

# Strategic Resilience: A Comprehensive Analysis of Jordan's Water Security, Digital Transformation, and Infrastructure Modernization

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## Abstract

This study evaluates the strategic transition toward “Hydrological Autonomy” through a Geo-Systemic and Techno-Economic framework and identifies a dual-nexus structural dependency: while the \$6 billion National Conveyance Project (NCP) is a sovereign priority based on the Organic Theory of the State, its long-term viability is anchored in the Energy-Water-Sovereignty Nexus. However, a systemic “Red Alert” is identified regarding the \$153.6 million Water Sector IT Roadmap, which faces a 60% CAPEX funding gap. This study demonstrates that bridging this digital gap is a prerequisite for broader resilience: digital modernization reduces physical and administrative losses, thereby increasing effective supply, preserving groundwater aquifers, and ultimately lowering the national energy burden for water pumping. To address the decline of national statistical capacity to 60/100, the study introduces the “Hidden Loss Gap”—an original contribution—to quantify masked network decay, incorporating newly calculated 2023 data. Findings reveal that Yarmouk Water Company (YWC) maintains a structural loss of 6,955 L/connection/day (L/C/D). In Amman (Miyahuna), an increase in supply duration to 38 hours triggered an NRW% rise to 44.7%, validating the “Operational Paradox” where traditional metrics penalize service improvement. Furthermore, with commercial losses (driven by unauthorized consumption) accounting for 70% of Non-Revenue Water (NRW), the Rule of Law (0.26 estimate) is primary technical prerequisite for enforcement. Finally, drawing from the CAO/IFC Baynouna investigation, the study warns that not institutionalizing transparent social compliance frameworks regarding land rights risks the \$2.2 billion in secured international financing required for construction.

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## Keywords

Water Security, Systems Analysis, Hidden Loss Gap, Desalination, National Carrier Project, Non-Revenue Water, Geopolitical, Hydrological, Energy-Water-Sovereignty Nexus, Jordan

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## 1. Introduction

### 1.1. Geopolitical-Hydrological Context and Strategic Imperative

Official data confirms that per capita availability of renewable freshwater resources has fallen to a critical 61 m<sup>3</sup>/year [1] [2]. This level is only about 12.2% of the United Nations' "absolute scarcity" threshold of 500 m<sup>3</sup> per capita per year [3] [4]. This figure represents a drop from historical levels of 1,857 m<sup>3</sup> in 1967 and 145 m<sup>3</sup> in 2013 [5].

This existential nature of Jordan's water challenge is compounded by a high reliance on external financing, with the Net Official Development Assistance (ODA) received as a percentage of GNI reaching 5.58% in 2023 [6]. This dependence underscores the sector's vulnerability to global donor shifts, particularly with severe demographic shocks as the influx of over one million Syrian refugees has increased water demand in northern governorates by 40% between the onset of the Syrian crisis and 2019 [7], with about 83.5% of refugees residing within host communities rather than camps, accelerating the degradation of existing networks and increasing groundwater pollution [8] [9]. Climate dynamics further exacerbate these pressures. Temperatures in Jordan averaged 18.79 Celsius from 1901 to 2024, reaching an all-time high of 21.23 Celsius in 2010 [10]. Precipitation in Jordan decreased to 89.38 mm in 2024 from 145.37 mm in 2023 [11]. Impacts are projected to include a 4 Celsius rise in average temperature and a 21% decrease in precipitation by the century's end [9].

In response, the government has adopted a critical dual strategy. The first pillar Supply Augmentation through the National Conveyance Project (NCP) is to provide 300 MCM/year [12] [13]. The NCP is structured as a Public-Private Partnership (PPP) between the Ministry of Water and Irrigation (MWI) and a consortium led by Meridiam (90%) and Suez (10%), emphasizing a transition toward modern utility management models [13]. The total project cost is estimated at \$6 billion, subject to further optimizations [9]. The International Finance Corporation (IFC) is considering an A loan of up to US\$ 375 million to anchor the financial closure [13]. Jordan has secured \$2.2 billion in grants and loans from a coalition of international partners including the Green Climate Fund (GCF) [14]. The second pillar targets operational efficiency by mandating a reduction in Non-Revenue Water (NRW) from approximately 50% to 25% by 2040 through the 2025-2030 IT Roadmap [15].

## 1.2. Review of Precedent Literature

A comprehensive review of recent academic and policy literature reveals critical insights into Jordan's water dynamics, while simultaneously highlighting a crucial analytical gap. The literature is grouped into three thematic areas:

Theme A: Geo-Political Constraints and Strategic Alignment. The strategic investment in high-capacity desalination projects is rooted in geopolitical and fiscal constraints. The foundational work on Hydro-Hegemony (Zeitoun & Warner, 2006) established that control over the Jordan Basin flows is influenced by strategic positioning rather than riparian position alone [16]. This confirms that reliance on transboundary solutions presents viability challenges for long-term strategies [17], thereby contextualizing the \$6 billion NCP as a necessity for national security and hydrological autonomy. This strategic alignment is further validated by Albatayneh *et al.*'s (2022) Energy-Water Nexus modelling, which found that transitioning to a 100% renewable energy system is the least-cost pathway to power future massive desalination requirements [18]. This analysis highlights that strategic water security is inseparable from energy sovereignty Framework by integrating dimensions of energy security [19].

