



## White Paper No. 1

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# Towards the Adoption of an Integrated Water-Energy-Food Nexus approach in Jordan: Challenges & Opportunities

## Abstract

Jordan is an emerging market economy with high potentials of growth fueled by its growing young population and its various international free trade agreements. However, some of Jordan's main challenges for development relate to the scarcity of its water resources and its reliance on energy and cereal imports. This white paper addresses these challenges, highlights national initiatives and demonstrates the importance of adopting a Water - Energy - Food Nexus (WEFN) integrated approach as a solution. The white paper is calling for the establishment of a national Water-Energy-Food-Environment Nexus (WEFEN) council that will be in charge of managing the extensive links between the four sectors. This council will be responsible for: strengthening the understanding of the overall scope of WEFN as an integrated approach to stimulate sustainable development; deliberating on the opportunities and challenges of embracing a nexus approach; supporting integrated natural resource management; raising awareness with regards to the approach among practitioners and the general public; and encouraging regional initiatives, projects and partnerships that support the MENA region on the WEFN

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# 1. Introduction

High population growth and development needs accentuated by the impact of climate change in Jordan have increased the demand for water, energy and food, and is depleting the available limited natural resources. While the population growth rate for the years (1994-2004) was 2.6%, this rate increased strikingly for the years (2004-2015) to be 5.3% due to the large influx of refugees, mainly from Iraq and Syria, which are causing additional pressure on already limited natural resources. In 2015, according to the Department of Statistics, Jordan hosted 1.3 million of Syrians, of whom only 664,226 were registered refugees with the United Nations High Commissioner for Refugees (UNHCR)[4]. Clearly, Jordan is affected by hostile regional and global political and economic crises as well as health crises with the recent COVID-19 pandemic, which worsened the macroeconomic situation and amplified the country's vulnerability to shocks.

This is raising an alarm that there is an urgent need to find solutions to meet the demands of the population from natural resources and help the economy achieve its sustainable growth strategy. The adoption of an integrated Water-Energy-Food-Environment Nexus (WEFEN) approach in Jordan that takes into account the environment will help address these challenges more efficiently and sustainably.

## 2. The Water-Energy-Food in Jordan: An overview

### 2.1. Climate-related challenges and national initiatives

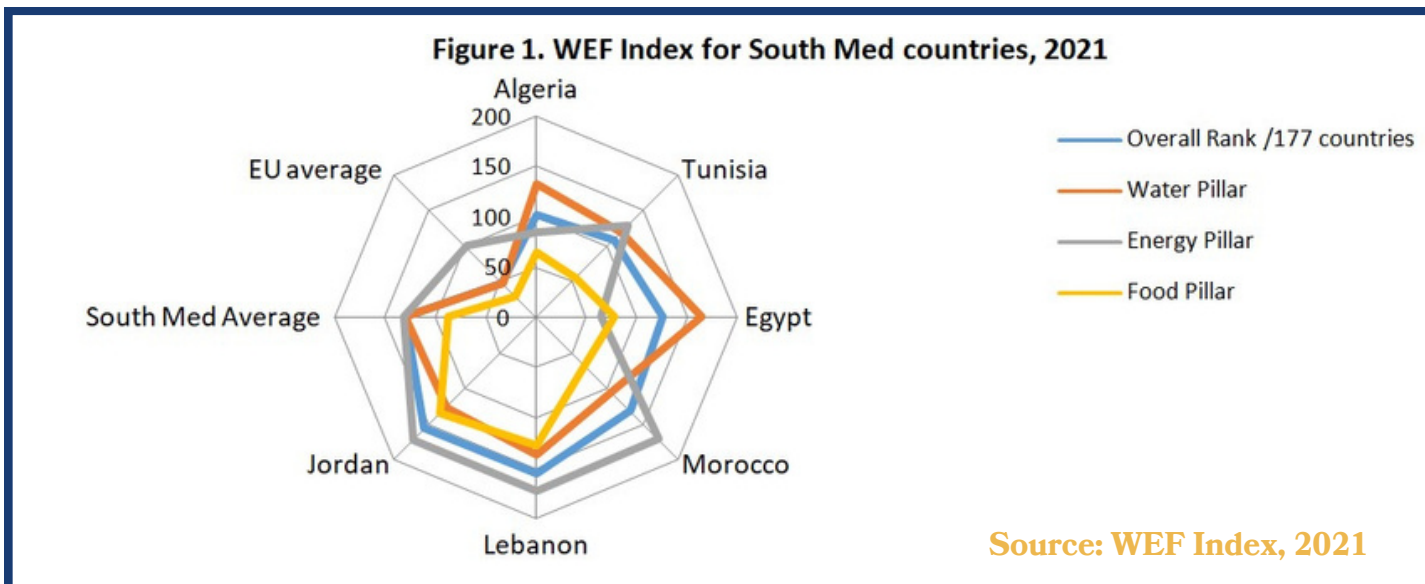
Population growth, which is further affected by the unprecedented influxes of refugees into Jordan, rapid urbanization, and economic development together with the impact of climate change, are key factors driving increased demand for water, energy and food, and thus an overconsumption of natural resources and a decline in their renewal rates. In fact, and similar to other countries in the southern Mediterranean region, Jordan is ranking relatively low in terms of its WEF Nexus index[5]. With an overall ranking of 157 (over 177 countries), Jordan is thus overtaken by Egypt (125), Tunisia (109) and Algeria (102). This is due to country's relative low rankings in the three pillars (Figure 1). In fact, Jordan has to grapple with a stark water scarcity (being one of the water poorest countries in the world[6]), due to the limited available water resources further exacerbated by the climate hazards that the country faces: noteworthy temperature increases, precipitation decreases, increased occurrences of drought and evaporation.

