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RESEARCH ARTICLE

AL-WEHDAH DAM: A VITAL SOURCE OF IRRIGATION WATER IN THE YARMOUK RIVER BASIN IN JORDAN- ASSESSING QUANTITY, QUALITY, AND SUSTAINABILITY

Maisa'a W. Shammout[a*], Mahmoud M. Abualhaija[a], Khaldoun Shatanawi[b], Tala Qtaishat[c], Lina Abu-Ghunmi[a], Thair Al-Momani[d]

[a]Water, Energy and Environment Center, The University of Jordan, Amman 11942 Jordan.
[b]School of Engineering, The University of Jordan, Amman 11942 Jordan.
[c]School of Agriculture, The University of Jordan, Amman 11942 Jordan.
[d]Ministry of Water and Irrigation, Amman-Jordan.
**Corresponding Author Email: m.shammout@ju.edu.jo; maisa_shammout@hotmail.com*

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ABSTRACT

This study highlights Al-Wehdah Dam as a sustainable irrigation water source in Jordan's Yarmouk River Basin, an area increasingly facing challenges due to declining river flows caused by excessive upstream water withdrawals. The methodology provides a comprehensive and detailed map of dams within the Yarmouk Basin, and the water quality index (WQI) of Al-Wehdah Dam over fourteen-years from 2007 to 2020 to assess quality trends and highlight sustainable irrigation water management strategies. Analysis of 2021 Landsat imagery revealed the presence of 48 dams across the basin, 44 of which are on the Syrian side and 4 on the Jordanian side, including Al-Wehdah Dam. Excessive water withdrawal by upstream farmers leads to water shortages for people living downstream and severely impacts sustainability. Initial findings in 2007 indicated poor water quality; however, significant improvements were observed in 2011, 2017, and 2020, coinciding with increased inflows and effective water management. This emphasizes the urgent need for transboundary cooperation to manage water quantity and quality equitably. Sustainable strategies, such as vegetation rehabilitation and continuous monitoring, are essential to mitigate geomorphic changes and ensure long-term water availability. These insights provide critical guidance for policymakers seeking to enhance the basin's agricultural sustainability and maintain ecological balance.

KEYWORDS

Dams, Decision-makers, Jordan, Strategies, Sustainable irrigation water, Water quality index (WQI)

1. INTRODUCTION

Dams are a crucial means of providing water and supporting economic development (Wei et al., 2009). While they offer significant benefits to populations, they are also a major contributor to the degradation of river ecosystems and the valuable services these ecosystems provide to society. The interaction between water quantity and quality in dams has become a pressing global issue, as it reflects the overall health of the environment and, consequently, the health of soil, water, and populations. Monitoring dams for both water quantity and quality is essential to control water pollution, facilitating ecosystem restoration, and improving the environment in water basins (Zhang et al., 2011). Identifying water sources for dams is crucial in assessing both pollution levels and the availability of water resources (Syeed et al., 2023). Managing shared river basins presents unique challenges, especially when excessive water extraction by upstream users results in water shortages for downstream populations, and the transfer of pollutants from upstream to downstream communities raises significant concerns about water quality and safety. Therefore, the benefit of this study lies in the importance of implementing effective management strategies for transboundary water basins. This will ensure the fair distribution of water resources between upstream and downstream communities (FAO, 2024).

