Water Scarcity in Syria: The Impact of the Crisis on Irrigated Agriculture

Vízhiány Szíriában: a válság hatása az öntözött mezőgazdaságra

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Abstract: Syria is situated in an arid to semi-arid climatic zone characterized by limited water resources in relation to the needs of its population. The country is classified as water-poor, with a per capita water share that falls below the international poverty line of 1,000 cubic meters per person per year. Through decades, the economic and social development, as well as population growth, have led to the depletion of non-renewable water resources, and press on renewable ones. The government's persistence on expanding irrigated agriculture has put further pressure on water resources resulting in water shortage, which was compensated by exploiting groundwater. In addition to that, the country experienced multiple severe droughts from 2007 to 2009, which led to substantial population internal displacements and a decrease in water availability. After more than twelve years into the crisis in Syria, water supply infrastructure, including irrigation networks and pumping stations suffer extensive damage and destruction. Moreover, a rapid economic downturn that began in 2019 and became the predominant cause of agricultural decline due to the limited fuel availability, unaffordable water costs, and rising production expenses. This review paper aims to assess the state of water resources and contribute to a better understanding of the Syrian crisis's repercussions on irrigated agriculture. The review employs data and statistics from various local and international reports, literature, and previous studies that discuss the effects of the crisis on agriculture and water resources. The results indicated a significant reduction in irrigated areas during the crisis years, with the largest reduction in 2022 as the economic situation reached its worst levels. Despite the effects of the crisis, there were notable advancements in modern irrigation techniques. Urgent economic solutions and sustainable water management strategies are required to address these issues.

Keywords*: Syrian crisis; irrigated agriculture; water; drought*

Összefoglalás: Szíria egy száraz és félszáraz éghajlati zónában helyezkedik el, amelyet a lakosság szükségleteihez viszonyítva korlátozott vízkészletek jellemeznek. Az országot vízhiányosnak minősítik, mivel az egy főre jutó vízmennyiség alacsonyabb a nemzetközi szegénységi küszöbnél, amely évi 1 000 köbméter per fő.

Évtizedeken át tartó gazdasági és társadalmi fejlődés, valamint a népességnövekedés a nem megújuló vízkészletek kimerüléséhez és a megújuló készletekre nehezedő nyomáshoz vezetett.

A kormány kitartása az öntözött mezőgazdaság kiterjesztése mellett további nyomást gyakorolt a vízkészletekre, ami vízhiányt eredményezett, amit a felszín alatti vizek kiaknázásával kompenzáltak. Ezen felül az ország több súlyos aszályt is átélt 2007-2009 között, ami jelentős belső népességmozgásokhoz és a víz rendelkezésre állásának csökkenéséhez vezetett.

Több mint tizenkét évvel a szíriai válság kezdete után a vízellátó infrastruktúra, beleértve az öntözőhálózatokat és a szivattyúállomásokat, jelentős károkat és pusztulást szenvedett el. Továbbá, a 2019-ben kezdődő gyors gazdasági visszaesés a mezőgazdaság hanyatlásának fő okává vált a korlátozott üzemanyag-ellátás, a megfizethetetlen vízköltségek és a növekvő termelési költségek miatt.

Áttekintő tanulmányunk célja a vízkészletek állapotának felmérése és a szíriai válság öntözött mezőgazdaságra gyakorolt hatásainak jobb megértése. Az áttekintés különböző helyi és nemzetközi jelentések, szakirodalom és korábbi tanulmányok adatait és statisztikáit használja fel, amelyek a válság mezőgazdaságra és vízkészletekre gyakorolt hatásait tárgyalják. Az eredmények jelentős csökkenést jeleztek az öntözött területeken a válság éveiben, a legnagyobb csökkenés 2022-ben következett be, amikor a gazdasági helyzet a legrosszabb szintre jutott. A válság hatásai ellenére figyelemre méltó előrelépések történtek a modern öntözési technikák terén. Sürgős gazdasági megoldásokra és fenntartható vízgazdálkodási stratégiákra van szükség ezeknek a problémáknak a kezelésére.

Kulcsszavak: *szíriai válság; öntözött mezőgazdaság; víz; aszály*

1. Introduction

Estimates of Syria's renewable water resources vary due to differing assumptions about cross-border inflows and outflows (Fanack, 2019; NAPC 2018; Mohammad, 2017). Annual rainfall is about 46 billion cubic meters, with 12 billion cubic meters usable after losses. Precipitation varies regionally: 1,000-1,200 mm/year on the coast, 600-800 mm in the southwest, and 200-300 mm in the northeast (Mourad and Berndtsson, 2011). Rainfall supports 71% of Syria's rain-fed agriculture (Bayram and Gök, 2020).