Theme B: Operational Governance and Digital Transformation. Daoud *et al.* (2022) analyzed the National Water Strategy using the OECD Governance Framework, concluding that while the policy framework is well-established, optimizing operational implementation mechanisms is a key area for development. This governance requirement is reflected in operational data [20]. Al-Assa'd and Charalambous (2022), in their analysis of NRW metrics in Jordan, highlighted what is termed the "Operational Paradox": Miyahuna's reported improvement in NRW percentage was statistically driven by adjustments in supply duration—dropping from 55 to 36 hours per week [21]. Ogata *et al.* (2022) asserted that management tactic, focused on reducing pressure, influences leakage volumes in official statistics while emphasizing the need to address persistent structural network requirements [22]. Furthermore, the IT Roadmap for the Water Sector (2025) quantified the core execution obstacle, revealing a 60% funding requirement for the necessary \$153.6 million Capital Expenditure (CAPEX) for digital systems [15].

Theme C: Socio-Economic Sustainability and Equity. The need for sustainable financing is critical. Hickey's (2025) analysis confirmed the fiscal success of the tariff reforms, noting that water billing revenue rose from covering 33% to 60% of real production costs by 2024 [23] [24]. However, simultaneously identified an associated social consideration: the current tiered tariff system may disproportionately affect large, low-income families, requiring careful alignment with social equity goals. Complementary studies highlight cost-effective alternatives, such as the 0.38/ m<sup>3</sup> cost of de-centralized brackish water desalination for high-value agriculture [25], suggesting demand-side optimization opportunities exist. Finally, the structural integrity of existing assets is addressed by Al-Taani *et al.* (2025) [26], which validated that sediment removal (dredging) is an economically viable strat-

egy for preserving dam capacity, which is essential for ensuring long-term resilience alongside new supply projects.

### 1.3. Defining the Research Gap and Unique Contribution

Existing research often treats these themes in isolation—focusing either on the geopolitical constraint or the technical NRW problem. This research bridges this gap by 1) introducing an integrated Geo-Systemic and Techno-Economic framework that systematically connects the strategic necessity of the NCP to internal operational and social dynamics. 2) The Hidden Loss (The Structural Gap) equation is the original contribution of this study, providing a calibrated lens to quantify network decay masked by intermittent supply regimes. 3) Proposing a Governance Solution: Advocating for the mandatory adoption of L/C/D as a regulatory KPI, moving the sector from a tactic-driven to a performance-driven governance model.

## 2. Methodology

### 2.1. Research Design and Integrated Geo-Systemic Analysis

This study employs an Integrated Geo-Systemic and Techno-Economic Analysis design. This framework is necessary to analyze the feedback loops between external drivers (geo-political and climate stress) and internal system responses (technology, finance, and governance). The theoretical underpinning utilizes the Organic Theory of the State [27], which views the state's survival and legitimacy as intrinsically dependent upon the effective control and sustainable management of vital natural resources. This framework elevates water management from an environmental issue to an imperative for national security, justifying large-scale sovereign supply investments alongside internal optimization. **Detailed Methodological Phases:** 1) **The Operational Paradox:** To resolve the “Operational Paradox” in intermittent supply systems, the study adopts the methodology of Al-Asa'd and Charalambous (2022) [21] to calculate Normalized L/C/D, adjusting measured losses to a standard 24-hour supply basis (168 hours/week). The study introduces the **Hidden Loss Gap equation** to quantify masked structural decay independent of supply duration amidst statistical capacity scores. 2) **Financial and Social Equity Analysis:** Analysis of real cost-recovery data (2021-2024) to assess financial performance, coupled with a review of the distributional impacts of the existing tiered-tariff system on vulnerable socio-economic groups. Reviewing Category A land acquisition requirements based on IFC standards and applying lessons from the CAO/IFC Baynouna investigation regarding stakeholders to safeguard international funding covenants. 3) **Governance & The Digital CAPEX Gap:** Correlating World Bank Governance Indicators—specifically Rule of Law and national Statistical Capacity—with the CAPEX funding deficit identified in the national IT Roadmap, and Evaluation the gap between strategic vision and the technical enforcement required to manage commercial losses (unauthorized usage).

## 2.2. Data Sources and Acquisition

Data were compiled from official public sector reports (MWI, UPMU), multilateral bank disclosures (IFC, AIIB), and peer-reviewed academic literature to ensure reliability: 1) **Performance Data:** MWI Utilities Monitoring Reports (2019-2023) [28]-[30], utilized to calculate L/C/D values [21] and Hidden Loss Gaps, 2) **Financial Data:** Official disclosures regarding the NCP's revised cost [31] and Public Private Partnership (PPP) structure [13], as well as detailed CAPEX requirements from the MWI IT Roadmap [14].

## 2.3. Raw Data Compilations

**Table 1** shows Operational Performance Benchmarks (2019/2022/2023), and Key Financial and Economic Metrics of Jordan's Water Sector (2021-2024) are shown in **Table 2**.