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[4] Updated Submission of Jordan's 1st Nationally Determined Contribution (NDC).2021, Ministry of Environment. <https://unfccc.int/NDCREG>

[5] The Water-Energy-Food (WEF) Nexus Index is a national-level composite indicator founded on 21 relevant indicators for 3 pillars: Water, Energy and Food with regards to their access and availability. <https://wefnexusindex.org/>

[6] Albatayneh, Aiman&Hindiye, Muna&AlAmaw, Rana, 2022.



As stated by the Ministry of Water and Irrigation, in 2021, the rainy season recorded less than 60% of the average annual precipitation[7]. The decrease in winter rainfall and increase in mean annual temperature are expected to reduce the renewable water supply, estimated at around 780 million m<sup>3</sup>, of which 275 million m<sup>3</sup> is groundwater, with the rest springing from surface water sources, and thus further aggravating the water shortage in the country.

Moreover, the increasing demand for water due to demographic changes and population growth has steered to a sharp decrease in freshwater availability in Jordan widening the gap between water supply and demand. The increase in water consumption by the population has increased the share of water withdrawal for municipalities, which led to a decrease in the share of water that is consumed by agriculture (see Table 1). According to the Ministry of Water and Irrigation, the agriculture sector consumed about 51.6% of the total water withdrawn with the domestic sector consuming 45%[8] as of 2020. In fact, the water withdrawal per capita has dropped by almost 30% in 19 years. If present trends continue, per capita water supply will drop from the current 109.37 m<sup>3</sup>/capita to only 91 m<sup>3</sup> by the year 2025, placing Jordan in the category of having an absolute water scarcity[9].

**Table 1: Water uses for different sectors in Jordan from 2000 to 2020**

Water uses	2000	2010	2020
<b>Agriculture</b> as % of total water withdrawal	66.22	56.10	51.65
<b>Industry</b> as % of total water withdrawal	4.53	4.48	3.34
<b>Municipal</b> as % of total water withdrawal	29.25	39.42	45.02
<b>Total water withdrawal</b> (10 <sup>9</sup> m <sup>3</sup> /year)	0.82	0.89	1.10
<b>Total water withdrawal per capita</b> (m <sup>3</sup> /inhab/year)	159.49	122.98	108.29

**Source: FAO AQUASTAT database, 2020**

[7]Updated Submission of Jordan’s 1st Nationally Determined Contribution (NDC).2021, Ministry of Environment. <https://unfccc.int/NDCREG>

[8]FAO, 2020.Environmental and Social Management Framework. Building resilience to cope with climate change in Jordan through improving water use efficiency in the agriculture sector (BRCCJ) <https://www.fao.org/3/cb3276en/cb3276en.pdf>

[9]Hadadinet al., 2010

However, Jordan's determination to solve water issues has led to noteworthy policies concentrating on water utilities, irrigation, and groundwater administration and the adoption of further laws to preserve the water sector and protect water resources such as the Water Authority Law and the Groundwater Law[10]. Moreover, the Jordanian government is presently planning the largest water generation scheme to be implemented in the country along the project pipelines route from Aqaba to Amman: the Amman Aqaba Water Desalination and Conveyance Project (AAWDCP) aims to deliver a safe and reliable freshwater supply for Amman and other governorates, including a conveyance system to provide up to 150 million cubic meters of freshwater to the Amman area[11]. In addition, Jordan has put in place a minimum of 34 wastewater treatment plants to treat and reuse wastewater, supplying 14% of water supply and about 25% of water used in irrigation and hence contributing to decreasing the freshwater withdrawal[12] in the future.

