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The Structural Transformation of the Jordan Valley's Agricultural Sector (1990-2023)

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Abstract

This study analyzes the profound structural transformation of the Jordan Valley (JV) agricultural sector between 1990 and 2023 within a critical political-economy framework. Quantitative analysis reveals a condition of "False Stability", where a marginal 3.4% decline in total cultivated area (from 29,000 hectare to 28,000 hectare) masks a radical internal restructuring. This shift involves a sharp contraction in traditional, water-intensive open-field crops (a combined loss of 11,500 hectare) compensated by a massive expansion in high-value, technology-intensive protected agriculture and fruit trees (a net gain of 10,500 hectare). This transformation is not organic growth but an adaptational restructuring driven by structural pressures and policy direction, propelled by geopolitical shocks, rising input costs, and acute water scarcity. Findings, updated with Q3 2025 metrics, reveal that this transformation occurs within a context of acute national stress, where Jordanian unemployment stands at 21.4% and female unemployment reaches 33.9%. The analysis further applies the Jevons Paradox, explaining how efficiency-focused policies paradoxically intensify water consumption by incentivizing a shift toward higher-value, yet still thirsty, crops. This phenomenon indicates deeper structural challenges rooted in institutional constraints and structural market barriers that favor large-scale resource concentration. This includes granting legal personhood to the Jordan River and implementing a just transition for smallholder farmers.

Keywords

Jordan Valley, Water Scarcity, Protected Agriculture, Structural Transformation, Political Economy, Jevons Paradox, Rights of Nature, Water Governance, Post-Water Political Economy

1. Introduction

The Jordan Valley (JV), a crucial geographic and economic segment of the Jordan River Basin, serves as a vital case study for the complex interplay between severe environmental stress and political economy (Conca, 2021). Jordan faces a chronic and deepening water crisis, positioning it among the most water-deprived nations globally (Economist Impact, 2022). As of December 2025, official data from the Department of Statistics (DoS) indicate that the national unemployment rate (residents) has declined to 16.2%, yet internal structural challenges for Jordanian citizens remain acute, with female unemployment at 33.9% (DoS, 2025). This crisis is not solely attributable to arid conditions; it is exacerbated by climate change, regional conflict, non-stationary climate patterns, rapid population growth, and, critically, internal political economy issues related to water allocation and governance (Wojnarowski, 2025; Hussein, 2025). Understanding the JV's structural transformation requires a comprehensive political-economy framework that extends beyond traditional economic and market analyses (Conca, 2021).

1.1. The Political Ecology of Water Scarcity

Jordan's water scarcity is compounded by complex interactions between environmental pressures and socio-economic dynamics, where the country struggles to sustain water resources against accelerated depletion (Ministry of Water and Irrigation (MWI), 2024). Hydrogeological data indicate the current water system is unsustainable, heavily reliant on non-renewable groundwater over-extraction. Annual per capita renewable freshwater availability has plummeted to approximately 61 m^3 (MWI, 2024), representing only 12% of the absolute scarcity threshold (MWI, 2024). This systematic depletion threatens to consume most economically accessible fresh groundwater reserves by 2050 (MWI, 2024). For instance, annual extraction (estimated at 1313 Million Cubic Meters [MCM]) significantly exceeds the estimated annual renewable supply (564 MCM) (MWI, 2024).

Although the Kingdom has formulated robust frameworks, such as the National Water Strategy 2023-2040 (MWI, 2023), previous strategies demonstrate a systemic constraint in institutional context (Daoud et al., 2022). Policy implementation has faced historical friction and structural obstacles, which require careful consideration of market concentration and investment patterns. This institutional dynamic has historically shaped water allocation to prioritize short-term considerations over long-term resource sustainability (Yorke, 2013). This context supports a "post-water political economy" (PWPE) view (Hussein, 2025), where climatic variability interacts with structural administrative limitations and varying infrastructure capacities to distribute scarcity unevenly, often creating acute shortages for some while ensuring abundance for others (Conca, 2021).

1.2. Documenting Structural Transformation (2023-1990)

Time series data from the JV "as shown in **Table 1**" illustrate a radical shift in agricultural land use over three decades, driven by the need to maximize economic return per unit of water (JVA, 2024).