**Table 1.** Utility performance benchmarks (NRW and Normalized L/C/D) (2019/2022/2023).

Indicator	Amman (Miyahuna)			Yarmouk (YWC)			Aqaba (AW)		
	2019	2022	2023	2019	2022	2023	2019	2022	2023
NRW %	38.7	42.8	44.7	46.1	51.1	47.6	36.2	33.1	33.8
Continuity of Supply	21.30	21.30	22.60	5.40	5.40	5.40	100	100	100
Supply Duration	36	36	38	9	9	9	168	168	168
Water Distributed	244.993	319.588	338.398	100.694	114.498	113.157	27.114	26.336	28.795
Authorized Consumption	150.223	183.389	187.569	54.552	57.109	60.396	17.307	17.714	18.768
Total Connections	731858	1,028,813	1134538	350974	377143	387961	43651	46147	44546
Total Volume of Losses (m <sup>3</sup> )	94770000	136199000	150829000	46142000	57389000	52761000	9807000	8622000	10027000
L/C/D (Measured)	355	363	364	360	411	373	616	512	617
L/C/D (Normalized)	1,656	1,693	1,610	6,723	7,782	6,955	616	512	617
<b>Hidden Loss Gap</b>	<b>1,301</b>	<b>1,330</b>	<b>1,246</b>	<b>6,363</b>	<b>7,365</b>	<b>6,582</b>	<b>0</b>	<b>0</b>	<b>0</b>

Total Connections is used here as a proxy for the total number of active subscribers, as reported in the MWI Annual Monitoring Reports.

**Table 2.** Key financial and economic metrics of Jordan's water sector (2021-2024).

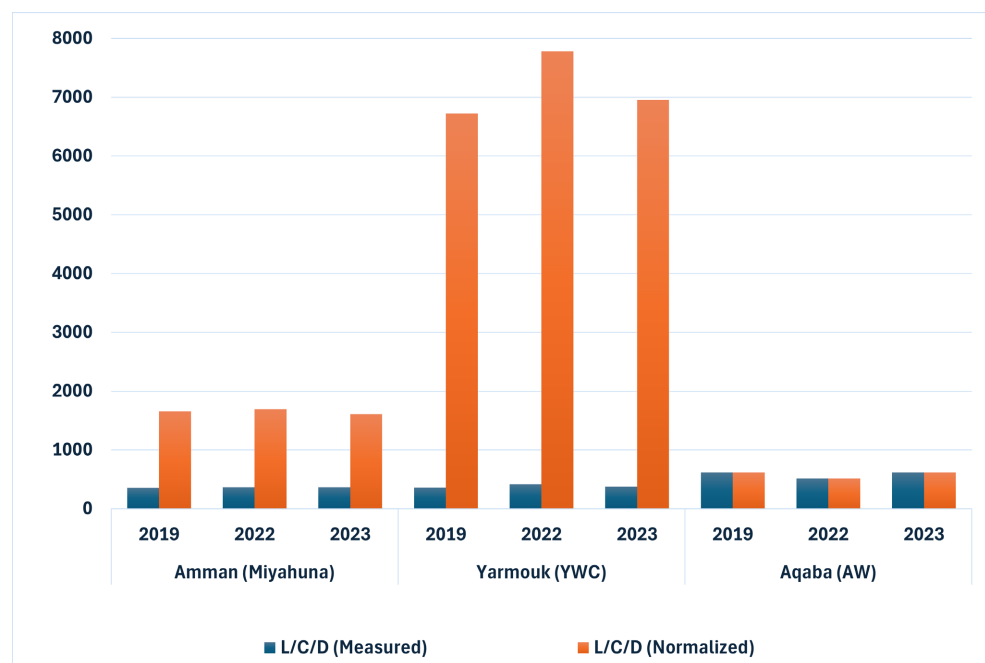
Financial Performance	2021	2024	Delta
Avg. Production Cost (JOD/m <sup>3</sup> )	2.16	1.93	-10.6%
Revenue Share of Actual Cost (Cost Recovery) (%)	33%	60%	+81.8%
External Debt (% of GNI)	90.6%	90.1%	-0.5%
Source/Notes	[23] [24] [32]	Efficiency gains	Stable trajectory

### 3. Results

The systemic analysis yielded three primary results detailing the contradictions between strategic goals and executable reality.