In Jordan, fifteen (15) surface water basins exist, including transboundary basins such as the Jordan River, Yarmouk River Basin, and Zarqa River Basin.. However, the country faces significant challenges related to water scarcity, as its water resources are inadequate to fulfill the diverse demands placed upon them, particularly in irrigation uses (MWI, 2018; Shammout, 2024). The Yarmouk and Jordan River Basins stand out as the most critical of these basins. Notably, the Jordan River derives approximately 50% of its water from the Yarmouk River (Obeidat et al., 2019). Data collected from the Al Adasiya runoff gauge, a pivotal monitoring station within the basin, provides essential insights into the overall flow dynamics of the Yarmouk River (Avisse et al., 2020). Hydrological flow within the Yarmouk River Basin exhibits considerable variability, depending on rainfall events and seasonal precipitation patterns (MWI, 2018). Al-Wehdah Dam was designed and constructed in the Yarmouk River Basin to enhance water supplies in Jordan, improve the environmental conditions surrounding the basin, and promote tourism (FAO, 2009). Built in 2006, the dam is situated on the Yarmouk River in northern Jordan, within the transboundary Yarmouk Basin, most of which lies in Syria. Changes in the flow regime have occurred due to the over-extraction of water by farmers in the highlands and the construction of numerous dams in the Yarmouk River on the Syrian side, resulting in reduced flow rates of the river on the Jordanian side (Avisse et al., 2020). To address these challenges, effective arrangements regarding transboundary waters need to be established, incorporating all available sources of water, particularly groundwater (Mongelli et al., 2019), which is often hydraulically connected to the flows of major rivers (Foster et al., 2018). The predominant challenges encountered by the alternative

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irrigation sources within the Yarmouk River Basin, specifically Al-Wehdah Dam, can be encapsulated in several key points: (i) The Yarmouk River Basin necessitates a comprehensive understanding of water usage concerning both quantity and quality to ensure the equitable allocation of transboundary water resources. Given that the Yarmouk River Basin operates under transboundary water governance, the existing bilateral agreements and the prevailing political and environmental discourses have negatively impacted water availability from the river, particularly influencing the water levels in the Al-Wehdah Dam (Zeitoun et al., 2019). (ii) There exists a critical imbalance between water supply for irrigation and agricultural water demand which exerts considerable pressure on groundwater resources (Shammout et al., 2013; Shatanawi and Shammout, 2011). It is noticed that reliance on groundwater pumping raises risks in the future because of resource depletion (Whitman, 2019). (iii) The capacity of water resource systems to respond to shocks induced by natural imbalances, such as drought conditions, as well as sudden demographic shifts, exemplified by the influx of Syrian refugees into the Mafraq Governorate near the Syrian border, remains inadequate. This influx has intensified the demand for water while simultaneously decreasing supply (Shammout, 2023). These factors collectively highlight the urgent need for strategic management policies to address the complex hydrological dynamics within the Yarmouk River Basin.

Therefore, the Yarmouk River Basin was selected as a case study for the "WE/2/08/2017" project, which received funding from the Scientific Research and Innovation Support Fund of the Ministry of Higher Education and Scientific Research in Jordan. This study focuses on Al-Wehdah Dam as a sustainable source of irrigation water within the Yarmouk River Basin along the Jordanian side. The primary objective of this study is to investigate the impact of the constructed dams throughout the Yarmouk River Basin, which includes both the Jordanian and Syrian sides, on the quantity and quality of water in Al-Wehdah Dam. To achieve this objective, we will undertake the following actions: (i) Create a detailed map of all the dams in the Yarmouk River Basin, (ii) Identify these dams while assessing the quantity and quality of the water in Al-Wehdah Dam, (iii) Calculate the water quality index (WQI) versus the inflow water amount to Al-Wehdah Dam, and then (iv) Highlight sustainable management strategies for irrigation based on the water quantity and quality of Al-Wehdah Dam. This will support decision-makers in effectively managing the dam's water resources.

2. Materials And Methods

2.1 Study site

The Yarmouk River Basin is situated in the northwestern part of Jordan (Figure 1), covering an area of approximately 1393 km². The elevation within the basin varies, down to -200 meters in the Jordan Valley and up to 1150 meters at the upper boundary of the watershed (Ras Munif). This basin spans four Jordanian governorates: Mafraq, Irbid, Jerash, and Ajloun. The western part of the basin is densely populated and includes major cities such as Irbid and Ar Ramtha, while the eastern part is less populated. The geological formations of the Yarmouk Basin are classified into three groups: the Ajloun Group, the Balqa Group, and the Jordan Valley Group, which date from the Upper Cretaceous to the Tertiary periods. Groundwater sources in the basin are categorized into Shallow aquifers and Upper Cretaceous aquifers. Groundwater levels range from zero to 250 meters, and the aquifers are confined, with flow directions predominantly toward the north and northwest (Ta'any et al., 2007).

