

Analyzing the Water, Energy, and Food Security Nexus Index in Morocco.

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Abstract. The WEF Nexus Index's quantitative perspective provides a way to evaluate the trade-offs that need to be taken into account for sustainable development. Morocco's natural resources are being impacted by climate change, and the demand for energy, water, and food are increasing the pressure on these resources. Academics are becoming more interested in measuring the synergies and trade-offs between this resource. The purpose of this paper is to offer an interpretation of how the Morocco WEF Nexus Index has changed over the course of 5 years, as determined by open databases. The index's value decreased and Morocco's ranking deteriorated during this period, as evidenced by the results. The results are useful for evaluating Morocco's progress in managing integrated resources and aiding in decision-making and policy development. On an interactive website, A group of visual representations linked to WEF Nexus Index has been put together. **Keywords:** WEF, Nexus, index, climate change, Morocco, open data, water, energy, food.

1 Introduction

The connection across water, food, and energy is strong, and decisions made in one resource generally lead to repercussions in others. This is the principal cause revolves around studying the 'Water-Energy-Food' nexus. A "nexus" is outlined as the connection or interaction between two or more elements, whether they depend on each other or not [1]. The "Water- Eenergy -Food nexus" includes investigating the interconnectedness of these three resources, as well as their synergies, conflicts and the repercussions that arise from their management[1][2]. The nexus can be impacted by variables such as climate change, population, land, and policies Fig. 1 [3].

The Nexus discussions were centered on the approach as a comprehensive and multi-dimensional approach that includes multiple stakeholders and abides by the stated principles[4]. Arab nations were the first to participate in global initiatives to develop and promote the 'NEXUS'. However, few if any countries in the MENA region have made progress in implementing such an approach [5]. This led to a concern about the application of this approach in the MENA region.

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A composite indicator or index is created to provide a comprehensive view of the context being examined, for example, the WEF nexus [3]. The WEF Nexus Index value serves as a reflection of a country's level of equitable access to and availability of these three critical resources [6]. This paper's objective is to evaluate how the WEF Nexus Index has performed in the past five years, focusing on comprehending the interdependent and intricate nature of the Climate-Water, Energy, and Food Security systems in Morocco. The purpose of this study is to illustrate the WEF Nexus Index's variability and its application for WEF linkage assessments.



Fig. 1. The Anthropocentric WEF nexus framework

2 Comprehending the Water, Energy, and Food security Nexus

The interrelation between water, energy, and food security cannot be ignored [7]. In basic terms, water is necessary for food production; energy is necessary for water extraction, treatment, and redistribution; in return, energy is a significant water consumer. Energy inputs, such as fertilizers, transport, and irrigation, have a significant impact on food cost.

The mix of environmental and climate changes, growing economies and populations influence on the relationships between the three resources. To prevent potential conflicts as different sectors plan, understanding and quantifying those interlinkages is crucial.[8] Dialogue with stakeholders involved is a key requirement for implementing the water-energy-food nexus approach.

Realizing the Sustainable Development Goals (SDG 2, SDG 6, SDG 7 and SDG 13) can be ensured by using the WEF approach[9]. The food objective aims to boost the production cereals; The objective of the water goal is to increase the utilization of desalinated and treated wastewater; The energy goal's objective is to increase the percentage of solar, wind energy, and incorporate hydrogen into the national energy mix.

3 Moroccan- WEF Nexus Index

Corresponding to the IPCC's latest report on Climate Change 2022: Impacts, Adaptation, and Vulnerability, Morocco is recognized as being highly vulnerable to climate change [10].

Precipitation, drought, and several economic and social sectors, including agriculture, have already experienced real impacts[11]. These impacts are making it more difficult for agriculture, which is a strategic sector economically and socially. [12]

Taking into account the framework presented in Fig. 2 [3]water, energy, and food are constituted of three equal pillars in the WEF Nexus Index. Every resource sector has sub-pillars of “access” and “availability” as shown in Fig. 2 [3][13]. JRC: COIN recommends choosing the indicators that will form the index as the next step in creating a composite indicator. The selection of indicators shown in Fig. 2 was guided by the framework, index, pillar, and sub-pillar structures developed for the system under assessment[6].

The selection of indicators can be difficult due to the lack of indicators that measure the linkages between elements of the constituent sectors. These indicators can be selected as part of an in-depth study for each country. After reviewing 87 indicators available globally, 21 relevant indicators were selected to build the WEF Nexus Index.