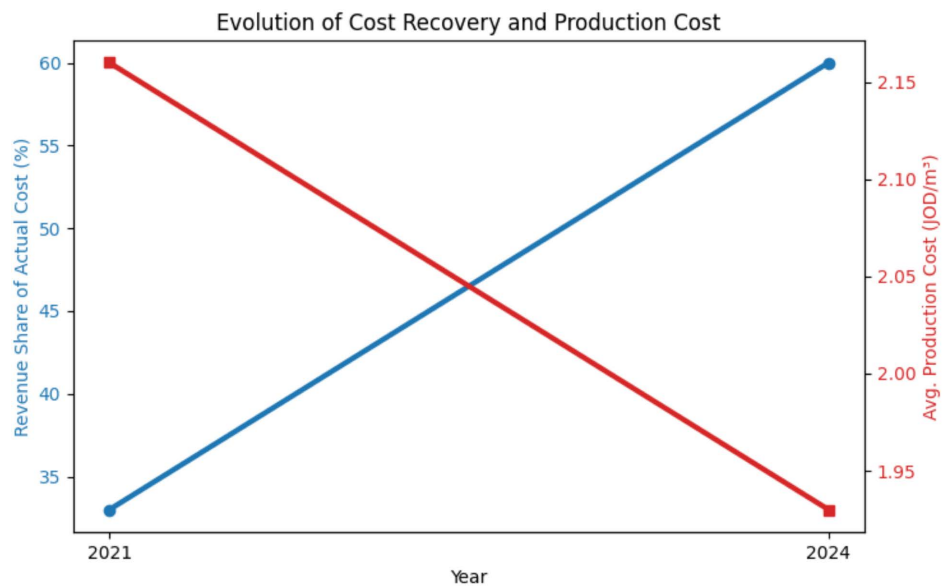
#### 3.1. The Operational Paradox

Results identify a significant correlation between supply management and performance indicators. The inclusion of 2023 data provide a critical validation of the 'Operational Paradox'. In Amman (Miyahuna), supply duration increased to 38 hours, which triggered a rise in reported NRW% to 44.7%. Yarmouk Water Company (YWC) exhibits a Normalized L/C/D of 6955, over 11 times higher than Aqaba Water (AW) at 617 L/C/D (Table 1, Figure 1). This disparity confirms that the NRW challenge is localized and heavily concentrated in utilities with clear operational challenges.



**Figure 1.** Comparison of NRW performance metrics using the Measured versus the Normalized Liters/Connection/Day (L/C/D) indicator across three Jordanian utilities (Amman, Yarmouk, and Aqaba) for the period 2019-2023.

### 3.2. Financial and Social Equity Analysis



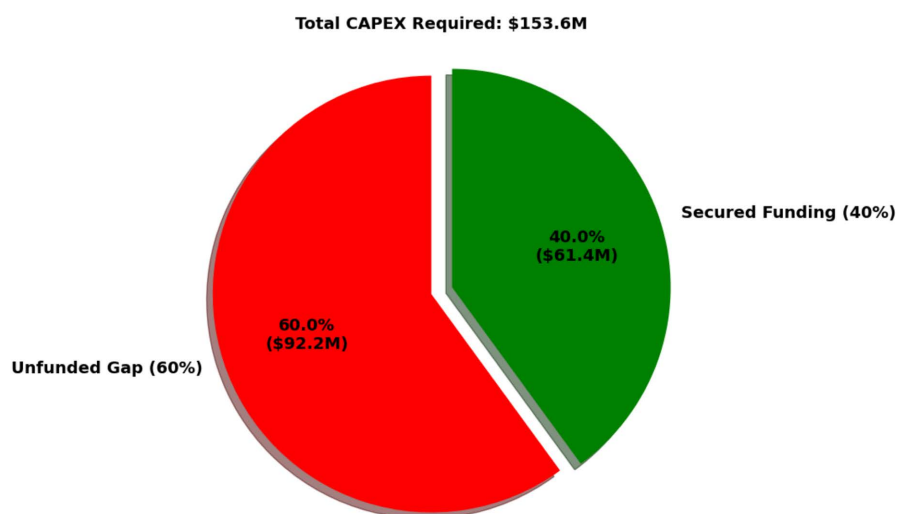
**Figure 2.** Evolution of cost recovery (revenue share) and production cost (2021 vs 2024).

Financial indicators confirm substantial progress in the sector’s fiscal sustainability. Revenue coverage of production costs rose from 33% in 2021 to 60% by 2024 (Table 2, Figure 2), driven by efficiency gains that optimized the real production cost to JOD 1.93/m<sup>3</sup> [23]. While this represents a critical milestone in reform success, the study notes the socio-economic importance of addressing the “shadow market” of private tankers, where costs remain significantly higher than municipal tariffs. Furthermore, the planned 4.6% annual tariff adjustment—designed to ensure the long-term viability of the NCP—requires careful alignment with social safety nets to maintain the progressive nature of the tiered system [23] [24].

The discourse surrounding the social cost of tariffs and tanker dependency is further complicated by the risks exposed in the CAO/IFC investigation into the Baynouna project. As a Category A project involving extensive land acquisition, the NCP faces scrutiny similar to Baynouna, where the CAO identified non-compliance regarding community consultations over land rights. This underscores a critical imperative: strategic urgency must not circumvent stringent environmental and social compliance. The prospect of losing international financing due to ESG non-compliance remains a tangible threat; thus, proactive adherence to IFC Environmental and Social Performance Standards (PS) is a fundamental determinant of project viability. Institutionalizing transparent consultative frameworks with local stakeholders is mandatory—not merely to satisfy international covenants, but to mitigate social friction and stabilize the project’s socio-spatial footprint. Absent such measures, high-cost desalinated water will primarily serve to subsidize structural leaks as supply duration expands nationwide [33]-[37].