Despite the fact that agriculture-based revenues are crucial to Jordan's economy, contributing to 28% of GDP and an estimated 18% of the country's total exports, the sector is meaningfully fragmented leading to small-scale landholding, generating high cost of utilities, with low productivity which has negatively impacted Jordan's competitiveness in meeting the high food demand in the region.

Besides poor water resources for irrigation and limited agricultural land[13], an appraisal of food security in Jordan also reveals its vulnerability. While Jordan is considered rather food-secure (WFP)[14], an estimated 53% of Jordanians are still vulnerable to food insecurity— representing around 3 million individuals— and approximately 3% of households are food insecure[15]. The Covid-19 crisis and the on-going war in Ukraine, which not only raised the prices of supplies such as cereals but also made trading more difficult, have exacerbated this fragility and accentuated the occurrence of poverty. According to FAO, over 97% of the domestic cereal food and feed needs in Jordan are contented through imports[16].

However, it is worth noting that Jordan has established numerous policies, laws and legislations in the agricultural sector to achieve agricultural development and address the problems of desertification, overgrazing, drought, and other climatic changes, such as Environmental Protection Law No. (52) of 1999, Agriculture Provisional Law No. (44) of 2002, the Agricultural Policy Charter (ACP), Irrigation Equipment and System Design Policy of 2008 and Irrigation Water Allocation and Use Policy of 2008[17]. Moreover, the Jordanian government is planning the implementation of notable projects, such as the project “Building resilience to cope with climate change in Jordan through improving water use efficiency in the agriculture sector (BRCCJ)”[18]

[10] Albatayneh, Aiman et al., 2022.

[11] Updated Submission of Jordan's 1st Nationally Determined Contribution (NDC).2021, Ministry of Environment. <https://unfccc.int/NDCREG>

[12] UNEP, 2022. “Decentralized Wastewater Treatment Systems (DWATS) As A Climate Change Adaptation Option for Agriculture in Jordan”. <https://jordan.un.org/en/175501-un-recycled-wastewater-provides-window-jordan-address-water-scarcity>

[13] Albatayneh, Aiman & Hindiye, Muna & AlAmaw, Rana, 2022.

[14] World Food Programme (WFP) in Jordan <https://www.wfp.org/countries/jordan>

[15] FAO, IFAD, World Bank & WFP, 2020

[16] FAO, 2022- <https://www.fao.org/giews/countrybrief/country.jsp?lang=fr&code=JOR>

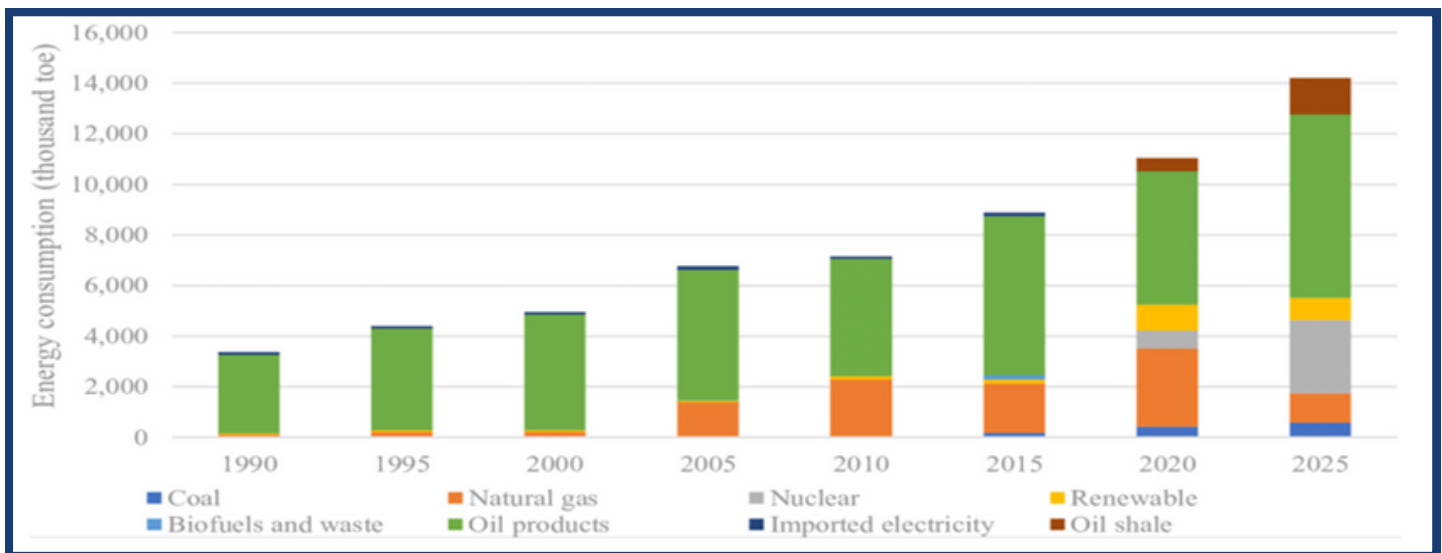
[17] Albatayneh, Aiman & Hindiye, Muna & AlAmaw, Rana, 2022.