The table confirms a drastic contraction in traditional sectors: Field Crops declined by over 60%, and Open-Field Vegetables fell by 46.7% (JVA, 2024). Conversely, intensive, high-value production systems boomed. Protected Vegetables increased 14-fold (from 500 ha to 7000 ha), facilitated by water-efficient technologies and government subsidy programs (FAO, n.d.-c). Fruit Trees rose by 66.7%, including high-export value crops like date palms, which require intensive labor (Nassar & Al-Amri, 2025). This pivot confirms a shift from a crop-driven to a value-driven approach (JVA, 2024). These high-capital investments are only feasible for actors who can secure reliable water access, reinforcing the potential for structural resource consolidation within high-capital investment frameworks (Conca, 2021).

Table 1. Modeled historical cultivated area in the JV (1990-2023).

Year	Field Crops (ha)	Open-Field Vegetables (ha)	Protected Vegetables (ha)	Fruit Trees (ha)	Total Area (ha)
1990	7500	15,000	500	6000	29,000
2000	5500	13,000	1500	6500	26,500
2010	3500	10,000	4500	7500	25,500
2023	3000	8000	7000	10,000	28,000

(JVA, 2024; DOS, 2023).

1.3. Drivers of Change

1) Climatic Vulnerability: Future hydrological modeling projects a structural freshwater shortage of 1521 MCM per year by 2050 (MWI, 2024). The agricultural sector must shift completely to treated wastewater reuse to conserve freshwater for municipal use (MWI, 2024).

The system's sensitivity is high: a 10% reduction in rainfall historically resulted in a 26.2% reduction in flood flows (Salameh & Abdallat, 2020). Future modeling using tools like SWAT projects a reduction in streamflow between 22.3% and 41.6% (Shammout et al., 2018). This necessitates radical measures, including intensified desalination and stricter water use efficiency in agriculture (Salameh & Abdallat, 2020).

2) Jevons' Paradox: The widespread adoption of efficient irrigation risks triggering the Jevons Paradox (Fei, 2021). By lowering the marginal cost of water, efficiency gains incentivize farmers to expand the total irrigated area or shift to crops that are more water-intensive in absolute terms (Sears et al., 2018). The rebound effect (Li et al., 2024) proves technical fixes alone are insufficient; strict, enforceable water quotas must be implemented to manage aggregate consumption (Gleick et al., 2011).

3) Geopolitical Shocks: Geopolitical volatility is a significant non-climatic risk.

The closure of major export routes through Syria and Iraq since 2011 imposed severe financial burdens, undermining the profitability required to sustain high-capital investments. Building powerful downstream marketing capacity is therefore a critical indirect climate adaptive measure (Mulabdic & Yotov, 2025).

1.4. The Need for Transformational Governance

The depth of the water crisis mandates a radical governance solution (Yorke, 2013). This study proposes granting Legal Personhood to the Jordan River (Takacs, 2021; Aliu, 2023). This approach breaks from the traditional anthropocentric legal framework (Atela, n.d.), recognizing the river as an entity with rights to flow, health, and restoration (Böll, 2025). Global precedents, such as the Whanganui River (New Zealand) and the Río Atrato (Colombia), established rivers as legal subjects, shifting disputes from political conflict to matters of corrective justice (Roy, n.d.). This transformation offers a critical mechanism to permanently prioritize ecological integrity over entrenched extractive interests (Roy, n.d.).

1.5. Research Objective and Study Structure

This study analyzes the JV's structural transformation as a forced adaptation to hydro-climatic and political pressures. It aims to: 1) Quantitatively document the structural shift (1990-2023), 2) Assess the role of the political economy, constrained governance, and Jevons' Paradox, and 3) Propose a transformational governance roadmap centered on systemic reform and the Rights of Nature.

2. Materials and Methods

2.1. Quantitative Structural Analysis

This study employs a quantitative, longitudinal approach using official reports (MWI, JVA, DOS) and published academic research to analyze cultivated areas in the JV for the years 1990 through 2023 (JVA, 2024). Data is categorized into four classes: Field Crops, Open-Field Vegetables, Protected Vegetables (plastic houses), and Fruit Trees. The Compound Annual Growth Rate (CAGR) was calculated for each crop category to assess the intensity of change over the 33-year period. Additionally, socio-economic context was enriched using the latest 2024 GDP per capita (PPP) data, which stands at 9520.3 Int$/cap (FAOSTAT, 2024)

The term "modeled data" signifies a methodological reconstruction used to standardize time series data against the 2023 baseline classification, accounting for temporal discontinuity and inconsistent classification terminology used by the Jordan Valley Authority (JVA) and the Department of Statistics (DOS) (JVA, 2024). This rigorous standardization ensures that the analysis of the 'False Stability' phenomenon is a robust, measured representation of the structural shift.

$$\text{CAGR} = \left(\left(\frac{A_{\text{final}}}{A_{\text{initial}}}\right)1/\text{Years} - 1\right)$$

where A_{final} is the cultivated area in 2023, A_{initial} is the area in 1990, and Years = 33.