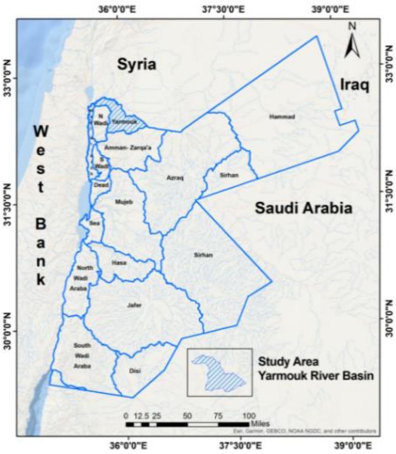

Figure 1: The water basins and the location of the Yarmouk River Basin in Jordan.

The Yarmouk River is a vital lifeline for the King Abdullah Canal, which is essential for the development of the Jordan Valley. This river ranks among the primary tributaries of the Jordan River in Jordan (Abualhaija et al., 2020; Abualhaija et al., 2019; FAO, 2009; Shammout et al., 2018; Shatanawi and Shammout, 2011). The annual flow of the Yarmouk River, measured at the confluence with the lower Jordan River, was recorded to be between 440 and 470 MCM/year from 1927 to 1954. Estimates suggest that the average total annual usable recharge of the Yarmouk aquifer is approximately 125 MCM/year. In Jordan, the net recharge for the section of the Yarmouk basin is estimated to range from 35 to 40 MCM/year. Furthermore, the side-wadi basin is replenished annually by 30 to 40 MCM/year (Courcier et al., 2005). The basin discharges its water at the confluence of the Yarmouk River with the Jordan River at an elevation of about 200 meters. The stream flow of the Yarmouk River is impounded at Al-Wehdah Dam, where the dam's water is used to irrigate various crops throughout the Jordan Valley, directly supporting the agricultural sector and enhancing food security in the region. Therefore, the sustainable management of this water resource is imperative for future development and environmental stewardship.

Several wadis are draining in the Yarmouk Basin, such as Wadi Al-Harir (on the Syrian side) and Wadi Al-Shalalah (on the Jordanian side). The Basin includes five municipal wastewater treatment plants: Al Akaidar, Wadi al Shalalah, Mafraq, Wadi Hassan, and Ramtha. As in most wastewater treatment plants, the amount of treated effluent has increased over the years due to the increase in population (Gonzalez, 2018), as the main driving factors are rapid population growth and high rates of resource use (Sala et al., 2000; Shammout et al., 2023).

2.2 Al-Wehdah Dam

Al-Wehdah Dam is a significant infrastructure project strategically located in the Yarmouk Basin. It was constructed on the Yarmouk River on the northern border between Jordan and Syria. It is a rolled concrete dam with a length of 110 meters and a storage capacity of 110 MCM. The reservoir created by the dam covers an area of about 3.75 square kilometers. The total drainage basin area of the dam encompasses 5590 square kilometers, of which 1200 square kilometers are within the borders of Jordan, and the rest falls within Syrian territory. The dam's reservoir started storing water on November 22, 2006. It holds the winter floods and available baseflow from the Yarmouk upstream catchment, including groundwater from springs. The main tributaries of the dam include Wadi Allan, Wadi Al-Harir, Wadi Zaizoun on the Syrian side, as well as Wadi Al-Shalalah on the Jordanian side (MWI, 2010-2018).

2.3 Create a detailed dam map for the study area

Two 2021 Landsat satellite images were used to create a detailed dam map for the entire Yarmouk River Basin, incorporating both the Jordanian and Syrian sides. This comprehensive map was specifically developed to support the objectives of this research. According to the specifications provided by (RJGC, 2021), the images utilized are identified as follows:

"LC08_L1TP_174037_20210421_20210501_01_T1,"
"LC08_L1TP_173037_20210516_20210525_01_T1."