### 3.3. Governance & the Digital CAPEX Gap

The analysis highlights a strategic opportunity to balance resource allocation between large-scale infrastructure and digital modernization. While the \$6 billion NCP has successfully secured international commitments, the Water Sector IT Roadmap (2025-2030) identifies a 60% CAPEX funding requirement (\$92.2 million) (Table 2, Figure 3). Addressing this requirement is essential for deploying unified SCADA systems and smart pressure management, which are critical for achieving the National Water Strategy's target of 25% NRW by 2040 [14], as well as to strengthen the technical enforcement of regulations against unauthorized water usage. Technical losses, including malfunctions and aging infrastructure, account for about 30%, while administrative losses related to violations and illegal usage constitute around 70% [38].



**Figure 3.** Capital expenditure (CAPEX) funding status for the Jordanian water sector IT roadmap (2025-2030).

The World Bank's Worldwide Governance Indicators provide a nuanced view of the sector's implementation environment:

1) **Source Data Assessment of Statistical Capacity:** Analysis of the longitudinal data for Source Data Assessment of Statistical Capacity indicates that Jordan maintained a stable score of 70/100 for over a decade. However, the score adjusted to 60/100 in 2020 [39]. This adjustment in statistical capacity directly influences the sector's framework for accurately measuring and reporting NRW, necessitating the adoption of more resilient metrics like the Normalized L/C/D.

2) **Government Effectiveness and Regulatory Quality:** Positive trends are observed in Government Effectiveness, with scores rising from 0.19 in 2022 to 0.39 in 2023 [40]. Similarly, Regulatory Quality has trended upward to an estimate of 0.22 [41], with a percentile rank of approximately 59.4% [42]. This progress suggests that while the strategic vision for mega-projects like the \$6 billion NCP is well-defined, the regulatory frameworks for technical implementation are in a

phase of continuous maturation.

3) **Macro-Fiscal Indicators:** The broader economic context remains a critical factor, with External Debt Stocks reaching 90.1% of GNI by 2024 [32]. Within this fiscal landscape, Net Official Development Assistance (ODA) continues to be a vital pillar of support, standing at 5.58% of GNI [6].

4) **Rule of Law and Control of Corruption:** The percentile rank (upper bound) for the Rule of Law reached 66.5% in 2023, compared to a peak of approximately 75% in 2014 [43]. The Rule of Law: Estimate shows a trend from a peak of 0.47 in 2014 to approximately 0.26 in 2023 [44]. Regarding the Control of Corruption, the Standard Error has shown an upward trend since 2018 [45], reflecting an increase in measurement variance, while the Percentile Rank (Upper Bound) for this indicator fluctuated between 62% in 2020 and 74% in 2003 [46]. These metrics may provide insights into the implementation trajectory of Jordan's robust policy frameworks.

#### 4. Discussion

Jordan's strategic transition toward hydrological resilience is a multifaceted endeavor that bridges the gap between massive sovereign infrastructure and granular operational efficiency. The success of the National Conveyance Project (NCP) is not guaranteed by its \$6 billion funding alone; rather, it is contingent upon a simultaneous revolution in digital governance and socio-economic protection. The NCP is confirmed as a sovereign necessity. The integration of a 281 MWp solar plant provides approximately 27% of energy needs [13], mitigating production costs which were optimized to JOD 1.93/m<sup>3</sup> by 2024 [23]. Pairing energy and water priorities is essential to secure IT Roadmap funding, as digital efficiency directly reduces national pumping energy consumption (14% - 15%) [47], which is driven by complex topography ranging from -420 m (Dead Sea) to 1850 m ASL [48].

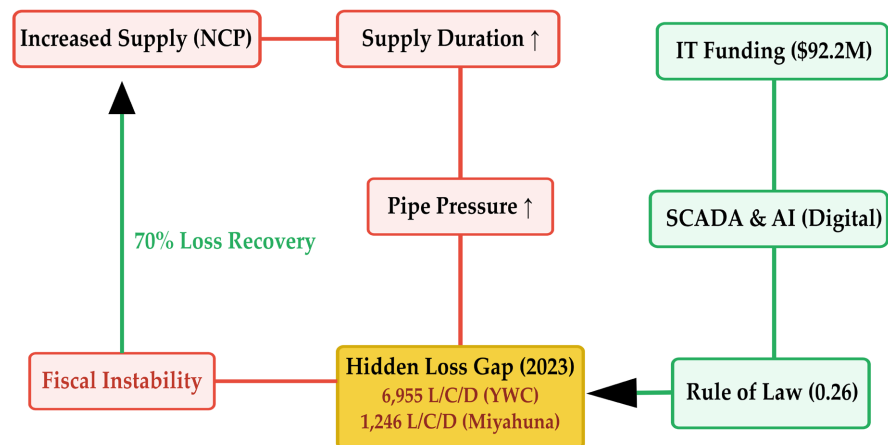
The interaction between variables is by two primary systemic loops, illustrating the "Red Alert" for decision-makers. **Figure 4** shows the reinforcing risk of infrastructure deterioration versus the balancing solution of digital governance.

The analysis has quantified two primary structural barriers. First, the "Operational Paradox" and its associated "Hidden Loss Gap" indicate that physical water production will be wasted unless the 60% CAPEX funding gap for digitalization is bridged. Without SCADA-enabled pressure management and AI-driven leak detection, the expensive desalinated water from the Red Sea will serve only to increase the volumetric losses in crumbling networks like those in the Yarmouk service area. Second, the fiscal transition to 60% cost recovery must be managed with extreme sensitivity to the regressive impacts of tiered tariffs on large, low-income families and refugees.