2.2. Political-Economic and Theoretical Framework

The analysis is grounded in a framework viewing resource allocation as a function of socio-economic factors and market concentration rather than pure market efficiency (Conca, 2021). Two core concepts are applied:

1) Structural Constraints and Resource Concentration: This examines how commercially dominant actors interact with institutions, potentially leading to a concentration of resources (Hussein, 2025; Wojnarowski, 2025).

2) Jevons Paradox (Rebound Effect): This analyzes how increased irrigation efficiency can lead to a net increase in total water consumption by reducing the effective cost of water and incentivizing farmers to expand cultivated areas or shift to more water-intensive, high-value crops (Fei, 2021; Sears et al., 2018).

3. Results

3.1. The Phenomenon of False Stability

Between 1990 and 2023, the total cultivated area in the JV showed a misleading "false stability", decreasing only marginally by 3.4% (JVA, 2024). However, this marginal change masks a radical, forced restructuring. The loss of 11,500 ha in Field and Open-Field Crops was nearly compensated by a net gain of 10,500 ha in Protected Vegetables and Fruit Trees (JVA, 2024). This divergence confirms the sector's overall stability (CAGR of −0.1%) is merely the outcome of a catastrophic collapse in traditional sectors being offset by a vigorous boom in intensive ones (JVA, 2024).

Table 2 provides a summary of the structural shift. The shift in land use is clearly illustrated in **Figure 1**.

Table 2. Compound Annual Growth Rate (CAGR) analysis of cultivated areas in the JV (1990-2023).

Crop Category	Area 1990 (ha)	Area 2023 (ha)	Absolute Change (ha)	Relative Change (%)	CAGR (1990-2023)
Field Crops	7500	3000	−4500	−60.0%	−2.7%
Open-Field Vegetables	15,000	8000	−7000	−46.7%	−1.9%
Traditional (Sub-Total)	22,500	11,000	−11,500	−51.1%	−2.3%
Protected Vegetables	500	7000	+6500	+1300.0%	+8.7%
Fruit Trees	6000	10,000	+4000	+66.7%	+1.6%
Intensive (Sub-Total)	6500	17,000	+10,500	+161.5%	+2.9%
Total Cultivated Area	29,000	28,000	−1000	−3.4%	−0.1%

Sources: JVA, 2024; DOS, 2023.

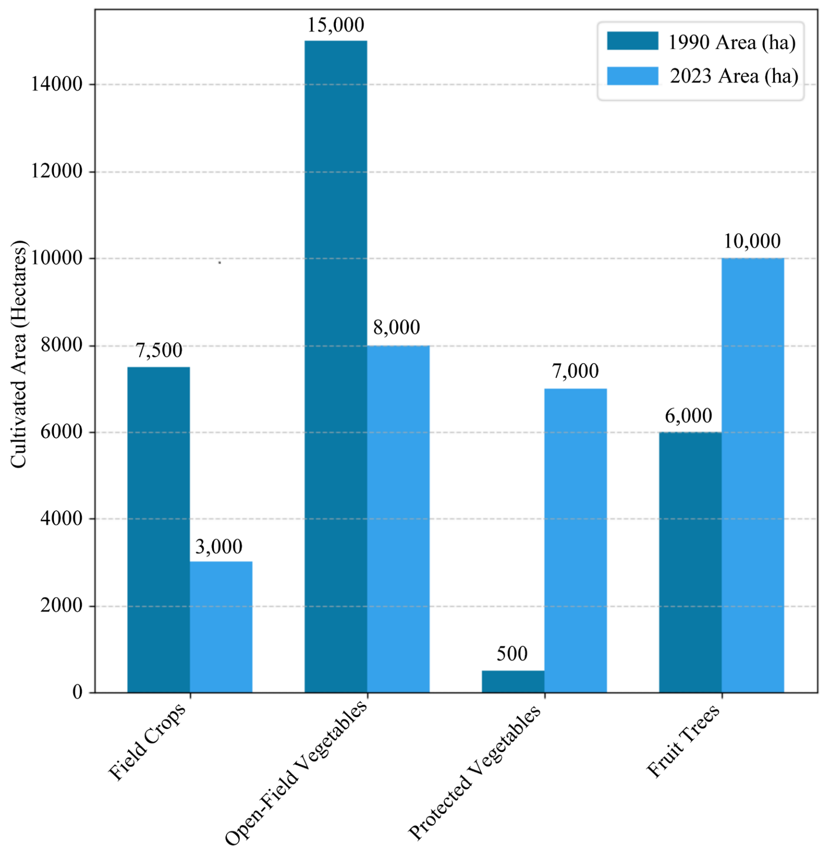

Figure 1. Comparison of Cultivated Areas in the JV (1990 vs 2023) showing the coercive structural shift from traditional to intensive farming.