2.4 Calculation of the water quality index (WQI)

Several quality indices are commonly used to assess water suitability for drinking and irrigation. These indices take into account various physical, chemical, and biological water quality parameters to provide an overall evaluation of water quality (Abbasi and Abbasi, 2012; Abualhaija, 2023; Abualhaija et al., 2020; Brown et al., 1972; Hossain and Patra, 2020; Meireles et al., 2010; Pryce et al., 2022). The water quality index (WQI) is a numerical index that indicates the overall quality of water and its suitability for any particular use. This index considers crucial water quality parameters at a specific location and time. It simplifies complex and essential water quality data into understandable and actionable information for decision-makers and pertinent organizations (Falowo et al., 2017). The weighted arithmetic index method (Brown et al., 1972) was used to compute the WQI.

WQI was used in this work to assess the quality of Al-Wehdah Dam water according to Jordan's standards for irrigation purposes (JSMO, 2021). In the WQI model calculations, all physicochemical and biological parameters were thoroughly analyzed, including pH, EC, TDS, TSS, Na^+, Mg^{2+}, Ca^{2+}, SAR, Cl^-, NO_3^-, HCO_3^-, and E. Coli. The calculation of the WQI was performed based on the following Eq. (1), as proposed by (Brown et al., 1972):

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$$\mathbf{WQI} = \sum_{i=1}^{n} \mathbf{W_i Q_i} / \sum_{i=1}^{n} \mathbf{W_i} \qquad \textbf{(1)}$$

Where Wi represents the unit weight of the ith parameter, Qi represents the water quality rating of the (ith) parameter. In contrast,(n) represents the number of parameters implicated in the calculation. The water quality rating (Qi) is determined by applying Eq. (2):

$$\mathbf{Q_i = 100}\ [(\mathbf{V_i - V_{id}})/(\mathbf{S_i - V_{id}})] \qquad \textbf{(2)}$$

Vi represents the value monitored for the ith parameter at a specific sample location. On the other hand, "Vid" stands for the typical value of the ith parameter in pure water. It is important to highlight that in pure water, the standard values for all parameters are typically zero (0), except for pH, which has a value of 7. Additionally, the variable "Si" refers to the standard allowable value for the ith parameter.

The relationship between the Wi and the standard value (Si) for each parameter can be expressed using the following formula Eq. (3), demonstrating that the Wi is inversely proportional to the standard value (Si).

$$\mathbf{W_i = K/S_i} \qquad \textbf{(3)}$$

Where K is the constant of proportionality, which is calculated using Eq. (4):

$$\mathbf{K = 1}/\sum(\tfrac{1}{\mathbf{S_i}}) \qquad \textbf{(4)}$$

Table 1 displays the classification of water quality based on WQI values (Brown et al., 1972; Chaterjee and Raziuddin, 2002; Tyagi et al., 2013). It's important to note that lower WQI values indicate better water quality, while higher values suggest poorer water quality.

Table 1: Classification of water quality of Al-Wehdah Dam water for irrigation based on the WQI values (Brown et al., 1972).

WQI value	Category
< 25	Excellent water quality
26 - 50	Good water quality
51 - 75	Poor water quality
76 - 100	Very Poor water quality
> 100	Unsuitable for the intended use

