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The Water-Energy-Food Nexus in the Arab Region

Understanding the Nexus and Associated Risks

Summary

Water security, energy security and food security are inextricably linked in the Arab region, perhaps more than in any other region in the world. Generally, the region is known to be energy intensive, water scarce, food deficient, and one of the world's most economically and environmentally vulnerable regions to climate change. This strong interdependency between water, energy, food and climate change in the Arab region calls for the nexus approach and thinking when addressing the management of these three vital sectors; an approach that integrates management and governance across sectors, and where conventional policy and decision-making in 'silos' gives way to an approach that reduces trade-offs and builds synergies across sectors especially in light of the global UN Sustainable Development Goals (SDGs) and the COP21 Paris climate change commitments in 2015. Fortunately, this has been recently well recognized in the Arab Strategic Framework for Sustainable Development (ASFSD), adopted by the League of Arab States in 2013, aiming at addressing the key challenges faced by the Arab States in achieving sustainable development during the period 2015-2030. This new development has created unprecedented opportunities for fundamental policy changes in various economic, institutional, technological, and social systems, as well as boosting resource efficiency and productivity by addressing externalities across sectors. This policy brief - a first in a series of six - aims at providing a better understanding of the interdependencies of water, energy and food and their related challenges in the Arab region. Besides, it is intended to shed light on the risks and impacts posed by one sector on the others through articulating a framework for determining trade-offs and synergies that meet demand on resources without compromising sustainability.

Recommendations

Policy makers in the Arab countries need to ensure the integration of the policy cycle for the Water Energy Food (WEF) nexus through a set of measures which include:

- Bridge the knowledge gap of the WEF nexus at the national and regional levels by understanding and quantifying the inter-linkages between water, energy, and food
- Identify and analyze the WEF nexus cross-sectoral interactions, trade-offs, and risks
- Adopt a WEF nexus approach policy making to increase policy coherence among the three sectors and climate change policies to provide integrated solutions and to mitigate nexus-related risks
- Implement integrated planning and management that reduces trade-offs and builds synergies across the three sectors

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The WEF Nexus

Globally, the inter-linkages between water, energy, and food sectors have been increasingly investigated over the last few years under what has come to be referred to as the "Water-Energy-Food (WEF) nexus". Now, the water, energy and food nexus is at the centre of global policy, development, and the research agenda, a testimony to the key role that the nexus approach has to play to meet the rapidly growing demand for water, energy and food in an increasingly resource-constrained world. It can be understood as a central way for approaching the Sustainable Development Goals similar to the Cradle to Cradle or the Circular Economy approaches.

Resources Needs and Stresses on WEF in the Arab Region

The Arab population is currently over 390 million and is expected to increase by 50% by 2050. In addition, the region has witnessed a significant economic growth with corresponding increase of demand and change of consumption patterns.

Poverty, resource depletion and degradation are present throughout the region. Despite having 43% of the world's oil reserves and having an immense potential for renewable energy, more than 50 million people in the region remain without access to modern energy services, mainly electricity. Additionally, the region merely has 0.3% of the world's freshwater sources, making it the world most water-scarce region in absolute and relative terms. Over 50% of Arab countries are already below the water stress level of 500 m3/capita/year and water availability is expected to decrease by 50% by 2050, while demand will continue to grow. The Arab region is the world's largest importer of wheat and recent economic

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instability has left its population even more vulnerable to food insecurity.

Moreover, climate change, which is mostly driven by energy use, consumption patterns, and land use changes, is an additional challenge that would exacerbate the critical situation of water and food resources, and would intensify the use of energy resources in the region. Climatic variability adds further pressures and is likely to induce more frequent and intense extreme weather events (such as droughts or floods), and less reliable water supplies, as well as less reliable agricultural productivity.

This complex web of interdependency has manifested itself over the past few years in new and increasingly interconnected crises (the food, energy, and financial crises, together with extreme climate events such as droughts and floods). These crises had impacted the Arab population heavily on varying degrees, hitting the poor the hardest.