3.2. Evidence of Coercive Restructuring

1) Collapse of the Traditional Sector: Field Crops saw a −60% contraction (CAGR of −2.7%), while Open-Field Vegetables shrank by −46.7% (CAGR of −1.9%). This indicates a rapid deterioration in the viability of traditional farming (Farhan et al., 2025).

2) Explosive Growth in Intensive Production: Protected Vegetable cultivation experienced exponential growth, soaring by 1300% (CAGR of +8.7%) (MoENV, n.d.). Fruit Trees, including high-cash-value date palms, grew steadily by 66.7% (CAGR of +1.6%), confirming a long-term investment shift (Al-Zyoud, 2021). The intensity of these divergent growth rates is visually represented in **Figure 2**.

Positive CAGR indicates intensive growth sectors; negative CAGR indicates traditional collapse sectors.

The analysis utilizes both **Table 2** and the corresponding visual representations (**Figure 1** and **Figure 2**). **Table 2** provides the necessary numerical precision for the magnitude of the shift (e.g., exact ha figures and calculated CAGR values). Conversely, **Figure 1** is crucial for visually communicating the central thesis of "False Stability" by juxtaposing the total area over time, while **Figure 2** isolates and dramatizes the rate of the coercive restructuring by plotting the divergent CAGR values, making them essential visual complements to the core quantitative data.

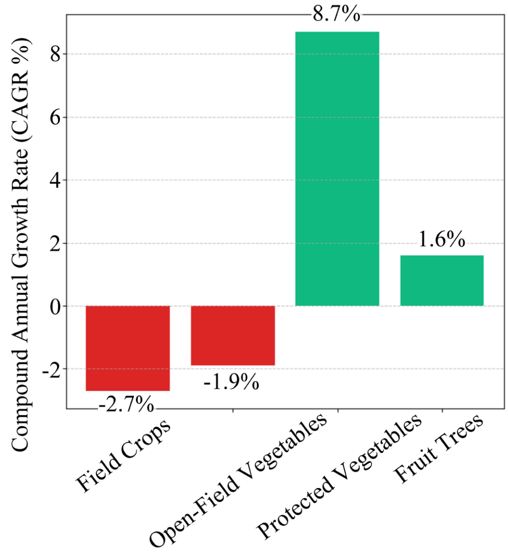

Figure 2. Crop category Compound Annual Growth Rate (CAGR) (1990-2023).

4. Discussion

4.1. Comparative Analysis and Value Added

The empirical results confirm that the Jordan Valley's agricultural sector is undergoing a "coercive restructuring", driven by an engineered scarcity that privileges capital-intensive systems. The following discussion expands this diagnosis by comparing our findings with external peer-reviewed studies.

4.1.1. Geopolitical Shocks and Economic Viability

The loss of 11,500 ha in traditional crops (Field and Open-Field Vegetables) is consistent with the findings of Mohammad et al. (2025), who documented that the closure of Syrian and Iraqi export routes in 2011 fundamentally broke the profitability of smallholder open-field farming. Our finding of a -60% contraction in field crops aligns with Farhan et al. (2025), who utilized GIS-based projections to prove that Jordan's wheat production decreased by 34.19% due to population pressure and erratic rainfall. This "Marketing Collapse" is further validated by Mulabdic & Yotov (2025), who argue that geopolitical risk acts as a structural barrier to trade, forcing agricultural systems to either collapse or shift toward high-value, niche exports to survive.