Syria is divided into seven main water basins, each with unique geological, meteorological, hydrological, and demographical characteristics (Issa, 2013;Fanack 2019). The Euphrates and Aleppo basin cover 28% of the area and provide 45% of total water resources (NAPC, 2018). Average renewable water resources are around 16,000 MCM/year, with 82% conventional and 18% non-conventional, including reclaimed agricultural water (Faour and Fayad, 2014).

Syria faces complex transboundary water sharing issues, particularly with Turkey and Lebanon, impacting equitable distribution (Daoudy, 2009). Groundwater resources are about 5,801 MCM, mostly from internal springs and wells, with inflows from Turkey and Lebanon, and outflows to Jordan (Mourad and Berndtsson, 2011). Groundwater springs, such as those feeding the Barada, Balikh, and Khabur rivers, are primary sources for these surface water bodies. The country has 162 dams with a total storage capacity of approximately 18,900 MCM (Issa, 2013).

2. Materials and Methods

This review utilizes a descriptive analysis approach, synthesizing findings from scholarly articles, reports from international organizations, and specific studies on Syria's water and agricultural conditions. Data were collected and analyzed to highlight essential patterns and trends, providing a comprehensive overview of water resources and the status of irrigated agriculture during the ongoing Syrian crisis.

3. Results and Discussion

3.1. Water Management Practices Before the Crisis

Water management in pre-crisis Syria faced significant challenges, not only because of its arid climate but also due to inadequate and ineffective management practices. In 2011, Syria's annual water withdrawal reached 160% of internal renewable resources, compared to 80% in Iraq and 20% in Turkey (Tabor et al., 2023). With 60% of its water originating outside its borders, particularly from the Euphrates Basin, Syria was vulnerable to upstream extraction (Tabor et al., 2023). The government aimed for food self-sufficiency through annual production plans, and the irrigated land has doubled between 1985 and 2012, reaching 1.42 million hectares. Agriculture consumed 89% of total water resources, averaging 13,195 MCM annually. Rapid population growth and rising demand necessitated efficient water use, but government policies focused on expanding irrigated agriculture, exacerbating water scarcity (De Châtel, 2014).

Traditional irrigation practices caused significant water losses. Despite government support for modern irrigations since 2005, adoption was low (Gleick, 2014). On the other hand, about 60% of the total irrigated land in Syria is irrigated using groundwater wells. Syria has over 170,000 pumping wells, with more than 55% unlicensed, leading to declining groundwater levels and affecting spring flows. (Salman and Mualla, 2004).

Severe droughts before the crisis impacted water resources, agriculture, and socio-economic stability. The 2007-2009 drought severely affected northeastern Syria's rainfed agriculture, causing crop failures and livestock deaths, particularly impacting al-Hasaka wheat (Kelley et al., 2015). This collapse of agricultural livelihoods led to mass internal displacement, with around 1.5 million people moving to urban areas between 2007 and 2010. This migration increased competition for scarce urban resources, exacerbated public health issues, and created social instability (Gleick, 2014).

3.2. Impact of the Syrian Crisis

In their phase, the Islamic State of Iraq and al-Sham (ISIS) strategically used control over water resources to undermine resistance, generate revenue, and strengthen governance (Daoudy, 2020). Between 2010 and 2022, there were 38 conflicts over water (Pacific Institute, 2023). Table (1) shows six events where water was used as a weapon.

Table 1. Water weaponization events during the Syran crisis (Pacific Institution, 2023)

Date	Description
2014	Free Syrian Army cuts off water supply to Wadi Barada: Syrian government forces are driven out of Wadi Barada's villages after the Free Syrian Army (FSA) cuts off water supply from Ain al-Fijah, a major spring serving the Damascus area.
2015	Syrian rebel groups cut off water supply to Damascus: In August 2015, Syrian rebel groups cut off water from a spring in Ain al-Fijah, reducing water output to Damascus by 90 percent for three days and leading to water shortages and rationing. Rebels continue to periodically shut off the supply from the spring, resulting in water shortages in Ain al-Fijah and Damascus. Rebels threaten to blow up the spring if government forces enter the region.
2016	Intentional attacks on water infrastructure in Syria: Control over power and water infrastructure and intentional attacks on that infrastructure are being used as weapons in the civil war in Syria. Officials estimate there has been a 50 percent reduction in access to safe water in the country since the war began.
2017	ISIS floods villages in the Deir Hafer Plain of east Aleppo: In response to the advance of the Syrian Arab Army, Islamic State in Iraq and the Levant (ISIL) floods villages they control in the Deir Hafer Plain of east Aleppo by pumping water from Lake Assad into the Al-Jar channel.
2018	Major dam and water source captured in Syria: The Afrin Dam, a major dam and water source on the Afrin River in Syria, is captured by Turkish forces and their Syrian militia allies, causing concern for the nearby communities that depend on the dam for water. These same forces are also in control of nearby Maydanki dam. Interruptions to water and electricity in communities dependent on these dams have occurred, along with reports of attacks on civilian centers and populations.
2018	A truck carrying water tanks is used by suicide bombers in a failed attack in Syria: On January 18, a group of suicide bombers using a truck carrying water tanks in Aleppo, Syria is stopped by the Free Syrian Army. Members of the FSA kill three of the assailants and a fourth dies when he detonates his explosive device.