The Water Energy Food Nexus

The Water-Energy-Food Nexus is framed by FAO within the broader debate on sustainable development that recognizes and tries to strike balance between the different goals, interests and needs of people and the environment. It explicitly addresses complex interactions and feedback between human and natural systems. The resource base refers to both natural and socio-economic resources, on which we depend to achieve different goals and interests pertaining to water, energy and food. Nexus interactions are about how we use and manage resource systems, describing interdependencies (depending on each other), constraints (imposing conditions or trade-offs) and synergies (mutually reinforcing or having shared benefits). Interactions take place within the context of globally relevant drivers, such as demographic changes, urbanization, industrial development, agricultural modernization, international and regional trade, markets and prices, technological advancements, diversification and changes of diets, and climate change.

Source: FAO (2014): Water-Energy-Food Nexus, A new approach in support of food security and sustainable agriculture

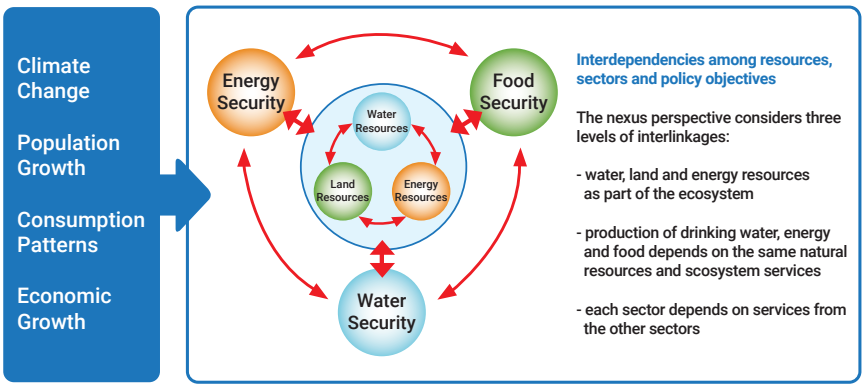
The strong interlinkages between the sectors can affect the extent to which three crucial policy objectives can be achieved, i.e., water, energy, and food security. The interlinkages mean that pursuing security in one sector depends on the developments in other sectors. Therefore, it is becoming imperative that policy formulation becomes coordinated among the three sectors as well as with respect to mitigation of- and adaptation to climate change. Conventional policy- and decision-making in 'silos' therefore needs to give way to an approach that reduces trade-offs and builds synergies across sectors.

Adopting a nexus approach to sector management requires a better understanding of the trade-offs and risks across the nexus sectors and involves analyzing cross-sectoral interactions to facilitate integrated planning and decision making.

Nexus: Identification, Quantification, and Risks

The interlinkages between water, energy and food systems intensify as the demand for resources increases with population growth and changing consumption patterns. Meanwhile, major global trends – notably climate change and competing land-use patterns – restrict the ability of existing systems to meet the growing demand in a reliable and affordable manner. These dynamics pose substantial risks for the sustainable development and resource security ambitions of the Arab countries, where the interdependencies of these three sectors are crucially strong, and are being intensified with time.