[18] FAO, 2020. Environmental and Social Management Framework. Building resilience to cope with climate change in Jordan through improving water use efficiency in the agriculture sector (BRCCJ) <https://www.fao.org/3/cb3276en/cb3276en.pdf>

which aims to increase the resilience of water management systems and that of the agricultural sector to climate change in the most vulnerable Governorates of the Dead Sea Basin, namely Karak, Madaba, Talifah and Maan. This initiative is expected to achieve 3% to 3.5% reduction in groundwater overdraft and achieve cumulative water savings estimated at approximately 1.83 million cubic meters (mcm) over a 10-year period. In addition, 10,600 hectares of agricultural land area will be made more resilient through climate-adaptive measures, such as the use of alternative sources of sustainable water (i.e. recycled water) and new practices of agricultural management to deal with water related stresses.

Undoubtedly, the parallel correlations between the increase in oil prices and those of agricultural products cannot be disregarded, as agriculture is likely to be extremely carbon intensive, from the manufacture of agricultural inputs to mechanization. In Jordan, the persistent increase in energy demand significantly affects the primary energy consumption from fossil fuels which already suffers from scarcity. In fact, the country is a net importer of hydrocarbons: according to statistics of Ministry of Energy and Mineral Resources, Jordan presently imports approximately 93% of its energy which represents around 8% of GDP[19]. Besides, extreme heat drives up energy demand and price while water scarcity increases energy demand and price and fiscal burden. In order to find solution to this challenge, the country has made progress in reducing dependency on foreign oil imports and further diversifies the energy mix by increasingly using natural gas, particularly in electricity generation, and introducing renewable energy sources (from 2020) to fulfill domestic energy needs at the lowest possible cost (Figure 2).

**Figure 2: Primary energy consumption mix in Jordan from 1990 to 2015 & the government plan for 2020-2025**



**Source: Qadourah, Jenan, 2019 (MEMR, 1997, 2003, 2011, 2017, 2018; Jordanian Department of Statistics, 2015; IEA, 2019b)**

However, one of the major challenges that are facing the water, energy and agriculture sectors in Jordan is related to the institutional and legal framework.

[19] Updated Submission of Jordan's 1st Nationally Determined Contribution (NDC).2021, Ministry of Environment. <https://unfccc.int/NDCREG>

## 2.2. Institutional & legal framework challenges

Despite the adoption of a bylaw[20] in 2012 establishing a framework for specific energy efficiency regulation (such as auditing, smart metering, etc.) following the establishment of the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF), critical hurdles to energy efficiency persist, including: weak enactment of prevailing measures and regulations, lack of knowledge by energy users of the advantages of energy efficiency, lack of harmonization between stakeholders in advancing energy efficiency projects, high initial implementation costs and perceived risks, lack of coherent institutional frameworks and access to finance.