The Euphrates Dam, the biggest dam in Syria and the most important for irrigation and hydroelectric power, suffered direct impacts to its flow regulation capabilities. Additionally, reduced water levels has led to failure of several hydroelectric turbines affecting the power supply and exacerbating water scarcity (Sottimano and Samman, 2022).

The crisis resulted in intermittent water supplies across various urban and rural areas, compelling residents to depend on private water trucking services often at inflated prices. Rural farming communities suffered from the breakdown of water management, with displaced farmers abandoning irrigation channels, leading to livestock and crop losses, worsening food insecurity (Sottimano and Samman, 2022). Public health deteriorated due to lack of clean water and sanitation, causing a rise in waterborne diseases like diarrhea (Abbara et al., 2021; Tabor et al., 2023).

An economic downturn that began in 2019 and became the predominant cause of agricultural decline due to the limited fuel availability, unaffordable water costs, and rising production expenses (IOM, 2024). Agricultural inputs like seeds, fertilizers, and pesticides are in short supply or unaffordable, further reducing productivity. This has prevented many farmers from operating their equipment effectively, resulting in lower yields(FAO, 2022).

In 2021, the flow of water from the Euphrates River from Turkey into Syria was significantly below average, leading to critically low water levels in Syria’s downstream reservoirs. This was

connected to political decisions in Turkey (Daher, 2022). Additionally, many regions in Syria are facing a water supply crisis due to prolonged electricity cuts and rationing. This power shortage is primarily due to insufficient fuel and gas to operate power plants (Daher, 2022). In areas where irrigation networks remained partially operational, fuel shortages and limited water availability prevented farmers from accessing and operating their equipment, reducing yields across crops. Many farmers could no longer afford the fuel needed for pumping water, contributing to lack of irrigation or abandonment of fields (Sottimano & Samman, 2022). Moreover, Syria faced multiple droughts during crisis, particularly in 2014 and 2021. These droughts have had severe consequences on agricultural production, water availability, and societal stability in the region. (Abbara et al., 2021). In addition to low water levels in the Euphrates River, the 2020-2021 season experienced extremely low rainfall, leading to what the Syrian Minister of Agriculture described as 'the most dangerous year in terms of drought in Syria since 1953.' (IFRC, 2022). This drought limited the cultivated area and ability to provide even supplementary irrigation for cultivated crops, and severely affected the food and nutrition security of households reliant on agriculture especially in Ar-Raqqa, Aleppo and Deir-ez-Zor. The water scarcity and high prices of fuel made irrigation out of reach for many households (IFRC, 2022). Figure 1. shows the annual changes in irrigated lands during the period from 2002 to 2022. It highlights a significant decline in 2008- 2009 and 2013-2014 seasons due to drought conditions in those years.

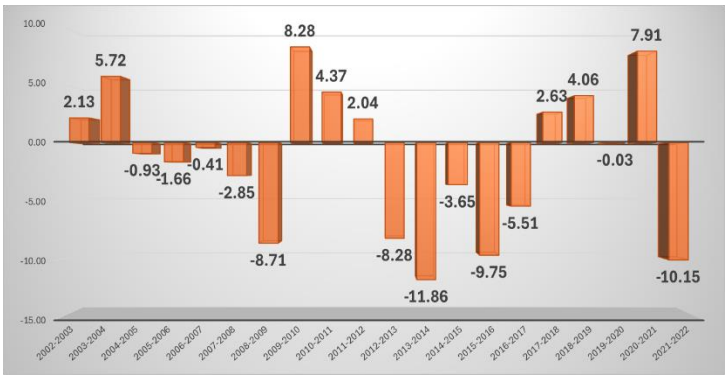

Figure 1. *The annual changes in irrigated lands during the period from 2002 to 2022 (%). Data derived from (MAAR, 2022)*

The years 2019 and 2020 witnessed noticeable increases in irrigated lands, attributed primarily to increased rainfall during those years, which enhanced water availability for irrigation. Following this, in 2021, despite the drought, there was an increase in irrigated areas due to a rehabilitation process launched by the government in multiple regions, especially in southern Aleppo, aimed at recovering irrigation infrastructure (USAID, 2021). However, the most dramatic decrease occurred in the 2022 season, with a substantial decline shown by a value of -10.15, mainly due to the economic downturn and the rising costs of water, making irrigation prohibitively expensive for many farmers.

