentieth century, the country had started centralizing its water administration to ensure coordinated management. The establishment of the Central Water Authority in 1959 and later the Water Authority of Jordan and Ministry of Water and Irrigation reflected a decisive move toward integrated and centralized control. This approach promoted more uniform policy application and strategic resource allocation. As Jordan's population and economic pressures raised, the government shifted from a supply-driven approach to a demand management and resilience-oriented framework. IWRM principles during the 1990s observed a turning point in joint administrative, legal, and technical measures to sustainability goals. Over time, successive strategies, including the 1997 Water Strategy, the 2016–2025 National Water Strategy, and most recently the 2023–2040 plan, have gradually expanded the focus from engineering solutions toward institutional coordination, governance reform, and financial sustainability.

The 2023–2040 National Water Strategy represents the conclusion of this evolution, integrating water policy with wider national development objectives. It emphasizes reducing non-revenue water, enhancing data-driven decision-making, and diversifying the resource base through desalination and wastewater reuse. Moreover, it considers the WEFE nexus, ensuring cross-sectoral alignment of resource policies. The strategy's governance vision aims to strengthen institutional performance by increasing service providers' independence, establishing an independent water regulator, and enforcing accountability through digital monitoring systems and transparent public reporting. From a management perspective, Jordan's experience displays how administrative adaptability and cumulative reform can mitigate structural vulnerabilities (Biodiversity Law Draft, 2025 ; Climate-Data.Org, 2025 ; Energy Efficiency Law Draft, 2025). Despite facing acute resource limitations, Jordan's constant focus on policy integration, legal clarity, and stakeholder engagement has enabled it to keep water stability. Each reform cycle, whether legislative, institutional, or strategic, has built upon lessons from earlier phases, forming a cumulative process of governance learning and policy refinement. This progressive adaptation also reflects broader regulations of resilience and adaptive governance, where flexibility, feedback, and cross-sectoral learning are essential to sustaining necessary public services under pressure. Jordan's water sector demonstrates how institutional innovation and strategic foresight can offset the constraints of geography and hydrology. Future resilience, however, will depend on strengthening enforcement mechanisms, maintaining financial viability (Water Use Regulation No. 85, 2025 ; Biodiversity Law Draft, 2025 ; Climate-Data.Org, 2025 ; Energy Efficiency Law Draft, 2025 ; Energy Law No. 13, 2025 ; Environmental Protection Law No. 52, 2025).

4. Conclusion

Jordan's water policy and legal evolution represent a century-long transformation marked by institutional innovation, strategic adaptation, and administrative reform in response to persistent water scarcity. From its early focus on irrigation rights and municipal supply to the establishment of national institutions such as the Water Authority of Jordan and the Ministry of Water and Irrigation, the country has built a robust framework that integrates technical, legal, and governance dimensions of water management. This progression demonstrates how effective public administration and evidence-based policymaking can transform resource challenges into opportunities for institutional learning and resilience. The integration of IWRM and the WEFE nexus into national planning has enhanced coordination across sectors, ensuring that water governance supports economic growth, food security, and environmental protection which is core components of the 2030 Agenda for Sustainable Development. Jordan's ongoing alignment with the Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation), as well as SDG 13 (Climate Action), SDG 2 (Zero Hunger), and SDG 7 (Affordable and Clean Energy), highlights its commitment to a holistic, sustainability-oriented approach.

The National Water Strategy 2023–2040 further strengthens this direction by promoting decentralization, accountability, and financial sustainability. Its measures to reduce non-revenue water, expand desalination capacity, and enhance wastewater reuse signal a transition from short-term emergency responses to long-term resilience and sustainability. Equally important is the strategy's emphasis on digital governance, data transparency, and regulatory monitoring, principles that link public administration efficiency with water security and sustainable development outcomes. Moving forward, maintaining Jordan's resilience will rely on deepening institutional reforms, advancing regional cooperation over shared water resources, and fostering innovation through technology and research. Ultimately, Jordan's experience exemplifies how strategic policy, adaptive governance, and continuous institutional learning can help water-stressed nations progress toward achieving SDG 6 and other interconnected sustainability goals.

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