By integrating the WEF Nexus approach—utilizing decentralized brackish desalination for agriculture and circular sediment management for dams—Jordan can alleviate pressure on its municipal networks. Furthermore, by internalizing

the lessons of the CAO investigation and prioritizing community-led environmental and social performance, the state can secure the institutional legitimacy required to manage its vital resources. Ultimately, Jordan's move toward "Hydrological Autonomy" represents more than an engineering feat; it is an exercise in systemic resilience.

### Causal Loop Analysis: Jordan's Water Resilience Nexus



**Figure 4.** Systemic feedback loop of Jordan's water sector.

## 5. Conclusion

The kingdom's ability to pair its \$6 billion sovereign supply augmentation with \$92.2 million in strategic IT investment and targeted social safety nets will define its stability for generations to come. This transition from traditional crisis management to a technology-driven, inclusive model of resource governance provides a vital regional template for adaptation in an increasingly water-scarce world.

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## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

## References

- [1] MWI (2023) National Water Strategy 2023-2040. [https://www.mwi.gov.jo/EBV4.0/Root\\_Storage/AR/EB\\_Ticker/National\\_Wa-](https://www.mwi.gov.jo/EBV4.0/Root_Storage/AR/EB_Ticker/National_Wa-)

- [ter Strategy 2023-2040 Summary-English -ver2.pdf](#)
- [2] Foresight4Food (2024) Understanding Water Conversion to Food in Jordan's Food System. FoSTr Jordan Policy Brief No. 3. <https://foresight4food.net/wp-content/uploads/2025/02/FoSTr-brief-2024-Water-conversion-to-food-Jordan.pdf>
- [3] Al-Rkebat, R.A. (2025) An Earth System Analysis of Jordanian Agriculture: From Vicious Cycles of Resource Degradation to Integrated Resilience Pathways. *Natural Resources*, **16**, 359-370. <https://doi.org/10.4236/nr.2025.1612018>
- [4] Al-Ansari, N., Alibrahiem, N., Alsaman, M. and Knutsson, S. (2014) Water Demand Management in Jordan. *Engineering*, **6**, 19-26. <https://doi.org/10.4236/eng.2014.61004>
- [5] Farishta, A. (2014) The Impact of Syrian Refugees on Jordan's Water Resources and Water Management Planning. Ph.D. Thesis, Columbia University. <https://academiccommons.columbia.edu/doi/10.7916/D8DF6ZKQ/download>
- [6] Trading Economics (2025) Jordan—Net ODA Received (% Of GNI). <https://tradingeconomics.com/jordan/net-oda-received-percent-of-gni-wb-data.html>
- [7] Hayek, L. (2023) Refugees and the City: How Migration Facilitated Mafraq, Jordan's Green Transition. PRAXIS. <https://sites.tufts.edu/praxis/2023/06/08/refugees-and-the-city-how-migration-facilitated-mafraq-jordans-green-transition/>
- [8] Ghaith, B. and Amman, J. (2024) How Water Scarcity in Jordan Hits Refugees Twice. UNHCR <https://www.unhcr.org/jo/news/how-water-scarcity-jordan-hits-refugees-twice>
- [9] Smart Water Magazine (2025) The Green Climate Fund Supports \$6 Billion Jordan Water Project with Its Largest-Ever Investment. <https://smartwatermagazine.com/news/smart-water-magazine/green-climate-fund-supports-6-billion-jordan-water-project-its-largest>
- [10] Trading Economics (2025) Jordan-Temperature. <https://tradingeconomics.com/jordan/temperature>
- [11] Trading Economics (2025) Jordan-Precipitation. <https://tradingeconomics.com/jordan/precipitation>
- [12] IFC (2025) IFC Project Information & Data Portal. Aqaba Amman Water Desalination & Conveyance (AAWDC). <https://disclosures.ifc.org/project-detail/SII/47924/aqaba-amman-water-desalination-conveyance-aawdc>
- [13] EWS Data (2025) Early Warning System, IFC-47924, Aqaba Amman Water Desalination & Conveyance (AAWDC). Project Details PDF. <https://ewdata.rightsindevelopment.org/projects/IFC-47924/pdf/>
- [14] IGC (2025) Setbacks & Opportunities in the Wake of USAID's Jordan Withdrawal. International Growth Centre (IGC). <https://www.theigc.org/sites/default/files/2025-09/Hickey-Working-Paper-July-2025.pdf>
- [15] MWI (2025) It Roadmap for the Water Sector in Jordan. [https://www.mwi.gov.jo/ebv4.0/root\\_store/ar/eb\\_list\\_page/it\\_roadmap\\_for\\_the\\_water\\_sector\\_in\\_jordan.pdf](https://www.mwi.gov.jo/ebv4.0/root_store/ar/eb_list_page/it_roadmap_for_the_water_sector_in_jordan.pdf)
- [16] Zeitoun, M. and Warner, J. (2006) Hydro-Hegemony—A Framework for Analysis of Trans-Boundary Water Conflicts. *Water Policy*, **8**, 435-460.