2.5 The physicochemical and biological parameters dataset of Al-Wehdah Dam

This research studied twelve physicochemical and biological parameters to evaluate the water quality of Al-Wehdah Dam and its appropriateness for irrigation from 2007 to 2020. These parameters encompassed hydrogen ion- pH (SU), electrical conductivity- EC (µs/cm), total dissolved solids- TDS (mg/l), total suspended solids- TSS (mg/l), sodium- Na^+ (mg/l), magnesium- Mg^{2+} (mg/l), calcium- Ca^{2+} (mg/l), sodium adsorption ratio- SAR (SU), chloride- Cl^- (mg/l), Nitrate- NO_3^-(mg/l), bicarbonate- HCO_3^- (mg/l), and Escherichia coli- E. coli (MPN/100ml). All these factors were considered and incorporated into the Water Quality Index (WQI) computation. The dataset of the parameters mentioned above was obtained from the Ministry of the Environment (MoE) in Jordan, as part of the National Water Quality Monitoring Project conducted by the MoE (MoE, 2007-2017). All the physicochemical and biological parameters were meticulously analyzed according to the Standard Methods for the Examination of Water and Wastewater (Rice et al., 2012).

3. Results And Discussion

3.1 Identifying the dams of the Yarmouk River Basin

The Yarmouk River Basin is located between Jordan and Syria. Since 1968, the water flow of the Yarmouk River available to Jordan has decreased by over 80% due to changes in the river's course and the construction of numerous dams on the Syrian side (Avisse et al., 2020). A total of 44 dams have been built in Syria, in addition to Al-Wehdah Dam, which was constructed along the border between Syria and Jordan as shown in Figure 2. Additionally, many groundwater wells have been drilled on the Syrian side, leading to excessive groundwater extraction and further contributing to the decline in Yarmouk River water flow (Avisse et al., 2020).

The Jordanian side of the basin has three small desert dams (Figure 2); however, they were not included in this study due to their frequent dryness and vulnerability to drought circumstances, caused by the low water flow in the Yarmouk River. In 2016, there was a significant shortfall of over 40% in available water resources from the Yarmouk Basin (MWI, 2016), which has continued to worsen in recent years. This has led to a persistent decrease in the Yarmouk River's base flow and a subsequent drop in the water table of shallow aquifers (Al-Kharabsheh, 2022). Therefore, urgent attention and intervention are needed to address this trend.

Al-Wehdah Dam was originally constructed to supply water for agricultural and domestic needs in Jordan (Hadadin, 2015; Yoon et al., 2021) and to produce hydroelectric power for Syria. However, due to concerns about the amount and quality of the water, its current usage has been limited to irrigation only. From 2006 to 2010, the dam only received 41 MCM of water as shown in Figure 3. Since 2011, there has been a significant increase in water inflow to the dam, peaking at 93.7 MCM in 2017 (Figure 3). This increase can be traced back to the Syrian crisis, which has forced hundreds of thousands of residents to flee southern Syria. Consequently, the area available for cultivation has diminished, and numerous dams built for rainwater collection on the Syrian side have been destroyed.

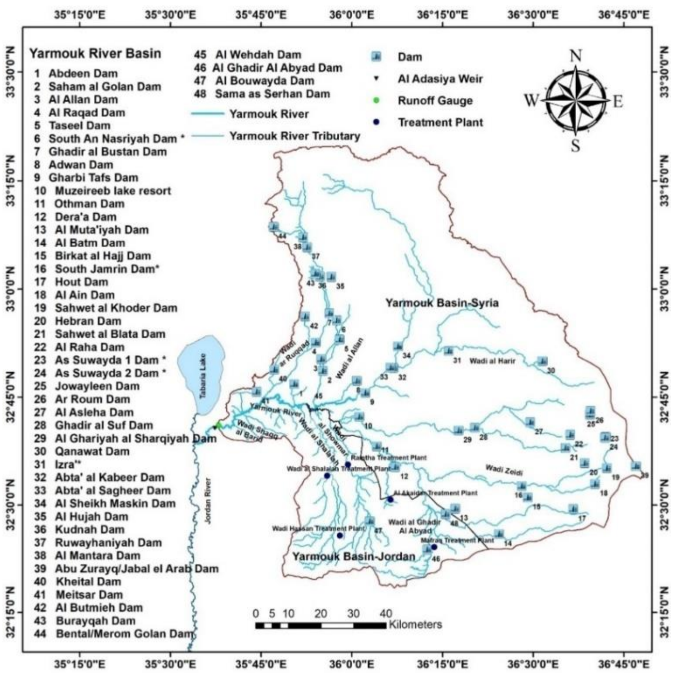

Figure 2: Syrian and Jordanian dams in the Yarmouk River Basin (Shammout et al., 2025).