The WEF Security Nexus

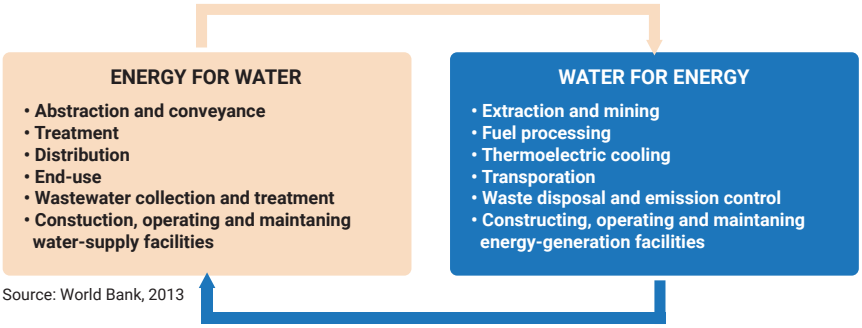


The Water–Energy Nexus

Water and energy are critical resource inputs for economic growth. The correlation between economic growth and energy demand has been widely established **(Policy Brief 2)**. Meeting energy demand, however, requires water. In most energy production processes, water is a key input: fossil fuel production requires water for extraction, transport and processing; thermoelectric generation based on nuclear, fossil fuels or Concentrated Solar Power (CSP) requires water for cooling; hydropower can be generated only if water is readily available in rivers or reservoirs; and renewable energy resources such as solar require water for cooling and cleaning panels or collectors for improved efficiency. The technology choice, source of water and fuel type determine the impacts of energy on the withdrawal, consumption and quality of water resources. It is anticipated that the commitments of the Paris Climate Change summit in 2015 of clean energy will shape a new trajectory of development in the Arab region. Moreover, the climate fund, which is expected to allocate US$100 billion per year in 2020 and beyond, will provide incentives to transfer and adopt clean energy.

Conversely, energy inputs are spread across the water supply chain. Energy is used in almost every stage of the water cycle: extracting groundwater, feeding desalination plants with its raw sea/brackish waters and producing freshwater, pumping, conveying, and distributing freshwater, collecting wastewater and treatment and reuse. In other words, without energy, mainly in the form of electricity, water availability, delivery systems, and human welfare will not function. It is estimated that in most of the Arab countries, the water cycle demands at least 15% of national electricity consumption and it is continuously on the rise.

The Water-Energy Nexus



Source: World Bank, 2013

As easily accessible freshwater resources are depleted, the use of energy-intensive technologies, such as desalination or more powerful groundwater pumps, is expected to expand rapidly. The Arab region is home to most of the world's desalination capacity, and the region's capacity is projected to increase more than five times by 2030. It is projected that this will raise total electricity demand for desalination in the region by three times, to 122 Terawatt-hours by 2030.

The risks and the impacts the water sector presents to the energy security and the energy sector presents to water security are numerous. However, in the Arab region they are more skewed towards the latter case due to the considerable role the energy sector plays in the water value chain.

The Arab countries, where desalination is playing an increasing role especially in the GCC countries, will be affected most by the cost of energy inputs into water production. The cost of desalination is dominated largely by the cost of input energy, with estimates suggesting that energy accounts for more than 50% of the economic cost of desalination plants. In the GCC countries, water and electricity cogeneration infrastructure has been developed which utilizes waste heat from power plants for distillation. In Dubai in the United Arab Emirates, for example, 95% of water is procured through cogeneration plants that use imported natural gas. Faced with the increasing cost of producing water and unable to ensure cost recovery through prevailing water tariff regimes, the Electricity and Water Authority introduced a fuel surcharge that better accounts for the changes in global fuel prices and to influence soaring water demands. Recently, Saudi Arabia, Bahrain and the Emirate of Abu Dhabi have made major municipal water tariff reforms to reflect its real cost.

The Water–Food Nexus

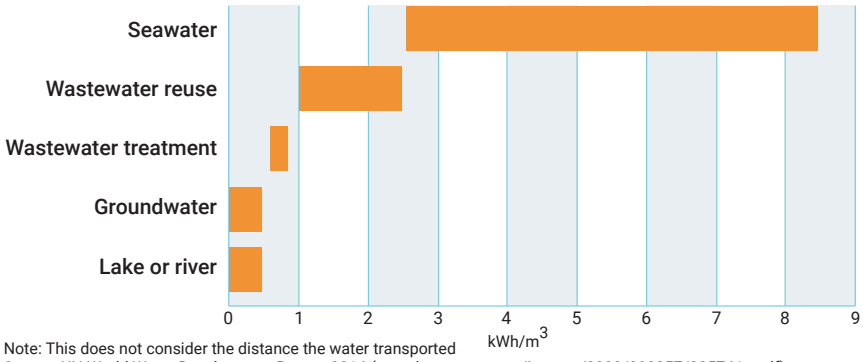
The relationship between water and food systems is among the most widely covered and quantified elements of the nexus. Today, the water–food nexus is symbolic of vulnerabilities on two fronts: changing patterns of water supply that are influencing the reliability of water-intensive sectors including agriculture, and the growing competition for limited water resources in meeting the projected increase in food demand. Moreover, the use of fertilizers and agro-chemicals has grown considerably under usual agricultural practices. Such inputs release chemical compounds that percolate to and degrade the quality of groundwater.