- <https://doi.org/10.2166/wp.2006.054>
- [17] Laura Kieweg, L. and Rahbek Lund, I.A. (2019) Water Governance in Jordan: Managing a Scarce Resource. [https://projekter.aau.dk/projekter/files/307171370/Kieweg\\_Lund\\_Water\\_governance\\_in\\_Jordan\\_Managing\\_a\\_scarce\\_resource.pdf](https://projekter.aau.dk/projekter/files/307171370/Kieweg_Lund_Water_governance_in_Jordan_Managing_a_scarce_resource.pdf)
- [18] Albatayneh, A., Hindiyeh, M. and AlAmawi, R. (2022) Potential of Renewable Energy in Water-Energy-Food Nexus in Jordan. *Energy Nexus*, **7**, Article ID: 100140. <https://doi.org/10.1016/j.nexus.2022.100140>
- [19] Al-Ghussain, L., Ahmad, A.D., Abubaker, A.M. and Hassan, M.A. (2024) A Country-Scale Green Energy-Water-Hydrogen Nexus: Jordan as a Case Study. *Solar Energy*, **269**, Article ID: 112301. <https://doi.org/10.1016/j.solener.2023.112301>
- [20] Daoud, I.Y.H., Dehnavi, S. and Ribbe, L. (2022) Towards Good Water Governance: An Analysis of Jordan's National Water Strategy. *Environmental Management*, **69**, 847-860. <https://doi.org/10.1007/s00267-022-01606-x>
- [21] Al-Assa'd, T. and Charalambous, B. (2022) Measuring and Benchmarking NRW Performance for a Non-Technical People—A Case Study Applied in Jordan. [https://www.researchgate.net/publication/362945548\\_Measuring\\_and\\_Benchmarking\\_NRW\\_Performance\\_for\\_a\\_Non-Technical\\_People\\_-\\_A\\_Case\\_Study\\_Applied\\_in\\_Jordan](https://www.researchgate.net/publication/362945548_Measuring_and_Benchmarking_NRW_Performance_for_a_Non-Technical_People_-_A_Case_Study_Applied_in_Jordan)
- [22] Ogata, R., Mahasneh, S., Alananbeh, A. and Fujii, N. (2022) Insights into Water Service Quality in Jordan from Key Performance Indicators and Consumer Perceptions. *Utilities Policy*, **78**, Article ID: 101406. <https://doi.org/10.1016/j.jup.2022.101406>
- [23] Hickey, M. (2025) How Can Jordan Achieve Water Tariff Reforms Despite Rising Costs? IGC. <https://www.theigc.org/blogs/jordan-water-tariff-reforms-costs>
- [24] Hickey, M. (2025) Designing Acceptable and Effective Subsidy Reforms: Lessons for Water Tariff Reform in Jordan. IGC. <https://www.theigc.org/publications/designing-acceptable-and-effective-subsidy-reforms-lessons-water-tariff-reform-jordan>
- [25] Qtaishat, T.H., Al-Karablieh, E.K., Salman, A.Z., Tabieh, M.A., Al-Qudah, H.F. and Seder, N. (2017) Economic Analysis of Brackish-Water Desalination Used for Irrigation in the Jordan Valley. *Desalination and Water Treatment*, **72**, 13-21. <https://doi.org/10.5004/dwt.2017.20435>
- [26] Al-Taani, A., Radaideh, N.E., Kateeb, W.A., Howari, F., Nazzal, Y., Iqbal, J., *et al.* (2025) Sustainable Sediment Management in Jordanian Dams: Feasibility, Economic Viability, and Agricultural Reuse Potential. *Journal of Water and Land Development*, No. 64, 211-220. <https://doi.org/10.24425/jwld.2025.153533>
- [27] Fiveabl (2025) Ratzel's Organic Theory Definition-AP Human Geography Key Term. Fiveable. <https://fiveable.me/key-terms/ap-hug/ratzels-organic-theory#:~:text=Ratzel's%20Organic%20Theory%20views%20political,land%20and%20resources%20to%20thrive>
- [28] MWI (2019) Jordan Water Utilities Monitoring Report 2019. Ministry of Water and Irrigation, Utilities Performance Monitoring Unit (UPMU) . [https://www.mwi.gov.jo/EBV4.0/Root\\_Storage/AR/EB\\_Pages/Monitoring\\_report\\_for\\_the\\_year\\_2019\\_1.pdf](https://www.mwi.gov.jo/EBV4.0/Root_Storage/AR/EB_Pages/Monitoring_report_for_the_year_2019_1.pdf)
- [29] MWI (2022) Jordan Water Utilities Monitoring Report 2022. Ministry of Water and Irrigation, Utilities Performance Monitoring Unit (UPMU). [https://www.mwi.gov.jo/EBV4.0/Root\\_Storage/AR/EB\\_Pages/Jordan\\_Water\\_Uilities\\_Monitoring\\_Report2-2022.pdf](https://www.mwi.gov.jo/EBV4.0/Root_Storage/AR/EB_Pages/Jordan_Water_Uilities_Monitoring_Report2-2022.pdf)