On a positive note, the establishment of monitoring bodies has provided the needed follow-up on government incentives and policies. This includes the Reform Secretariat at Ministry of Planning and International Cooperation (MoPIC), which is contributing to the follow-ups and support the implementation of the 5-year reform matrix; and the Prime Minister's Delivery Unit, which has been following delivery of the Government's Economic Priorities program 2021-2023, and more recently the new Economic Modernization Vision. However, the lack of dialogue between government bodies and stakeholders has prevented the established policy and regulatory framework from achieving its objectives.

More specifically, despite noteworthy developments in water-supply infrastructure and national initiatives, a significant supply-demand imbalance persists and requires a revised governance strategy and institutional framework to ensure adequate execution of operational plans for water resourcing, distribution and delivery systems, sustainable recovery of operating and maintenance costs and protection of the quality of water resources and water-dependent Ecosystems.

At the same time, inefficient agricultural institutions, weak cooperative system, limited private sector engagement coupled with an inadequate legal framework to administer the agricultural sector (with some of the regulation being either absent, weak or poorly enforced) has affected the country's food security agenda. Although numerous policies, strategies and plans have been initiated, donor support to the sector is negligible as a result [21].

However, despite challenges, the Jordanian government is clearly determined to find solutions and to achieve its objectives of being placed one of the most vibrant and modernized economies of the region. This was reflected in the country's vision of 2022-2033.

## 3. Jordan's "Better Future" through sustainable development

The **Jordan's Economic Modernisation Vision (2022-2033)**[22] and its Roadmap demonstrates the country's willingness to pursue its efforts to address needs related to climate change (including the achievement of the Paris Agreement), food security and water, and availability of clean energy. It aims to achieve the Sustainable Development Goals (SDGs), compatibility with global approach towards a green economy, and to stimulate national and international investments into sustainable projects, to foster entrepreneurial and innovative solutions, to improve the export competitiveness of the country and eventually, to generate sustainable jobs for the future. Jordan succeeded in enhancing and strengthening its commitment to the international climate change governance system by raising its macroeconomic greenhouse gas emission reduction target from 14% to 31% in its updated National Development Contribution (NDC)[23].

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[20] The Ministry of Energy and Mineral Resources issued this energy efficiency By-law (No. 73), titled "Regulating Procedures and Means of Conserving Energy and Improving Its Efficiency".

[21] IUCN ROWA, 2019

[22] Economic Modernisation Vision: Unleashing potential to build the future. (2022). <https://www.jordanvision.jo/en>

[23] Updated Submission of Jordan's 1st Nationally Determined Contribution (NDC).2021, Ministry of Environment. <https://unfccc.int/NDCREG>

The country is committed to the **National Energy Strategy (2020-2030)** which is a ten years' plan with the aim of reducing dependence on costly foreign fuel imports that spoil the country's economy by increasing self-sufficiency through exploitation of domestic natural and renewable resources (such as hydrogen), as well as expansion of existing energy developments. This strategy entails to decrease the energy consumption by improving the energy efficiency measures in different sectors (expected to increase by 9% in 2030 compared to 2018, and that of the water sector by 15% in 2025) and to diminish the carbon dioxide emissions by 10% by the year 2030. This also implies increasing the proportion of electricity produced from local sources from 15% in 2019 to 48.5% in 2030.

Furthermore, this strategy offers opportunities to diversify the fuel types to operate the industrial and transportation sectors by fostering the use of natural gas (as an alternative greener and lower-cost fuel), particularly in industrial operations to decrease the production costs and enhance competitiveness of the national products. However, there is still work to do towards accomplishing a reliable, sustainable, stable (electricity sector) and sturdily connected energy sector to support growth through diversification and innovation.

With respect to the water sector, the government recognizes in its updated NDC the need to integrate climate adaptation and resilience measures in policy and institutional reforms, improve water demand management and reducing the gap between water demand and supply and enhance the efficiency of water use for sustainable development and the contribution of non-conventional water resources to the national water budget. As part of the country's efforts to tackle the challenges related to the on-going water scarcity, the **National Water Strategy (2016- 2025)** encompasses provisions for water-energy-food nexus, sustainability of overexploited groundwater resources, the use of new technologies, comprising decentralized wastewater management, and reuse of treated wastewater, as well as commercialization and consolidation of wastewater services and increasing private sector engagement

Besides, the government advanced a ten-year **National Strategy for Agricultural Development (2016-2025)** with the aim of ensuring sustainable development of agricultural resources that will generate a close link between production and market demand and strengthen food security for the entire country as well as the economic benefits of increased exports. Through Jordan's new **National Food Security Strategy(2021-2030)**, the government is working to move towards more efficient, inclusive, resilient and sustainable Agri-food systems for better production to enable Jordan to become a strategic regional agri-food export hub, to manage efforts and interventions associated to food security and to diminish food and agricultural loss and waste (through digitization).