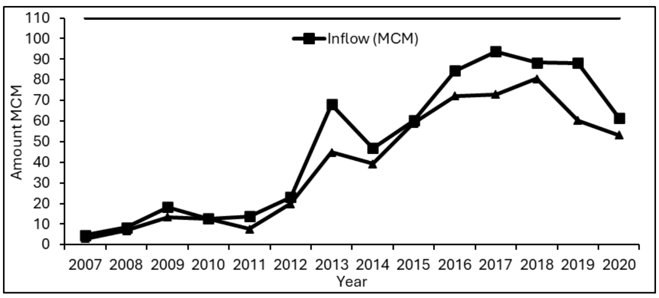

Figure 3: Annual inflow and outflow amount of Al-Wehdah Dam (MCM/Year).

3.2 Water quality of Al-Wehdah Dam and its suitability for irrigation purposes

3.2.1 The physicochemical variables of water quality

In this work, we studied twelve physicochemicaland biological parameters in the water of Al-Wahda Dam for the years 2007, 2010, 2017 and, 2020. The results for all these parameters across the studied years are presented in Table 2.

Upon thorough examination and comparison of the results related to the physicochemical and biological parameters in this study with the specified Jordanian standards for irrigation water (JSMO, 2021), as detailed in Table 2, it is evident that the values of these parameters are well within the acceptable range defined by the Jordanian standards for irrigation purposes, which indicates that the water from Al-Wehdah Dam is suitable for irrigation.

Table 2: Quality evaluation of Al-Wehdah dam water and the Jordanian standards for irrigation.

Parameter	This study				Jordanian standards for irrigation (JSMO, 2021) (Maximum permissible level)
	2007	2011	2017	2020	
pH (SU)	8.34	7.7	8.00	8.40	6-9
EC (µs/cm)	1092	1082	904	849	2400
TDS (mg/l)	600	623	570	480	1500
TSS (mg/l)	13.8	14.0	12.0	5.50	100
Na (mg/l)	120	102	91.0	71.1	230
Mg (mg/l)	34.0	33.0	23.0	28.8	100
Ca (mg/l)	78.0	75.0	45.0	50.7	230
SAR (SU)	2.83	2.48	2.79	2.02	9.0
Cl (mg/l)	138	135	108	103	500
NO_3^- (mg/l)	13.73	14.2	8.17	1.00	16
HCO_3^- (mg/l)	290	280	209	200	400
E-Coli (MPN/100ml)	9.54	130	1.9	1.8	-----

3.2.2 Water quality index (WQI) of Al-Wehdah Dam

Water quality indices are indispensable for assessing and monitoring water quality in dams. They are critical in identifying trends and implementing vital interventions to uphold high water quality standards (Abualhaija and Mohammad, 2021; Meireles et al., 2010).This study employed the water quality index (WQI) to evaluate the suitability of Al-Wehdah Dam water for irrigation.

Based on the weighted arithmetic index method (Brown et al., 1972) for calculating WQI (section 2.4), the calculations revealed that the WQI values for Al-Wehdah Dam were 54.6, 44.3, 37.3, and 38.5 in 2007, 2011, 2017, and 2020, respectively (Table 3). The water quality classifications for irrigation based on the WQI values presented in (Table 1) indicated that the water from Al-Wehdah Dam was categorized as having "Poor water quality" for irrigation in 2007. However, it is noteworthy that in subsequent years, 2011, 2017, and 2020, the water from the same dam was consistently categorized as having "Good water quality". This trend signifies a notable improvement in water quality over the years and underscores the potential for dependable irrigation from Al-Wehdah Dam.

