



The nexus approach to water–energy–food security: an option for adaptation to climate change in Algeria

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ABSTRACT

The water energy food (WEF) nexus approach seeks to assess relevant and consistent strategies to address challenges to the development of the three sectors, to meet the demand and achieve sustainable development. They are the most indispensable elements for life and development respectively. Besides that, the production and cost of one depend highly on the performance of each other. Not any country could attain a sustainable development without first developing the three sectors and satisfy the demand. Most of developing countries face the challenges in handling the management of these resources due to different reasons. Among those reasons, the most predominant are high population growth, lack of skills in water management, low use efficiency and energy resources management and impact of climate change. This research seeks to find out the best ways to handle barriers to WEF nexus development with the target to satisfy the need in a sustainable way.

Keywords: Water–energy–food nexus; Nexus strategy; Policies; Climate change; Water scarcity

1. Introduction

Algeria stretches over 1600 km from Tlemcen in the West to El-Taref in the East and 2200 km from Algiers in the North to Tamanrasset in the South. Despite the significant difference in climatic conditions (there are three types of climate: the mild Mediterranean climate of the coast, the transitional climate of the northern hills and mountains, a little more continental and moderately rainy, and finally the desert climate of the vast area occupied by the Sahara), the entire country is faced with similar challenges. The country has to cope with a water deficit, while it strives to achieve

a self-sustaining agriculture at the same time [1–3]. Energy production in the country still strongly relies on fossil fuels, even though there is a high potential for renewable energies. Sectoral thinking dominates institutions and administration, but bridging approaches are developing [4,5].

Algeria is energy intensive, water scarce, and food deficient. The interdependency among water, food, and energy in Algeria is strongly and closely interlinked and expected to be intensified with population growth and changing consumption patterns [6].

Moreover, the challenges of meeting growing demand for water, energy, and food, are expected to be further compounded by the impacts of climate change and climate variability. Such conditions create immense challenges to the government of Algeria. In 2030, with an expected popula-

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tion of nearly 48.3 million people, the country will need 3.5 billion m³ of water annually to fill water demand for all use sectors [7,8].

Government tends to address challenges in each sub-sector individually, although there have been attempts at bureaucratic unification. Algeria has integrated its ministries of environment and renewable energy into a single ministry, in the hope of facilitating better management of the intertwined generation of climate change and renewable energy. The supplying of 20% of the country's projected energy demand in 2030 with renewable energy could be accomplished. This would enable the country to meet its Paris commitments with minimum pressures on land area [9].

The Water–Energy–Food Nexus (WEF) seeks to assess relevant and consistent strategies to address challenges to the development of water, food and energy sectors, to meet the demand and achieve sustainable development.

2. Energy-water nexus

The water-energy nexus is the relationship between water used to generate and transmit energy, and energy required to collect, clean, move, store, and dispose of water. A pictorial representation of energy-water nexus is shown in Fig. 1.

Water is a rare commodity in Algeria. Predictions regarding climate change indicate that rainfall might decrease by more than 20% by 2050, resulting in worsening of water shortages in different parts of Algeria. The challenge of the hour in Algeria is to decrease the use and carefully manage the available renewable water resources. A strategic component of future water policy would be the utilization of non-conventional water resources (desalination and wastewater reuse) [11–16].

But on the contrary, the development of non-conventional resources to meet the requirements of water has increased the energy consumption of the water sector. In Algeria, the water sector in 2011 consumed around 4983 GWh and is set to rise to 16,090 GWh by 2030, more than three times the consumption of 2011 [8]. This predicted increase is attributed mainly to seawater desalination, water transfer projects, the supply of water through pipes and wastewater treatment facilities.

In Algeria, there are about 40 million people who need water and energy. While there are many impediments and challenges towards NEXUS approach, these can be overcome by comprehensive planning, risk assessment and, policy implementation. Undoubtedly, the holistic Nexus approach in Algeria will empower a hub for knowledge and technology exchange and for innovating, adding value to the economy by providing employment opportunities, reducing environmental impacts, adapting and benchmarking solutions [2].

The water shortage of freshwater resources in Algeria triggered the use of desalination, mainly based on reverse osmosis (RO). The implemented desalination plants increased the overall energy consumption. As energy production is based on fossil fuels, a finite source, it is obvious that promoting renewable energies to power desalination plants is needed. To further avoid the water scarcity a co-ordination is required between the water and energy sectors.