## 4.Opportunities for a WEF-Nexus approach in Jordan

The interlinkages between Water-Energy-Food (WEF) are clear. As Jordan moves towards water desalination to tackle water scarcity, it has to be coupled with low-carbon electricity generation in order to not aggravate climate change[24]. At the same time, while diminishing non-revenue water can have positive effects on municipal unmet demands and decreases energy for pumping, it does not foster agricultural water productivity and may have negative impact on the Jordan Valleys aquifer levels. Energy efficiency can stimulate energy-intensive projects, such as desalination, by significantly decreasing the pressure on the energy system, preventing increased emissions and accomplishing a more resilient water system. That said, when interventions are not examined together, downsides cannot be mitigated and addressed accordingly.

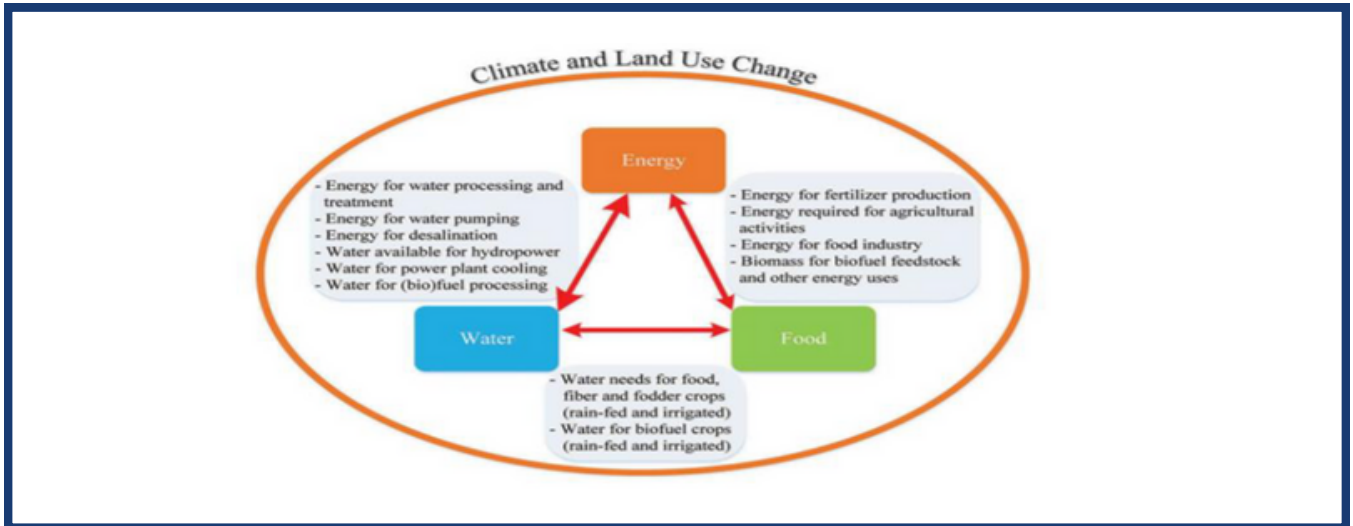
Therefore, finding solution clearly requires addressing water, energy and food challenges in an integrated approach rather than in each sector individually (Figure 3). The WEFN equation is a multi-objective, multidimensional and non-stationary problematic based on the fact that water is irreplaceable and therefore prioritizing its preservation is a prerequisite to sustainable agriculture[25]. This entails the need to assess the long-term renewable and stored water resources and consider alternative solutions for food production and energy use that take water security into account.

[24] Ramirez et al., 2022

[25]Ganoulis, Jacques. 2021

As Jordan has to deal with a stark water scarcity, using the renewable energy for desalination of seawater and for cooling of greenhouses in integrated production systems can improve water availability, foster crop productivity and engender co-products and co-benefit[26]. Water, energy, and climate-smart municipalities can also stimulate their overall resource productivity, create further employment, foster economic growth, and improve human well-being.

**Figure 3: Illustration and examples of the WEF interconnections**



Source: Liu et al., 2017

Hence, the WEFN approach helps to strike the balance between maximizing food production while using renewable water and energy and implies building an ecosystem where all stakeholders will be involved, allowing collaboration with neighbouring countries.