4.1.2. The Jevons Paradox: Technical Gains vs. Systemic Losses

Our evidence of a 1300% growth in protected agriculture provides a powerful empirical verification of the Jevons Paradox (Rebound Effect) in an arid context. This matches the observations of Sears et al. (2018), who argued that technological efficiency gains in irrigation often incentivize farmers to cultivate more water-intensive crops. Furthermore, van Halsema et al. (2025) found that in Jordan's Highlands, drip irrigation led to "actual evapotranspiration increasing at the basin level", mirroring our findings of "False Stability" in the Jordan Valley. The 66.7% growth in fruit trees, specifically date palms, is supported by Nassar & Al-Amri (2025), who noted that date palms require intensive capital and labor, making them viable only for large investors. This proves Fei's (2021) thesis that the rebound effect is the direct hydrological footprint of profit maximization over resource sustainability.

4.1.3. Resource Consolidation and Social Equity

The boom in high-capital systems was only feasible for actors who could secure reliable resources due to enhanced financial leverage and specialized infrastructure capacity. This confirms Hussein's (2025) argument that scarcity in Jordan is "manufactured" to reinforce existing power structures. Our finding that capital requirements displace smallholder farmers is consistent with Wojnarowski's (2025) ethnographic research, which found that influential users continue operating private wells on outdated licenses while smallholders face strict enforcement. The study findings showed that Jordan's NWS managed to capture to some extent, good water governance principles for Policy Framework, but failed to provide Governance Mechanisms for implementation Daoud et al. (2022).

The sustainability of this primary water supply is fundamentally threatened by over-exploitation, as documented by Radaideh (2022), who proved that aquifer depletion has led to the widespread drying of natural springs in Jordan. As Belhaj (2025) notes, failure to address these governance bottlenecks could cost Jordan up to 14% of its potential GDP by 2050, as resource scarcity compounds with the 33.9% female unemployment rate to threaten social peace and economic modernization targets.

4.2. A Roadmap for Transformational Governance

Escaping the "Systemic Trap" requires an integrated strategy focused on legal, economic, and diplomatic reform (Yorke, 2013).

- **Pillar I: Transformational Governance and Legal Reform**

Table 3. Proposed jurisdiction of the water security court vs. existing water bodies.

Feature	**Specialized Water Tribunal for Regulatory Enforcement**	**Existing Regulatory/Judicial Bodies**
Primary Mandate	Judicial enforcement of water rights, resource protection, and Rights of Nature (Roy, n.d.).	Executive management, infrastructure operation, and policy setting; judicial role is secondary or administrative.
Jurisdiction Scope	Function directly under ministerial authority; decisions are guided by immediate operational priorities and the necessity of managing complex multi-sectoral socio-economic pressures.	Limited jurisdiction over permits and compliance; high-stakes disputes often revert to politically susceptible civil courts reflecting challenges in specialized enforcement.
Institutional Status	Independent, specialized judicial body, insulated from Ministerial changes and political lobbying promoting long-term resource objectivity.	Function under ministerial authority; mandated to balance urgent domestic demands within existing fiscal and administrative constraints.

As shown in **Table 3** To escape this "Systemic Trap", we propose granting legal personhood to the Jordan River, a move supported by Takacs (2021) and Aliu (2023) as a way to shift environmental disputes from political conflict to corrective justice. The proposed specialized water security court (**Table 3**) is designed to address the structural and resource-based limitations inherent in existing ad-ministrative frameworks. Unlike current bodies, which Daoud et al. (2022) found to be "efficiency-oriented but implementation-weak", this independent court would guarantee long-term resource objectivity. This transformational governance, coupled with a Just Transition for smallholders (ActionAid, 2019), provides the only viable path to genuine water resilience.

- **Pillar II: Economic Transformation and a Just Transition**

As shown in **Table 4** The shift must adhere to the principles of a Just Transition, ensuring the transformation is economically and socially fair (CIF, 2023). Policy must ensure a "Just Transition" by providing subsidized, low-interest credit and technical training to small farmers (Al-Adwan, n.d.). Public investment in agro-processing and canning facilities (Support for Agro-Processing) is also crucial. This absorbs surplus, stabilizes local prices, and mitigates the risk posed by collapsed export markets (Abdullatif, n.d.).

Table 4. Just transition framework and policy instruments.