In the Arab region, agriculture is largest user of water accounting on average for about 85% of total freshwater withdrawals, driven in many countries by food-self sufficiency policies. However, under limited cultivable land, highly stressed and dwindling water resources, coupled with an impoverished bio-capacity ofagricultural resources, increasing food production is indeed a challenging task. The region is already suffering from water scarcity and witnessing intense competition with other sectors, including manufacturing, electricity production, domestic use, and environment. In the face of these competing demands, increasing allocation of water for irrigation will be challenging.

Meeting growing demand for water and food will require careful management of risks and opportunities which are closely related to the interaction between the different attributes of food security and water security. Accessibility to water of adequate quality, for instance, affects several food security aspects. Water is necessary, of adequate quantity and quality, to produce food and further downstream, during the preparation and consumption of food. Similarly, the intensification of certain food production practices, for example, a more aggressive use of soil-enriching nutrients has significant implications for water security.

Water is a critical input along the different stages of the agri-food supply chain. As the main input in agricultural production, the risks that the water sector presents to food security are considerable. Globally, food production is regionally concentrated, illustrating the high importance of Asia in producing rice, wheat, cereal and sugar. Such "food bowls" of the world are already facing water stress due to droughts and depletion of blue water resources, which poses significant risks for global food security, including many Arab countries such as the GCC countries.

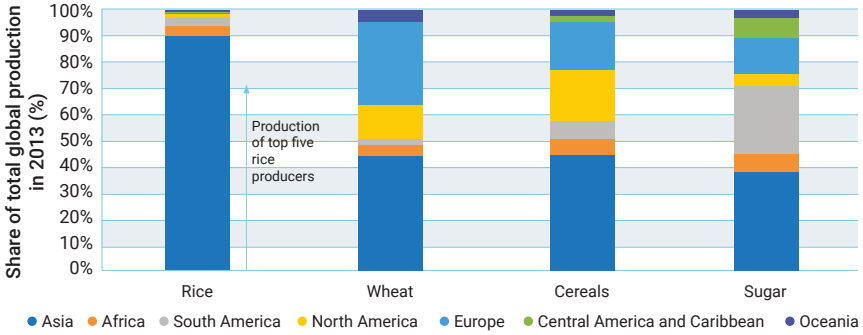
Amount of energy required to provide one cubic meter of water safe for human consumption from various water sources (UN Water, 2014)



Note: This does not consider the distance the water transported
Source: UN World Water Development Report, 2014 (unesdoc.unesco.org/images/0022/002257/225741e.pdf)

Moreover, river basins in the Arab region that are critical in the water–food nexus–such as the Nile, Euphrates and Tigris – are predicted to be "closed basins" (over-allocated), particularly due to energy and agricultural production, and could face challenges from the effects of climate change and lack of regional water agreements.

Share of global production of rice, wheat, cereals and sugar, by region



Source: Based on data from FAOSTAT Database, 2014

In terms of food-related risks to water security, agricultural practices have substantial impacts on water security for a broader set of stakeholders. Domestic food security is high on the agenda of many Arab countries. In the wake of the 2008 global food crisis, when at least 25 countries imposed export bans or restrictions on food commodities, many food-importing countries realized the grave food security risks that such situations posed. Several Arab countries (e.g., GCC countries) for which food self-sufficiency is very difficult to achieve, began buying or leasing land in relatively water-rich countries. In this context, concerns emerge regarding the effectiveness of regulations that govern water rights, extraction and utilization, with some asserting that, in effect, this land acquisition amounts to de facto water acquisition. This is particularly relevant given that many of the recipient countries are home to significant populations of malnourished and are often on the receiving end of food aid. FAO various assessments of the impact of international investment on the host country found that, in many cases, the water security of local communities can be negatively affected, as local farmers face off against competing water users.