The water-access sub-pillar represents SDG 6 (access to basic drinking water and sanitation services) and the degree of Integrated Water Resources Management (IWRM; which is an indicator of good governance in terms of water resources management). The energy-access sub-pillar includes both access to electricity (SDG indicator 7.1.1) and two indicators that appertain to the degree of renewable energy consumption (SDG indicator 7.2.1) and implementation, as well as CO2 emissions (which is an indicator of the degree of dependence on fossil fuels). These indicators have been aggregated because SDG 7 appertains to access to affordable, reliable, sustainable and modern energy for all, and not simply ‘access to energy’. The food-access sub-pillar includes, amongst others, SDG indicators 2.1.1 (prevalence of undernourishment), 2.2.1 (percentage of children under five years of age who are stunted) and FAO indicator 4.8 (prevalence of obesity in the adult population). The food-accessibility sub- pillar includes FAO indicators 1.1 (average dietary energy supply adequacy), 1.2 (average value of food production) and 1.4 (average protein supply), and the cereal yield in kilograms per hectare.



Fig. 2 A schematic representation of the WEF Nexus Index, with its constituents pillars, sub-pillars, and indicators. Source (<https://wefnexusindex.org>)

Organizations like national statistical offices, government departments, non-governmental organizations, and international organizations like the World Bank, FAO, and others are all involved in the collection of data globally. Special national data can be collected and provided by national organizations.

Sub-pillar scores were determined by taking the weighted arithmetic average of the indicators in every sub-pillar. The pillar scores were established by calculating the average of the sub-pillar scores, and the pillar scores were averaged to create the final index score. [6]

A free access and interactive website associated with the WEF Nexus Index presents the results for the index of all calculated countries (170 countries) namely <https://www.wefnexusindex.org>

This website provided us with the results of our case study. The Fig. 3 illustrates the calculated WEF Nexus index for Morocco over the past five years. The results give a complete view of the main index and its three main components (water, energy, and food).

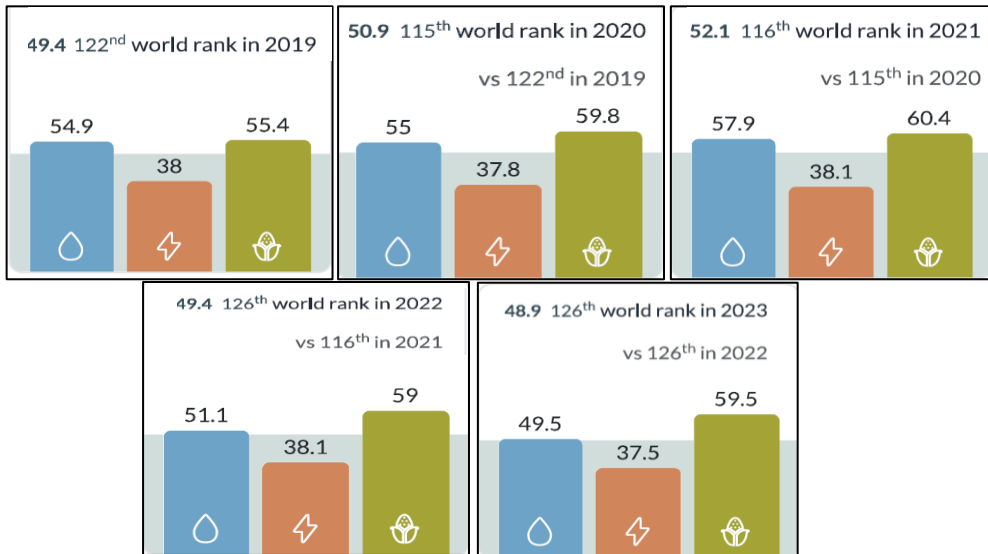


Fig. 3. A graph that depicts data of Morocco showing the WEF Nexus Index, pillar values, and ranking.

We can clearly conclude the decline of the index and its downgrading putting Morocco from class 122 internationally to class 126 out of 170 countries. Several factors may have contributed to the downgrading of Morocco's nexus index. It is clear that the value of the water pillar has decreased from 54.9 in 2019 to 49.5 in 2023 and this is reflected in the consequent drought suffered by Morocco. The energy pillar remains more or less stable. Climate-induced changes in water availability for rainfed agriculture are well noted. In addition, the website (<https://www.wefnexusindex.org>) delivering a specific page for every country that provides further information about that country, such as availability and access to sub-pillar values, a radar chart, international rankings, a scatter diagram of accessibility and access, and the indicator values themselves.

4 Discussion

Fig. 4 presents a set of 5 radar maps that exhibit Morocco's six sub-pillars from 2019. The graphs shows that access to water, energy, and food have been nearly identical for the last 5 years, this may be due to various reasons.

