

A water-energy-food nexus assessment in the Ain Temouchent region, Algeria

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1. Brief study area description:

Ain Temouchent is located in the north-western of Algeria, 520 km from the capital Algiers. The Oran region borders Ain Temouchent to the east, Sidi bel Abbes to the southeast, the Tlemcen region to the southwest, and the Mediterranean Sea to the north (Figure 1).



Figure 1: Geographical location of the Ain Temouchent region, Algeria.

It has an area of about 2,376 km² with a coastline of 84 km (ANIREF, 2018). The population is about 426,762 inhabitants of which about 268,994 are economically active. The service, agricultural, and construction sectors employ 15.76%, 15.22%, and 14.19% of the economically active population. The region of Ain-Temouchent is characterized by a Mediterranean climate with hot summers and mild winters. The summer months (June, July, August) are dry and with low precipitation while the rest of the year is humid and characterized by alternating wet and relatively dry months. The geographical location, and in particular the hydrogeological features, result in limited and variable water supply. This highlights the need for the region to increase water resources and the development of infrastructure to ensure water security.

Agriculture is a major sector and water user in the region and its increasing intensification is leading to the overexploitation of groundwater resources. The establishment of a reverse osmosis desalination plant (Benisaf Water Company) with a production capacity of 200,000m³/day significantly alleviated the water concerns, but its fossil fuel-based energy supply and high consumption and environmental impact are raising several questions. A large gas-powered electricity generator station was recently established and the assumption is that the region now has ample electricity.

2. Hoff's Analytical Framework

2.1. Nexus framing

Ain Temouchent region is currently working towards improving the socio-economic system and thus the livelihoods of its inhabitants. Coupled with investments in ensuring water, energy, and food security for the population. Population growth as well as climate change impact (especially increased extreme events such as drought), are putting pressure on the Ain Temouchent resources and the region has to find solutions to meet increasing water, energy, and food demand sustainably and improve the population's quality of life.

Although subject to naturally high climate variability, increasing intensity, and frequency of drought affects surface and underground water resources available in the region as groundwater and small hill reservoirs are depleted and not recharged in these periods; this impacts water security in the region.

In addition, the drought heavily impacts agricultural production and drives land use change with an unavoidable impact on food security and the socio-economic system especially in terms of its impact on local food market, food export, and food prices.

The Ain Temouchent region is characterized by different primary water sources: surface water, groundwater, and non-conventional water, mainly seawater desalination, and the reuse of treated wastewater. The surface water supply is about 28736 m³ day⁻¹ and it is transferred from the adjacent Tlemcen region to a treatment plant. However, this is currently not working. Groundwater resources are about 9500 m³ daily (Department of Water Resources and Water Security, 2021). Although the area has several water resources, they remain insufficient to meet the demand of the different sectors. In 2010, the establishment of seawater desalination plants using Reverse Osmosis technology with a capacity of 200000 m³ day⁻¹ was established in the region contributing to ensuring water security. Currently, water from the desalinization plant is used to supply water for domestic, tourism, and industrial needs. However, 50% of the desalinated water is transferred to the adjacent Oran region (BWC, 2010) and is not available to the inhabitants of Ain Temouchent. Given this situation, only 40% of the population has daily access to drinking water supply, 40% every two days, and the rest every three or more days, as a result, the government is working on improving the region's drinking water supply. Although the use of

desalination was essential to alleviate the water crisis, its cost in terms of economics, energy, and the environment raises several questions. The cost for one cubic meter of water through seawater desalination ranges between 0.65 to 0.85 dollars equivalent to 91 to 120 Algerian dinars (Da). Additionally, the Algerian government subsidizes the price of drinking water, and as a result, citizens pay only about 6 Da per cubic meter. This pricing does not reflect the actual cost of production and supply. It is reported that when consumer prices are lower than the cost price of water, it encourages waste and dissipation of the resource. (Department of Water Resources and Water Security, 2021). The electricity consumption is 4.15 kWh per m³ of water produced (BWC, 2010) which is provided by the electrical station designed to operate the entire plant with two power lines of 220000KV for each; those lines are supplied from the national grid. (Sonelgaz, 2021). According to the Department of Water Resources, 99% of the urban population is connected to the public drinking water network. However, given the transfer to adjacent regions, supply is intermittent. Regarding wastewater treatment, the Ain Temouchent region has several infrastructure facilities, including six lagoons and three wastewater treatment plants. Despite the high potential, the treated wastewater is currently not effectively reused (only very little amount for irrigation), instead being discharged into rivers or the sea. The reuse of treated water could offer an opportunity to enhance water supply for multiple purposes in the future. The treated wastewater that is used for irrigation, is only a small amount, largely due to the unstable operationalization of the treatment plants in the region.

While both water treatment and desalination require energy, water is essential for ensuring food production. The agricultural sector is the major water user in the region, in particular groundwater. This sector currently covers more than 76% of the total area, i.e., about 180994 ha, of which 119976 are used by collective farms. The most cultivated crops in the region are citrus, arboriculture, viticulture, fodder, market gardening, and cereals. Currently, 147000 ha are covered by field crops, including cereals, while viticulture, arboriculture, and citrus cover about 4319 ha, 2890 ha, and 393 ha, respectively (Department of Agricultural Services, 2021). Agricultural production is very diversified and is experiencing considerable development, especially in the adoption of organic production in certain parts of the region. Given the increasing food demand, the government is planning the construction of a new reservoir aimed at storing surface water for irrigation purposes. This could contribute to enhancing the agricultural system and, thus the socio-economic sector, but the environmental impact of this infrastructure should be assessed and considered.