Pillar of Transition	Core Objective	Policy Instrument Examples (JV Context)	Grounding (Based on Relevant Literature)
Livelihood Protection	Protecting livelihoods of small-scale producers during adaptation (CGIAR, n.d.).	Subsidized, specialized low-interest credit for protected agriculture technology; land-lease protections against speculative seizure (Al-Adwan, n.d.).	Ensures climate adaptation does not accelerate socioeconomic vulnerability (CIF, 2023).
Policy Coherence	Ensuring inclusive access to high-value systems while mitigating market risk (CGIAR, n.d.).	Public investment in agro-processing and storage; Guaranteed cooperative contracts for surplus absorption to stabilize local prices (Abdullatif, n.d.).	Mitigates fragility exposed by geopolitical shocks and input cost spikes (Mohammad et al., 2025).
Governance Support	Aligning institutional policies to favor sustainable, inclusive practices (CGIAR, n.d.).	Strengthening land tenure rights; supporting the formation of agricultural cooperatives to restore collective bargaining power.	Challenges the "Systemic Trap" by distributing resource control and preventing disproportionate impacts (Wojnarowski, 2025).

- **Pillar III: Critical Water Diplomacy**

Future agreements must prioritize strategic diversification of sourcing and technology to secure the nation's minimum strategic water reserve independent of regional political fluctuations (SIWI, n.d.). Water allocation policy must shift from fixed quotas to rewarding the highest Economic Water Productivity (Value Added per m^3 of water) (MoENV, n.d.).

4.3. Analytical Limitations and Paths for Future Research

Acknowledging its limitations, particularly those inherent in using aggregate land-use data (JVA, 2024).

- Hidden Variable I: Farm Ownership Concentration: The data tracks cultivated area by crop category but omits changes in ownership (JVA, 2024). The paper infers Resource Consolidation Dynamics from high capital requirements (Hussein, 2025). However, without ownership concentration data (e.g., land registry figures), the rate at which smallholder lands are sold or leased to larger investors cannot be empirically quantified (Aqel, n.d.). Future research must track farm ownership concentration directly to move the inference of capture from a theoretical argument to a measured empirical finding.
- Hidden Variable II: Variations in Water Efficiency within Crop Categories: The analysis generalizes Protected Agriculture as "water-efficient" (MoENV, n.d.). This masks significant variations in Water Use Efficiency (WUE) regarding absolute annual consumption (Sears et al., 2018). While protected vegetable cultivation is plot-efficient, the 66.7% growth in permanent, high-cash-value crops such as date palms (Nassar & Al-Amri, 2025) requires consistent, high-absolute consumptive water use year-round. Aggregate data cannot confirm if the Jevons Paradox is driven solely by the most efficient protected crops or substantially by the highest-profit, permanent crops that increase aggregate consumptive use (Sears et al., 2018). This nuance reinforces the PWPE argument: investors prioritize financial returns even if they increase aggregate water consumption (Fei, 2021).

5. Conclusion

The structural transformation of the JV's agriculture is a stark example of a sector adapting adaptively to acute political, economic, and climatic pressures (Conca, 2021). The quantitative evidence of "False Stability" confirms that the agricultural system is intensifying vertically (JVA, 2024). The core challenge is not lack of water, but the entrenched political economy that mediates its allocation, leading to phenomena like the Jevons Paradox (Hussein, 2025).

The analysis confirms that the persistent water crisis in politically structured arid regions is a consequence of a complex interaction between environmental factors and governance policies rooted in the dynamics of commercially dominant actors (Wojnarowski, 2025). The biggest challenge to effective water governance lies in dismantling the reciprocal relationship where short-term operational priorities are privileged over long-term resource sustainability (Yorke, 2013).

Escaping this "Systemic Trap" mandates a radical, integrated governance and social reform package:

1) Institutional Reform: Granting Legal Personhood to the Jordan River and establishing an independent, Specialized Mechanism for Accelerated Regulatory Enforcement will provide the necessary legal and judicial mechanisms to enforce ecological integrity and support strategic allocation decisions to guarantee long-term resource sustainability and equitable distribution (Takacs, 2021).

2) Social Equity: The adaptation must be managed via a Just Transition frame-

work, requiring subsidized financing, strengthening land tenure rights, and providing market support to stabilize livelihoods and counteract resource concentration (CGIAR, n.d.).

3) Neutralizing the Jevons Paradox: Policymakers must move beyond merely increasing technology efficiency by imposing strong, binding negative incentives, such as raising effective water tariffs, to break the vicious cycle of increased aggregate consumption (Gleick et al., 2011).

Furthermore, as of December 2025, while the national unemployment rate (residents) has declined to 16.2%, Jordanian female unemployment remains at 33.9% (DoS, 2025). Future success hinges not on technical fixes alone, but on a coordinated national approach that links water sector reform directly with the dismantling of systems that grant disproportionate resource privileges, guaranteeing genuine, long-term water resilience and equity for the JV (Hussein, 2025).

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Conflicts of Interest

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

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