The surrounding land use and the sources of water inflow greatly influence the quality of water in dams. Agricultural runoff, urban runoff, and groundwater all contribute different contaminants, significantly impacting water quality (Brainwood et al., 2004). Insufficient water inflow can also lead to a decrease in water quality within dams, which poses a significant threat to the ecosystem and the suitability of the water for irrigation and consumption. Many studies have examined the factors contributing to the deterioration of water quality in dams, with particular emphasis on the effects of low water inflow, sediment retention, and the accumulation of pollutants (Brainwood et al., 2004; De La Mora-Orozco et al., 2017). In 2007, the water quality of Al-Wehdah Dam was alarmingly poor. This was likely due to the dam receiving and storing a limited amount of water, which was less than 10% of its total storage capacity during the initial years of its operation (Figure 4). However, since 2011, there has been a remarkable turn around. The water inflow into the dam has steadily increased, reaching its peak at 93.7 MCM in 2017 (Figures 3 and 4). This surge in water flow has significantly transformed the water quality from "poor" to "good" in 2011, 2017, and 2020 (MWI, 2010-2018). Moreover, this remarkable improvement was a direct result of the Syrian crisis and military attacks, which led to the displacement of hundreds of thousands of residents in southern Syria. This situation resulted in reduced cultivated areas and the destruction of several dams that used to collect rainwater on the Syrian side (Müller et al., 2016; MWI, 2010-2018). Despite this increase in the water inflow into the dam, the flow of the Yarmouk River into Jordan still falls well below the volume that Jordan anticipated based on the bilateral agreements with Syria in 1987 and 2001. This shortfall has significant implications for Jordan's water resources and necessitates urgent action to address the situation.

Table 3: WQI values of Al-Wehdah Dam water during the studied years.

Year	WQI value
2007	54.6
2011	44.3
2017	37.3
2020	38.5

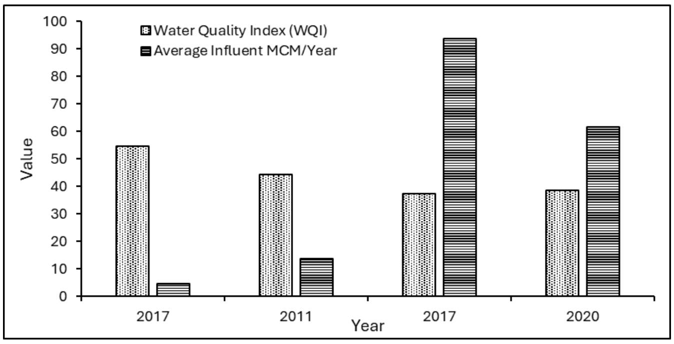

Figure 4: The Water Quality Index (WQI) and Annual Average Influent for Al-Wehdah Dam over the studied years.

3.3 Sustainable management strategies for irrigation water supply in Al-Wehdah Dam

According to the long-term bilateral agreement between Jordan and Syria, the hydroelectric power generated by the Al-Wehdah Dam is primarily allocated to Syria, along with approximately 18% of the water resources from the Dam. The remaining portion is designated for Jordan. This arrangement highlights the importance of safeguarding both the quality and quantity of water at the Al-Wehdah Dam, as it is crucial for meeting Jordan's water needs, especially considering Syria's significant water resource (Al-Taani, 2013; Al-Taani, 2014). Therefore, it is essential to develop and implement sustainable management strategies for the Al-Wehdah Dam, which can be outlined as follows:

- Achieving a cohesive agreement among countries that share transboundary river basins is imperative for effectively reconciling the diverse interests of upstream and downstream communities. The proliferation of dam constructions in upstream areas is likely to diminish the river flow and subsequently decrease water levels within the Al-Wehdah Dam, thereby affecting the sustainability of irrigation systems downstream. Moreover, there is a critical necessity for a robust institutional framework capable of efficiently regulating public interests across these shared water resources. This framework should facilitate collaborative governance and equitable resource distribution, ensuring that the needs of all stakeholders are met while promoting sustainable water management practices.