From the same perspective, the changes in irrigated areas according to sources and irrigation methods during the periods 2003-2012 and 2013-2022 is presented in (Figure 2). The figure shows a decline in the total irrigated area by an average change rate of -23%, and particularly for well irrigation, which decreased by -29% due to fuel shortages and the overall increase in the cost of water pumping during crisis years. on the other hand, Modern irrigation, particularly drip irrigation, saw a significant improvement during the second period, with a change rate

between the two periods reaching 25% (Figure 2). the irrigated area for summer crops and vegetables showed increase over several years, especially noticeable since 2019 (Figure 3). This increase is partly due to a reduction in violence, allowing a slight recovery in agricultural activities, particularly with the high rainfall that year. Additionally, the growth can be attributed to an increase in small holdings, as rural communities sought to secure their food sources. These small-scale agricultural operations often focus on summer crops and vegetables, which can be cultivated on smaller plots of land and provide essential nutrition and economic benefits to the local populations.

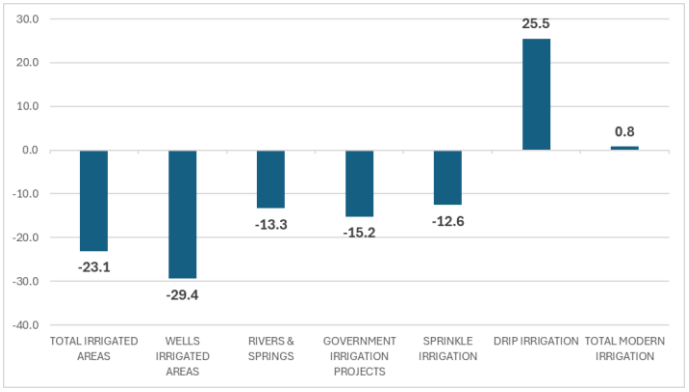

Figure 2. *The changes in irrigated lands according to sources and irrigation methods between the periods (2003 to 2012) and (2013-2022). Data derived from (MAAR, 2022)*

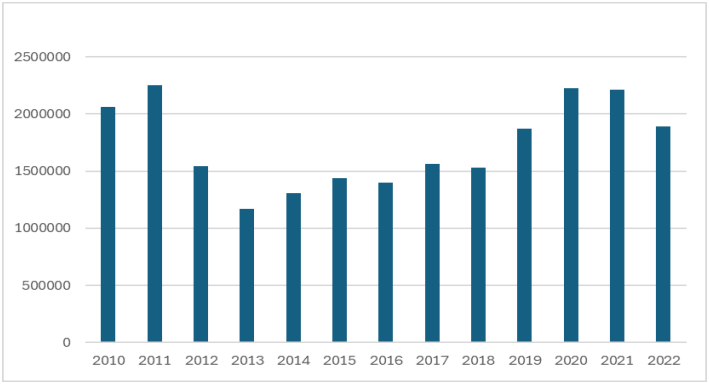

Figure 3. *Summer (crops & vegetables) irrigated area from 2010-2022. Data derived from (MAAR, 2022)*

4. Conclusions

The study highlights the severe challenges facing Syria regarding water resources, intensified by prolonged crises. Pre-crisis, Syria's water management struggled with over-extraction of groundwater driven by intensive agricultural policies, leading to groundwater depletion. Severe droughts, from 2007 to 2009, severely impacted agriculture, prompting mass internal displacement and socio-economic instability. The Syrian crisis further exacerbated these issues, causing substantial infrastructure damage and intermittent water supplies across various areas. The economic downturn from 2019 to the present has led to severe fuel and water shortages, leaving many farmers unable to sustain irrigation, reducing agricultural productivity and increasing food insecurity. Despite some modest rehabilitation efforts and increased rainfall in certain seasons, ongoing economic difficulties and persistent water scarcity continue to hinder agricultural productivity and public health. Additionally, the severe drought in 2021 further limited water availability and agricultural output. However, there have been improvements in

modern irrigation techniques, such as encouraging and promoting the adoption of drip irrigation. These findings underscore the urgent need for economic solutions and sustainable water management strategies (e.g., rainwater harvesting and efficient water distribution systems). The study highlights the need for further research to develop comprehensive nature-based solutions that address both immediate and long-term challenges facing Syria in the post-crisis period.

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