## 5. Conclusion & recommendations

The multi-sectoral planning and investments that are requested to face the WEF challenges in Jordan impose the need for cooperation among the water, agriculture, and energy sectors and an active engagement of local actors, private companies, and investors. Besides, there is a need to improve the legal framework[27] that links to the usage of natural resources, to ensure that the climate change objectives are embedded in national legislation, and enhance cooperation between different relevant ministers and national agencies.

Adopting a WEF integrated approach in Jordan that ensures the formulation, implementation and adoption of national policies that can resolve the existent environmental and resources challenges, would require a high-level cooperation among Water-Energy-Food-Environment (WEFE) sectors.

This can only be done by establishing a WEFE council. This council will be able to engage in a dialogue, exchange on practices on how to modernize infrastructure and enhance efficiency, raise awareness on water scarcity and change in culture about WEF consumption, and will lead to the creation of adequate national strategies to be implemented. More specifically, the WEFE council, which will require the development of an appropriate governance, institutional, and legal framework and the provision of adequate human resources that are empowered/mandated to collaborate with all stakeholders as needed, will:

[26] Holger Hoff, et.al. 2019

[27] IUCN ROWA, 2019



(1) Ensure coordination between the water-energy-food-environment sectors and contribute to the overall assessment, management and planning of sustainable projects, supporting the development of new regulations and policies adapted to the future. It will ensure the development of integrated management of water and energy resources to support the functioning of the energy system without affecting agriculture and water supply, and similarly for the other sectors, with the overall target of strengthening the economy.

(2) Work towards accomplishing a reliable, sustainable, stable and sturdily connected **energy sector** to support growth through diversification and innovation and will exchange on how to move towards a more efficient (greener and lower cost) power sector, through renewable sources, and strengthen Public Private Partnerships (PPPs), and project development. Furthermore, it will contribute to the achievement of **water security** in Jordan in a financially sustainable manner by improving water supply/demand management monitoring and control, reducing water losses and finding new sources, and adopting strict efficiency measures of energy use in the water sector.

(3) Foster climate resilience and sustainable water use in the agriculture sector and ensure sustainable **food security** to satisfy present and future needs. This council will work towards reducing food and agricultural loss and waste, leveraging the latest AgTech and smart solutions to revamp agricultural production techniques and to enable Jordan to become a regional agri-food export hub, improving the strategic stocks of grains, and increasing the planted areas projected for these crops.

(4) Encourage international and **regional initiatives, projects and partnerships** seeking to stimulate integrated natural resources management and advance towards sustainable development in the Arab region, such as the MENA Regional Innovation Hub (MENA RIH) which aims to scale mid-to-later stage enterprises from the MENA region, including Jordan, with an environmental and social impact in the WEFN by providing them with the financial and technical assistance needed to make food production and farming more sustainable and productive. This initiative is firmly entrenched in the global Water & Energy for Food Grand Challenge (WE4F) framework[28] which aims to : foster food production along the value chain through a more sustainable and efficient deployment of water and energy, increase income of women and men in both rural and urban areas and sustainably scale innovators' solutions to address the challenges in the WEFN while stimulating climate and environmental resilience through the sustainable utilization of natural resources and ecosystems.

(5) Will be able to discuss proposed initiatives, which align with Jordan's **Economic Modernisation Vision**, including but not limited to:

- The development of an energy transition roadmap (shift to renewable and alternative options, optimization of power plants, and enhancement of interconnectivity with the region).
- Energy infrastructure upgrades (smart power grid and meter with high connectivity to efficiently serve Jordan's needs and ramp up exports to region, storage technologies, time of use tariff, capacity building, pipelines for transport and distribution).
- Improved water supply/demand management monitoring and control and implementation of national desalination projects and water dam pumped energy storage projects
- Balancing economic tradeoffs from a national perspective for mega investments and projects in the energy, water and agriculture sectors (e.g., national conveyance project, desalination projects, green hydrogen development, etc.)
- -Modernization and innovation of the agricultural sector, and expansion of the use of modern technologies
- Agri education and vocational training for farmers' upskilling, etc.

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[28] WE4F is initiated by the German Federal Ministry for Economic Cooperation and Development, the European Union, the Ministry of Foreign Affairs of the Government of the Netherlands, Sweden through the Swedish International Development Cooperation Agency, and the U.S. Agency for International Development.

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