Managing Water, Energy and Food Nexus in Egypt

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Introduction

Water, energy, and food are fundamental for human well-being and promoting sustainable development and are inextricably linked through complex interactions and feedback. These cross-sectoral interdependencies influence the operation and developments in the coupled system; therefore, action in one sector affects the other sectors (Abulibdeh & Zaidan, 2020; Hoff, 2011). Population growth, economic development, and continued urbanization, among other factors, are putting immense pressure on resources. Future projections indicate that global water, energy and food demands are estimated to increase by over 50% by 2050 compared to 2015 levels (Ferroukhi et al., 2015). As the resources are becoming scarce under growing pressures, competition over them increases, thus compounding cross-sectoral challenges and interdependencies (Hoff, 2011; Zhang, Tan, Yu, & Zhang, 2020). Furthermore, these combined pressures could reduce the resiliency of these resources in the face of shocks (such as climate change), and increase conflicts over resources, hence threatening the socio-ecological system (FAO, 2014; Hoff, 2011). Therefore, integrated management of water, energy, and food is necessary to balance human-environment systems.

The Water, Energy and Food Nexus Approach

The Water, Energy and Food (WEF) nexus approach has emerged as a holistic framework that considers the three domains equally and recognizes their linkages and interdependencies (see Figure 1). The approach aims at increasing the overall system efficiency, detecting trade-offs, identifying synergies, and promoting improved governance across sectors and regions (Hoff, 2011). The nexus linkages are complex and dynamic, occurring at a wider domain beyond the control sphere of a given nexus sector (FAO, 2015; Liu et al., 2017). For example, water and energy are essential inputs for food production. Similarly, in energy production systems, water can be used for cooling and/or hydropower generation, while biomass cultivation can be adopted for biofuel production. Energy is needed to pump, treat and transport water. However, return flow from agricultural and sewerage systems not only impacts the availability of water, but also its quality. Such flows can cause serious health issues, be constraint for future development plans, and destabilize ecosystem functions (Beusen et al., 2022; Cai, Wallington, Shafiee-Jood, & Marston, 2018). In light of these complex interlinkages and interdependencies, the nexus framework offers an opportunity for multi-sectoral planning and management while also enhancing policy coherence and resource governance.

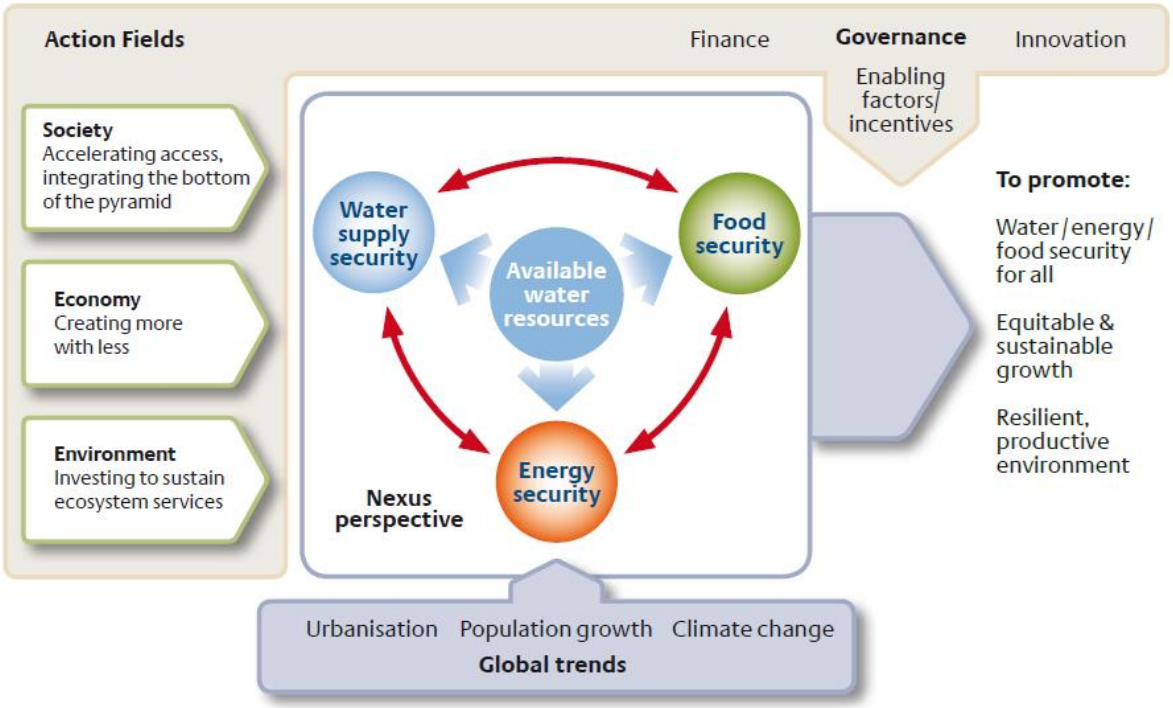

Figure 1: The water, energy food nexus security (Hoff. 2011)