It was discovered through the integrated analysis that the Energy pillar is the lowest pillar for Morocco. Although there is difficult, electricity is still well-managed and accessible because of the increase in renewable electricity facility, which reached 42% of its installed capacity in 2020, with the intention to reach 52% by 2030[7].

The availability of water in the country has been negatively impacted by the consecutive decrease in rainfall over the past few years [14]. The water supply per capita is currently 606 m³, as a result of the sensitive nature of the water situation which is less than the level of water poverty (1000 m³), according to Minister Nizar Baraka's most recent statements. Despite these obstacles, Morocco manages to guarantee its population access to basic drinking water by either desalination or dam construction and safely managed sanitation services.

It is true that Morocco's attempt to achieve food sovereignty has been hindered by adverse weather conditions and the lack of water resources. This is the explanation for the need to import cereals, which has increased because of the Ukrain War. However, access has been guaranteed by national production in recent years. In order to prevent a national food shortage, efforts are being made by the Ministry of Agriculture to expand the area of cereal production land that is irrigated.

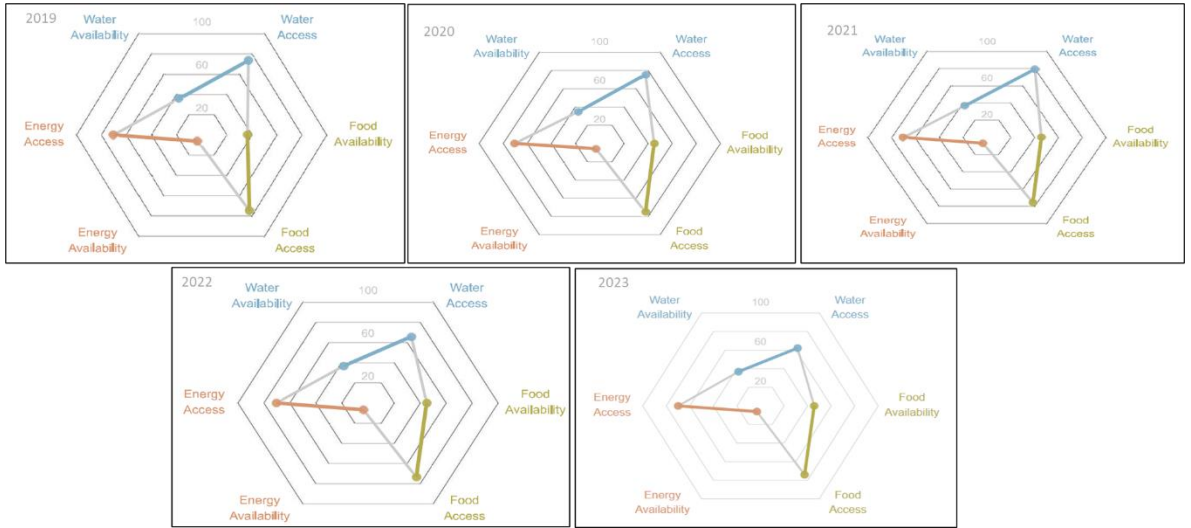


Fig. 4. Radar chart presenting the WEF Nexus Index sub-pillar values for Morocco

By examining this index, it is potential to decide that there is still opportunity for improvement in the energy sector to maximize national potential, as well as to evaluate the advantages of new solutions in resolving the problem of water scarcity and ensuring food sustainability through the utilization of all available resources.

According to this study, Morocco must implement the strategies of the Nexus WEF approach. A focus must be placed on policies, equity issues, institutional structures, modes of governance and management, technologies, strengths of each sector, financial and other elements.

5 Conclusion

The WEF Nexus Index study is not meant to provide solutions to the development and environmental concerns that are faced by the country. The inclusion of this tool in the sustainability toolkit can aid the country in its journey of development, its can help in the process of monitoring. Morocco needs to improve its integration of the Nexus approach into its devolution strategy. To succeed in this transition, it is important to have a dialogue with stakeholders from different sectors. The WEF Nexus Index study is not meant to provide solutions to the development and environmental concerns that are faced by the country. The inclusion of this tool in the sustainability toolkit can aid the country in its journey of development, its can help in the process of monitoring. Morocco needs to improve its integration of the Nexus approach into its devolution strategy. To succeed in this transition, it is important to have a dialogue with stakeholders from different sectors. Conducting additional research on the connection between WEF Nexus in Morocco is recommended, as well as focusing on regional levels. Acquiring a more complete understanding of the

synergies and incoherence among sectors is crucial for improving the effectiveness of political development guidance.

Data availability statement

The 'WEF Nexus Index' website provides access to the datasets presented in this study <https://wefnexusindex.org/>

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