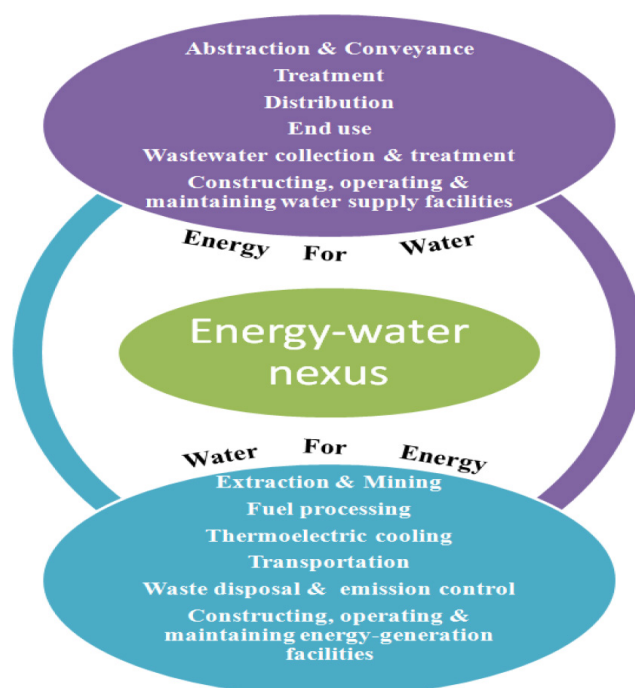


Fig. 1. Pictorial representation of Energy water nexus [10].

The use of renewable energy (most important is solar) must be promoted which will help save fossil fuels, share water needs in a sustainable manner and also be the reason for technical advancement [11].

3. Water Food Nexus

Water-energy and food in Algeria are strongly inter-linked and highly interdependent. Algeria is facing water scarcity challenges, where agriculture is its predominant consumer. Water withdrawals for irrigation, livestock and aquaculture purposes account for approximately 4.99 billion m³ per year, or 64% of global water withdrawals today [17], and is forecast to grow at a compound annual rate of 6.8%.

In addition to the increase in water scarcity, the agricultural sector faces an enormous challenge of producing almost 50% more food by 2030 and doubling production by 2050.

A study conducted by the World Bank has shown that more than half of the food calories consumed in Algeria is imported and would increase dramatically over the next decades. An older study in the mid-1990s has shown that the food import of Algeria was equivalent to 87% billion m³ of virtual water [18].

4. Research

Researchers through their research activities actively contribute to Algeria's WEF nexus knowledge base by funding fundamental water research, growing scientific capacity and disseminating knowledge to important stake-

holders through various formats (i.e., publications, reports). Research-funded projects directly address the country's WEF challenges by investigating new technologies and methods to enhance WEF nexus implementation, supporting policy and legislation, and providing much-needed guidance to implementers. The research topics cover all aspects of the WEF nexus, including water resource management, renewable energy, desalination, water reuse, and the use of efficient irrigation techniques. They also look at aspects of climate change that may affect our water resources and agriculture in the future.

Several agreements to strengthen bilateral cooperation in the research field of water with countries that are facing the same challenges (i.e., droughts, flooding and other events exacerbated by climate change) were signed aiming at facilitating the inflow of relevant results from research projects to the water sector and promote collaboration.

Moreover, The European Union and Algeria are strengthening their scientific collaboration under several research and innovation programmes in order to better tackle issues related to water research and innovation.

5. Policy recommendations

The strong nexus between water, food, and energy sectors is the starting point from which further synergies and deeper integration can be achieved; adopting it durable is a critical concern for scientists, governments, and policymakers to support the transition to a green circular economy. It requires an integrated planning policy and more collaborative mechanisms between these sectors.

Based on the above obviousness inventory, the following recommendations for decision-makers on ways to bridge the gaps between policy and nexus in Algeria are given:

- Developing water supply, including desalination, and integration of energy systems, including renewable energy.
- Reuse of treated wastewater for irrigation in order to reduce the pressure on natural resources.
- Adopting appropriate water pricing to help reducing overexploitation of natural resources.
- Encouraging and promoting technology transfer and innovation with riparian countries.
- The integration of the Intended Nationally Determined Contributions (INDC) measures into national policies positively contributes to the deployment of renewable energies, afforestation, reforestation, water management, public health and transport, and waste valorization.
- The integration of the sustainable development goals (SDGs) into plans, budgets, and strategies.
- Set up action plans for new research. Science can bridge the gap between policy and practice.
- Coordination mechanisms between ministries to bridge the gap and at the same time avoid overlap that helps drive change and support actions to enhance the nexus implementation.
- Enhance the role of the civil society in the decision-making process.

- Promote and adopt an integrated approach to food production issues.
- Develop innovative solutions for agriculture and water constraints.
- Leverage health, nutrition, and education for food security.
- Increasing the net import of water through well-designed trade policies.
- Promoting water desalination using renewable sources of energy.
- Cultivation of water saving and drought-resistant crops.
- Adopting decentralized governance in order to provide the flexibility for operating and implementing a nexus approach at the local level.

6. Conclusions

The adoption of WEF nexus concept offers many environmental and economic benefits to Algeria, including reduction of reliance on fossil fuels, and diversification of water, energy supply sources, and decreasing foodstuffs dependence on other regions. Advancing in its implementation is directly linked to mitigating climate change and supply to support economic growth. Given these potential advantages, the WEF concept deserves to be adopted in greater depth. Some measures and policies need to be placed to promote a nexus approach, including research and development, human resource development, regulatory framework, and inter-ministerial coordination.

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