Risks involved in GCC Countries agricultural foreign investments

In the aftermath of the food price crisis, both GCC governments and private investors in the region have been studying alternative ways of ensuring food imports by controlling the source of supply. The main strategies are buying or long-term leasing land in developing countries to use for export-oriented farming. Gulf-owned farming projects are already being considered, negotiated, or implemented in North Africa, Sub-Saharan Africa, central Asia, southern Asia and eastern Europe. However, this strategy carries with it many risks and requires careful and continued management and making sure that benefits are shared for both sides. Co-benefits could include investing and providing funds in improved agricultural productivity in developing countries, aligning GCC foreign aid spending more closely with food security aims by helping countries to create food surplus to be exported, and consultation and negotiation with local farmers. Other but equally important proposed strategies to reduce exposure to market price volatility include the risk management tools of regional strategic food reserves and regional purchasing approach. Source: Al-Zubari, 2014 (Afedonline.org/Report2014/E/Binder-eng.pdf)

The Energy–Food Nexus

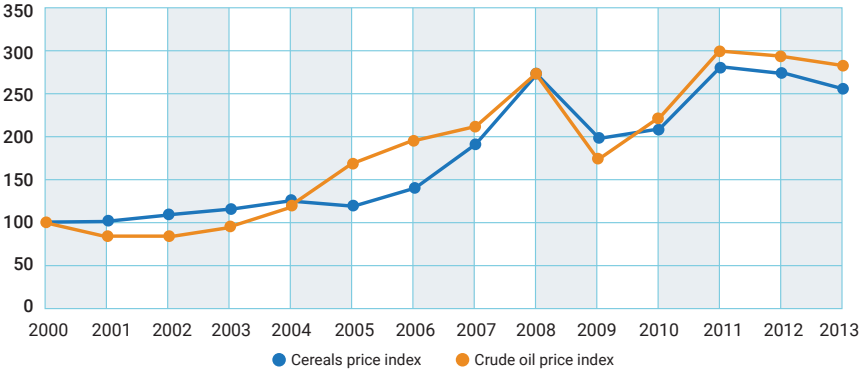
The energy–food nexus relates mainly to energy use within the food supply chain. Depending on the extent of mechanization, agricultural production consumes energy directly in the form of fuels for land preparation and tillage, crop and pasture management, and transportation or electricity supply, and indirectly through the use of

energy-intensive inputs, such as fertilizers and pesticides, or energy for manufacturing agricultural machinery. It is anticipated that the COP21 climate change commitments in 2015 will be a driver to make a transition to clean and efficient energy. Energy is also needed during processing, distribution, storage, retail and preparation of food products. This makes food security particularly sensitive to the quality and price of energy inputs: in some countries, the price of oil has a rather direct effect on the price of food. Another dimension of the energy–food nexus, that is gaining prominence, is the impact of the growing share of modern bio-energy in the world's energy mix, which is emerging as a viable renewable energy option for many countries.

An important consideration is also energy, as well as water, embedded in the substantial amounts of food wasted. A large amount of food, with a significant energy footprint, ends up as waste. In the Arab region, grain post-harvest losses (due to improper methods used in the harvesting, processing, transportation, and storage of the crops, as well as inefficient import supply chain logistics) and wheat import losses amounted to about US$ 3.7 billion at 2011 import prices, which represents 40% of the wheat produced in all Arab countries in value terms. This is equivalent to about four months worth of wheat imports. This wastage represents significant opportunity costs manifested in the loss of valuable water, land, energy and labor inputs that have gone into producing the food, while at the same time contributing to greenhouse gas emissions.