Energy security in the region is ensured by a combined cycle gas-powered electricity station with a capacity of 1200 MW. The plant has been operating since 2012 by using natural gas as a primary energy source and diesel as a backup option during emergency times. The utility has played a crucial role in ensuring energy supply and promoting economic development in the Ain Temouchent region. Currently, the plant provides a secure electricity supply for the entire region, with the possibility to export the energy to other foreign countries. The cost of producing 1Kwh of electricity in Algeria is approximately 4.01 Da, and the Algerian citizen pays for the first 125 Kwh consumed 1.904 Da/Kwh, and 4.472 Da/Kwh for additional consumption (Sonelgaz, 2021). With this plant, the current electricity supply connection in the area is 94%, with a 73% connection rate to the gas supply (Sonelgaz, 2021). Electricity and gas are the two main energy sources in the region. These sources are mainly used for satisfying domestic (household work, public lighting, and transportation), tourism, industrial cooling and transportation, and agriculture (pumping groundwater for irrigation, harvesting, food processing, and transportation) needs. Energy is required in water production, primarily in desalination and wastewater treatment plants. In turn, water is required in energy production, for example in the gas power electricity generation plants and for cooling in different industries.

The Ain Temouchent region has a high potential and could be a leader in the agricultural sector meeting the needs of its population and those of neighbouring regions, but inadequate management in all the sectors, especially in agriculture, limits the opportunities for sustainable socio-economic development.

2.2. Nexus Opportunities:

- Reuse of purified wastewater
- Adoption of the most efficient irrigation method for water-saving
- Energy production based on biofuels from dry residues is feasible
- Reduction of the amount of energy used in the production of drinking water (especially seawater desalination).
- Sustainable development strategy to satisfy tourists in terms of water, energy, and food.

2.3. Technical and economic nexus solutions

- The use of solar panels (photovoltaic)
 - The gradual replacement of oil lamps by LED.
 - The use of more efficient and less expensive irrigation methods.
 - Use of solar energy for pumping groundwater.
 - The mobilization and storage of rainwater by hill reservoirs.
 - The adoption of composting, for agricultural use, and energy production
- The most important is:
- the sensitization of citizens on the importance of preserving these resources, through conferences, school visits, television programs, and through social networks widely used by young people.

2.4. Stakeholders involved

- -The different ministries in charge of water, energy, and food management, in addition to the ministry of the environment.
- -The various institutions responsible for water management at the regional levels.
- -The population, farmers, farm owners, fishermen and sailors, tourists, owners of aquaculture farms, health, officials
- The academics contribute to promoting the WEF nexus in the region, as part of their research and innovation, through teaching and public engagement, interdisciplinary collaboration, and contributing in developing skills and knowledge to implement the WEF nexus approaches.

Ministries:

- Ministry of Water Resources and Water Security
- Ministry of Energy and Mines
- Ministry of the Environment and Renewable Energy
- Ministry of Agriculture and Rural Development

Water institutions

- Algerian Waters institution

Missions. Water quality standardization and monitoring, water preservation, efficient transfer and distribution networks, and reduction of water waste.

- National Sanitation Office

Missions. Resources and the environment are protected and safeguarded, and all sources of water pollution are fought against to preserve public health.

- National Irrigation and Drainage Board

Missions. Management, operation, and maintenance of irrigation networks; conducting irrigation; supporting farmers with practical advice on irrigation and providing them with agricultural equipment.

- National Agency for Dams and Transfers

Missions. It provides access to a variety of services based on existing cartographic data from the national agency for dams and transfers. It allows observation and consultation, on a national scale, of the water reserve's evolution on all dams. It is the most reliable entry point for researching the primary geographical data, their characteristics, and the means of accessing, visualizing, and exploiting them.

- Watershed Agency

Missions. Management of the river basin information system; contribution to the development, evaluation, and updating of hydrographic plans; collection of data on hydrographic basins.

- National Agency for Integrated Water Resources Management

Missions. Conduct surveys and research on integrated water resources and develop integrated water information management systems.

- National Water Resources Agency

Missions. Tasks involved in water and soil resources include prospecting, information collection, monitoring, and preservation/protection against degradation.

Agriculture Institutions

- Department of agricultural services

Energy Institutions

- Sonelgaz and Sonatrach

2.5. Framework conditions

The proposed solutions combine technical, political, and social solutions/measures. The lack of knowledge, especially in the implementation of integrated approaches, such as the WEF Nexus approach, is a relevant limitation in the region. Typically, development continues in a siloed approach. The involvement and engagement of the different local interested stakeholders such as experts and the

ministries are essential to achieve the success of the WEF nexus operationalization in the region and to be able to develop policies, plans, and strategies that consider the Ain Temouchent region system in an integrated way. This would allow for the acceleration of the achievement of the SDGs by 2030, thus ensuring an inclusive and sustainable socio-economic development in the region.

2.6. Monitoring, evaluation, and next steps

The WEF nexus analysis in the Ain Temouchent region can contribute to providing knowledge about the status of the nexus components and their interactions in the region. The nexus approach can be applied considering the role of local experts and stakeholders as essential for co-developing, testing, validating, and refining the WEF nexus analysis in an interactive collaboration. The nexus assessment can support decision-making in developing short-medium-long-term strategies for sustainable integrated resource management in the region itself and others with similar characteristics. The outcomes of the WEF nexus analysis may provide a means to assess progress toward relevant Sustainable Development Goals in the Ain Temouchent region.

3. References

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