- Rehabilitating vegetation cover and enhancing its fundamental functions is a viable strategy for the banks of the Al-Wehdah Dam reservoir, given the crucial role that well-maintained vegetation plays in supporting water quality. Well-maintained vegetation can stabilize riverbanks by increasing hydraulic roughness, consolidating soil roots, and providing a buffering capacity that filters and traps sediment and associated pollutants. This, in turn, improves the dam water quality (Tang et al., 2017).

- Regular and systematic analysis and monitoring of the Al-Wehdah Dam ecosystem will enhance benefits while mitigating the effects of climate change and fluctuations in river flow. This approach is crucial for addressing societal needs and promoting economic development. Furthermore, the analysis and monitoring should include comprehensive assessments related to infrastructure, such as repairs, re-operation, and renewal.

- It is essential to evaluate and manage the geomorphological changes, hydrological features, and erosion risks within the sub-watersheds of the Yarmouk River Basin. Prioritizing management strategies, such as erosion control measures, is crucial to prevent degradation and sedimentation (Naoui et al., 2025; Shammout and Abualhaija, 2019).

- Implementing comprehensive strategies to detect and prevent illegal groundwater extraction in the Yarmouk River Basin is crucial for the sustainability of water resources in both Jordan and Syria (Shammout, 2023). These measures are essential for preserving the ecological integrity and hydrological flow of the Yarmouk River, ensuring its viability for future generations.

4. Conclusions

Water scarcity and shortages in Jordan pose a significant threat to the sustainability of water resources, with supplies becoming increasingly limited due to the growing demand for irrigation and domestic use. Currently, Al-Wehdah Dam serves as a crucial source of irrigation water in the Yarmouk River Basin in Jordan, a vital region along the Jordan-Syria border. However, it faces challenges from water scarcity and fluctuations in river flow, mainly due to excessive water withdrawal from upstream to satisfy irrigation demands. This research involved the creation of a detailed map of dams throughout the Yarmouk River Basin, encompassing both the Jordanian and Syrian sides. The study identified the dams within the basin, calculated the water quality index (WQI) versus the inflow volume to Al-Wehdah Dam from 2007 to 2020, and proposed sustainable management strategies and options to ensure the ongoing viability of the water supply from Al-Wehdah Dam.

The findings of the current study indicate that water withdrawal by users upstream has a significantly negative impact on downstream farms and reduces the water flow to Al-Wehdah Dam. This issue arises from the construction of numerous dams along the river, totaling 48 on both the Jordanian and Syrian sides, with 44 of them situated on the Syrian side in addition to Al-Wehdah Dam. By employing the weighted arithmetic index method, the water quality index (WQI) for Al-Wehdah Dam was measured at 54.6, 44.3, 37.3, and 38.5 for the years 2007, 2011, 2017, and 2020, respectively. In 2007, the water was classified as having "poor water quality" for irrigation purposes. However, by 2011, and continuing through 2017 and 2020, it consistently achieved a "good water quality" rating, demonstrating significant improvement over the years and confirming its suitability for reliable irrigation. A comparison between the dam inflow and the WQI reveals that water quality improves with increased flow. Specifically, in 2007, when the WQI was 54.6, inflow was below 10 MCM. By 2020, the WQI improved to 38.5 alongside an inflow of approximately 62 MCM. The results of the present study highlight the urgent need to implement sustainable management strategies to ensure the long-term viability of the Al-Wehdah Dam. Strategies must be developed that prioritize the interests of all stakeholders, including both upstream and downstream communities. Key actions should include establishing strong agreements among nations that share water resources, rehabilitating riparian vegetation, actively monitoring ecosystems, and effectively managing geomorphic changes. Ultimately, the insights gained from this research will serve as a valuable resource for decision-makers committed to the sustainable management of the irrigation water supply, and the implementation of sustainable strategies is highly recommended.

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