The nature of energy supply into the agri-food sector can substantially influence food security. The key risk posed by the energy sector on food security is that the dependence on fossil fuels increases volatility of food prices and affects access to food. Fossil fuels continue to provide the majority of the energy inputs for conventional development of the agri-food sector, ranging from electricity and/or diesel for pumping, food processing and storage, to fuel for agro-machinery. This is expected to be changed as the Arab region has a mandate to make a transition to clean energy (solar, wind, hydropower) in light of the Paris COP21 commitments and intended contributions of nation-states to mitigate and adapt to climate change. This reliance on fossil fuels comes at a cost – related not only to climate change but also to fluctuations in fossil fuel prices, which can cause dramatic changes in food prices. The 2007-08 global food crisis was due in part to increasing oil prices, which had a cascading effect that led to greater demand for biofuels and to trade stocks in the food market. Another component of the food supply chain that is affected by energy prices is packaging (containers, boxes, etc.), for which fossil fuels are key input.

Oil-Cereal price inter-linkages 2003-2013



Source: Based on FAO Food Price Index and BP Statistical Review of World Energy 2014 (Base 2000 = 100)

The risks posed by the food sector on energy security are mainly related to population growth and changing diets in emerging economies, which are expected to place increased burdens on energy and food production systems due to higher demand for fertilizers and agrochemicals, higher levels of livestock production, and demand for more sophisticated retail, distribution, processing, cooking and food preparation. Energy inputs into the food supply chain are likely to increase in the coming decades, leading to increased energy production necessities and likely strains on energy delivery systems. As food demand rises, so will water needs, which have their own energy footprint impacts.

The WEF Nexus Approach

It is important to note that in general there has been weak or lack of real coordination in the Arab region in terms of policies and strategies for water, agricultural land, and energy. Moreover, climate change policies are still being addressed as an add-on policy issue rather than a core challenge for development in the region. Climate change policies need to be coordinated within the triple context of water security, energy security and food security, and in line of the COP21 commitments to ensure a low ecological footprint through having a decarbonized economy.

International experiences have shown that a "silo" approach to managing these vital three sectors has often led to unsustainable policy and development choices. There is growing recognition of the need to better understand the linkages between water, energy and food, and to adopt an "integrated", or a "nexus" approach to managing these sectors. The integrated resource management is not a new concept and has been a key feature of well-known development approaches.

The nexus approach is meant to integrate strategic management and governance across sectors and to shift from conventional sectoral planning towards utilizing the opportunities offered by the interlinkages among the three sectors. Adopting the nexus thinking and approach can boost resource efficiency, sustainability, and productivity by addressing externalities across sectors and making a transition to clean energy to meet both the sustainable development goals (SDGs) and climate change commitments in Paris Climate Change Summit in 2015. There is a large potential to increase overall resource use efficiency and benefits in production and consumption. Additionally, the nexus thinking offers real opportunities for synergies such as coordinated investments in infrastructure related to water, food and energy, and innovation to improve resource use efficiency and adaptive capacity.

This should be coupled with the use of economic instruments for stimulating investment, including: pricing of resources and ecosystem services, maximizing the beneficial uses of water and energy amongst other competing demands, applied and adaptive research to enhance adaptation to climate change in the agricultural sector to ensure its resilience, capacity building and sharing of experiences and good practices at national and regional levels, and finally bridging the present science-policy gap.

Conclusion

The strong interdependency between energy, water and food needs to give way to an approach that reduces spill- over effects or externalities and trade-offs and builds synergies across sectors. This has been well recognized in the Arab Strategic Framework for Sustainable Development (ASFSD), adopted by the League of Arab States in 2013, aiming at addressing the key challenges faced by the Arab States in achieving sustainable development during the period 2016-2030. This new development will create unprecedented opportunities for fundamental policy changes in various economic, institutional, technological, and social systems in the Arab region. Institutional analysis and cross-sectoral organizational learning across WEF nexus are critical to develop new knowledge on the value of integration to achieve SDGs and global climate comittments/targets in the post 2015 agenda (**Policy Brief 4**). To mainstream the nexus approach in policy development, it is imperative to have three necessary conditions, i.e., knowledge about the opportunities and challenges of the nexus (**Policy Brief 2**), enabling institutional framework (**Policy Brief 3**), and capacity building on tools used to better understand the value-added of integration (**Policy Brief 5**).

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