Perspectives on the WEF Nexus in Egypt

Egypt epitomizes an important nexus aspect where the country's limited resources are subject to intense pressure from growing population, expanding economy, and climate change. Located in the northeast corner of Africa, Egypt is home for more than 100 million people and is estimated to exceed 150 million by 2050 (United Nations, 2022). The Egyptian economy grew by 3.6% per year between 2011 and 2021 (The World Bank, 2022) and is expected to grow by 5-6% per year by 2030 (Bohl, et al. 2018). The Nile River is the main water supply in Egypt, providing over 90% of fresh water supplies through High Aswan Dam with an average annual flow of 55.5 km^3/year (Elsayed 2020, CAPMAS 2022). The country is utilizing other water resources to fill its growing water demands through a variety of sources, e.g., groundwater, rainfall, desalination, and the reuse of agricultural drainage water and treated wastewater. In 2018, total annual water withdrawal was estimated at 76.25 km^3/year with over 80% allocated to the agricultural sector (CAPMAS, 2022). The country is currently experiencing severe water scarcity as indicated by its per capita freshwater share at approximately 550 m^3/capita/year (Al-Kady, 2022). In the light of growing population, the situation is intensifying with limited water supply and will only be further complicated by climate change and planned upstream infrastructure developments in the Nile river basin (Elsayed, 2020).

The agricultural sector plays an important role in the Egyptian economy with as a source of food, income, employment, and raw materials for industry. Between 2010 and 2019, the sector has contributed to about 11.8% of the country's GDP and provided around 26% of total employment (CAPMAS, 2022; The World Bank, 2022). Fertile agricultural land covers just

only 4% of the vast country land with an estimated area of 4.0 million hectares stretching across the Nile Valley and Delta (CAPMAS, 2022). Given the arid climate of Egypt, irrigated agriculture is predominant. Egypt is relying on crop intensification and desert land reclamation to improve food security. Despite having highly productive agricultural land, Egypt is a net food importer with an annual food import bill reaching $15.62 billion in 2019 (FAO, 2019). Given limited arable land and water resources in Egypt, the food gap is expected to grow in the future driven by rising population, increased living standards, and climate change impacts.

Egypt is devoting considerable efforts and devising ambitious master plans to the increasing demands of its ever-rising population, while maintaining sustainable economic growth. For example, the Integrated Sustainable Energy Strategy aims at increasing the renewable energy share in the electricity mix by 42% by 2035. However, this may lead to an increase in water use and could further impact food production. On the other hand, the two national strategies for water resources and agriculture have common goals and measures to improve water and food security through various policy measures. These include enhancing agricultural water use efficiency and agricultural land expansion. Such measures, however, are likely to have knock-on effects on other sectors. For example, shifting surface irrigation methods to pressurized irrigation systems as a water conservation measure will lead to an increase in energy use. Similarly, unconventional water supply measures such as expansion of seawater desalination and treated wastewater reuse will also result in increased energy use. On the other hand, the success of plans to expand agricultural land depend on the availability of water (Biswas, 1993). Another dilemma pertains to the excessive use of fertilizers to achieve the crop yield potential which requires high energy consumption and contributes to the deterioration of the quality of soil, water and air. Unlike silo approaches, the nexus approach offers an integrated framework for cross-sectoral coordination and integration to avoid such unintended consequences, and to ultimately improve policy planning and resource management (Albrecht, Crootof, & Scott, 2018).

Application of the nexus framework in policy analysis helps identify synergies and trade-offs and set priorities for such measures. Results from a nexus study (Elsayed, 2020) suggest that improving existing agricultural land productivity should be prioritized over land expansion policies. Likewise, the overall nexus outcomes of water demand management policies (e.g., reducing per capita water consumption and improving irrigation and domestic water network efficiency) outweigh those of water supply policies. Agricultural land expansion plans should be adequately aligned with water supply and demand policies. On the other hand, utilizing renewable energy sources to modernize the irrigation system in Egypt would maximize the promising outcomes of water and food sectors (increasing water supply reliability by 5% and food production by 13% when compared to the status quo scenario). Improved understanding among key stakeholders of sectoral linkages and interdependencies is central to seeking nexus solutions. This significance also extends to encourage cross-sectoral investment, improve policy coherence, and resource management.

Towards Sustainable Resource Management in Egypt

As discussed, addressing the rising challenges for sustainable development in Egypt requires integrated approaches. Explicit inclusion of the WEF nexus is key to set development strategies, harmonize cross-sectoral policies, maximize investment across sectors, and pave the way towards a sustainable growth. Cross-sectoral integration offered by the nexus framework presents an opportunity to address such a multifaceted issue. Leveraging this nexus feature would help achieve the goals of the Sustainable Development Strategy (SDS) for Egypt (Ministry of Planning and Economic Development, 2016). The comprehensive strategy followed a participatory approach in developing a strategic national plan for inclusive sustainable development by 2030. Following a series of workshops and sessions, a unified vision for SDS objectives was reached and agreed among a wide range of participants including academics, experts, civil society representatives, government officials and development partners. The WEF nexus approach would assist implementing and monitoring progress on SDS targets given their close relationship. The science-policy dialogue environment offered in developing SDS offers an important opportunity to develop nexus-based policies in Egypt that are economically feasible, environmentally sustainable, and socially acceptable. On the other hand, more efforts and initiatives are needed to realize cross-sectoral benefits offered by the nexus framework. Ongoing national efforts such as the recently launched Nexus on Water, Food and Energy (NWFE) platform is a step forward to achieve sustainable development goals through the adoption of nexus-based solutions and investments (MOIC, 2022). Similar efforts are much needed to operationalize the nexus approach and provide transferable lessons to implement interdisciplinary solutions to rising global challenges.

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