- [30] MWI (2023) Jordan Water Utilities Monitoring Report 2023. Ministry of Water and Irrigation, Utilities Performance Monitoring Unit (UPMU).  
[https://www.mwi.gov.jo/EBV4.0/Root\\_Storage/AR/EB\\_Info\\_Page/Jordan\\_Water\\_Utilities\\_Monitoring\\_Report\\_-\\_2023\\_.pdf](https://www.mwi.gov.jo/EBV4.0/Root_Storage/AR/EB_Info_Page/Jordan_Water_Utilities_Monitoring_Report_-_2023_.pdf)
- [31] Mop (2022) \$1.830b Pledged for National Water Carrier Project—Planning Ministry.  
[https://www.mop.gov.jo/En/NewsDetails/1830b\\_pledged\\_for\\_National\\_Water\\_Carrier\\_Project\\_%E2%80%944\\_Planning\\_Ministry](https://www.mop.gov.jo/En/NewsDetails/1830b_pledged_for_National_Water_Carrier_Project_%E2%80%944_Planning_Ministry)
- [32] Trading Economics (2025) Jordan—External Debt Stocks (% Of GNI).  
<https://tradingeconomics.com/jordan/external-debt-stocks-percent-of-gni-wb-data.html>
- [33] Jordan: Masdar Baynouna-01/East Amman. Office of the Compliance Advisor/Ombudsman.  
<https://www.cao-ombudsman.org/case/jordan-masdar-baynouna-01east-amman>
- [34] Jordan: Aqaba-Amman Water Desalination and Conveyance Project (AAWDCP).  
<https://www.aiib.org/en/projects/details/2025/proposed/jordan-aqaba-amman-water-desalination-and-conveyance-project-aawdcp.html>
- [35] MIGA (2025) Aqaba-Amman Water Desalination and Conveyance.  
<https://www.miga.org/project/aqaba-amman-water-desalination-and-conveyance>
- [36] CAO (2024) Compliance Investigation Report Regarding Community Complaint about IFC’s Investment in Baynouna Solar Energy Company, Jordan. IFC Project #39339.  
<https://www.cao-ombudsman.org/sites/default/files/downloads/CAO-Investigation-Report-JordanBaynouna-Oct212024-ENG.pdf>
- [37] IFC Board Approves Action Plan for CAO Investigation Related to IFC’s Investment in Baynouna Solar Energy in Jordan. International Finance Corporation.  
<https://www.ifc.org/en/pressroom/2025/ifc-board-approves-action-plan-for-cao-investigation-related-to-ifc-s-investment-i>
- [38] Jordan Times (2025) Jordan Network Upgrades Save \$160 mln, 20 m Cubic Metres of Water in 2024.  
<https://www.zawya.com/en/economy/levant/jordan-network-upgrades-save-160mln-20m-cubic-metres-of-water-in-2024-hpclrprzs>
- [39] Trading Economics (2025) Jordan—Source Data Assessment Of Statistical Capacity (Scale 0-100).  
<https://tradingeconomics.com/jordan/source-data-assessment-of-statistical-capacity-scale-0--100-wb-data.html>
- [40] Trading Economics (2025) Jordan—Government Effectiveness: Estimate.  
<https://tradingeconomics.com/jordan/government-effectiveness-estimate-wb-data.html>
- [41] Trading Economics (2025) Jordan—Regulatory Quality: Estimate.  
<https://tradingeconomics.com/jordan/regulatory-quality-estimate-wb-data.html>
- [42] Trading Economics (2025) Jordan—Regulatory Quality: Percentile Rank.  
<https://tradingeconomics.com/jordan/regulatory-quality-percentile-rank-wb-data.html>
- [43] Trading Economics (2025) Jordan—Rule of Law: Percentile Rank, Upper Bound of 90% Confidence Interval.  
<https://tradingeconomics.com/jordan/rule-of-law-percentile-rank-upper-bound-of-90percent-confidence-interval-wb-data.html>
- [44] Trading Economics (2025) Jordan—Rule of Law: Estimate.

- 
- <https://tradingeconomics.com/jordan/rule-of-law-estimate-wb-data.html>47Trading
- [45] Trading Economics (2025) Jordan—Control of Corruption: Standard Error. <https://tradingeconomics.com/jordan/control-of-corruption-standard-error-wb-data.html>
- [46] Trading Economics (2025) Jordan—Control of Corruption: Percentile Rank, Upper Bound of 90% Confidence. <https://tradingeconomics.com/jordan/control-of-corruption-percentile-rank-upper-bound-of-90percent-confidence-interval-wb-data.html>
- [47] Darwish, H.H. and Talazi, S. (2024) Assessment of Water Footprint in the Jordanian Industrial Sector as a Means for Sustainable Water Resources Management. *Nafta-Gaz*, **80**, 450-468. <https://doi.org/10.18668/ng.2024.07.07>
- [48] MWI (2023) The Water Sector’s Energy Policy 2023-2040. [https://mwi.gov.jo/ebv4.0/root\\_storage/ar/eb\\_list\\_page/the\\_water\\_sectors\\_energy\\_policy.pdf](https://mwi.gov.jo/ebv4.0/root_storage/ar/eb_list_page/the_water_sectors_energy_policy.pdf)