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Seawater Desalination in Algeria: A Comprehensive Assessment of its Viability as a Water Security Strategy

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Abstract

This paper investigates Algeria's strategic shift towards desalination to meet water demands. Presently at 17%, desalinated water supply is set to rise to 22% by 2024, aligning with the National Water Strategy (2021-2030) aiming for 60% desalination reliance by 2030. Examining technological advancements and sustainability measures, the study highlights desalination's pivotal role in enhancing water security amid climate change and urbanization challenges. By emphasizing environmental consciousness and cutting-edge technology, Algeria's approach provides a global blueprint for sustainable water management. This research offers essential insights for policymakers, emphasizing the convergence of innovation, environmental stewardship, and socio-economic development in addressing water scarcity.

Keywords : Desalination, water scarcity, National Water Strategy

Jel Classification Codes : L95, Q 53.

Introduction:

In many arid and semi-arid regions of the world, including Algeria, water scarcity is a significant problem. Due to its huge size, rapid population increase, the effects of climate change, and ineffective water management policies, Algeria, one of the largest countries in North Africa, is experiencing rising water stress. The country's coastal regions are especially susceptible to water scarcity, thus creative solutions are urgently needed to guarantee dependable and sustainable water supply.

Seawater desalination has become a viable technology in recent years for increasing freshwater supplies and reducing water scarcity in coastal areas. In order to provide potable water suited for a variety of purposes, seawater must be treated to eliminate salts and contaminants. The installation of desalination projects is accelerating in Algeria as demand for clean water rises.

This scientific paper aims to provide a thorough evaluation of seawater desalination's ability to alleviate Algeria's problems with water security. The study intends to investigate the viability, advantages, and disadvantages of desalination technology in the Algerian environment using a multidimensional analysis. The inquiry will examine the status of the nation's ongoing desalination projects and assess their capabilities, efficacy, and overall influence on the supply and accessibility of water. The study will also look at current developments in desalination technology with an emphasis on methods that are both environmentally friendly and energy-efficient. The project will look into ways to use renewable energy sources to power desalination plants, lowering carbon footprints and operating expenses. Energy consumption is a major challenge in desalination procedures.

An important component of the investigation will focus on the potential environmental effects of desalination on Algeria's coastal ecosystems. Strategies for responsible brine management and reducing ecological disruptions will be investigated, along with the discharge of concentrated brine back into the ocean and its possible consequences on marine life. The research probe will adopt a multifaceted approach, emphasizing economic factors while evaluating the feasibility of large-scale desalination projects in Algeria. In addition to the economic considerations, this study delves into the social ramifications of seawater desalination. It scrutinizes aspects like affordability, equitable water distribution, and community engagement in decision-making processes, while also investigating the impact of augmented water supply on neighboring towns. This holistic examination aims to provide a nuanced understanding of the viability and implications of desalination projects in the Algerian context. In light of the aforementioned discussion, the focus of our efforts will be directed towards resolving the following issue:

How can the implementation of desalination projects help Algeria's water shortage problem?

1- The concept of seawater desalination

Seawater desalination was invented primarily in response to the need for a sustainable and reliable source of freshwater in regions facing water scarcity.

1.1- What is seawater desalination?

The process of purifying saltwater to eliminate dissolved salts and other contaminants in order to provide fresh water fit for drinking, industrial usage, and agricultural irrigation is known as seawater desalination. In areas where conventional freshwater sources are few or insufficient, it is a technologically driven solution to the problem of water shortage. Reverse osmosis, distillation, electrodialysis, and other techniques are used in seawater desalination to separate the salinity of the seawater from the freshwater. In order to supply the rising demand for clean water in dry and coastal regions around the world, the desalination process is essential.

Desalination of seawater is the process of removing salt and other impurities to create potable water. This technology is essential in areas where freshwater sources are scarce or cannot keep up with rising demand. In reverse osmosis, seawater is driven through a semipermeable membrane, enabling only water molecules to pass through, leaving behind the salts and contaminants, desalination plants often use advanced filtering and separation processes like this. The resulting fresh water can be used for irrigation, drinking, industrial processes, and other critical uses, greatly aiding in the management of water resources and promoting sustainable development in areas with limited water resources.

Using a process called seawater desalination, salts and other minerals are taken out of seawater to produce potable water (Farahani & all, 2020, p 05). The method tries to transform seawater—which is plentiful but unfit for direct consumption—into a source of clean, potable water for a variety of purposes. Both distillation, in which saltwater is heated to create steam and subsequently condensed into freshwater, and reverse osmosis, in which seawater is pressed through a semipermeable membrane to separate fresh water from concentrated brine, are common techniques for desalinating seawater. In coastal and desert places all over the world, seawater desalination has emerged as a key solution to the problem of water scarcity and to guarantee a steady supply of water.

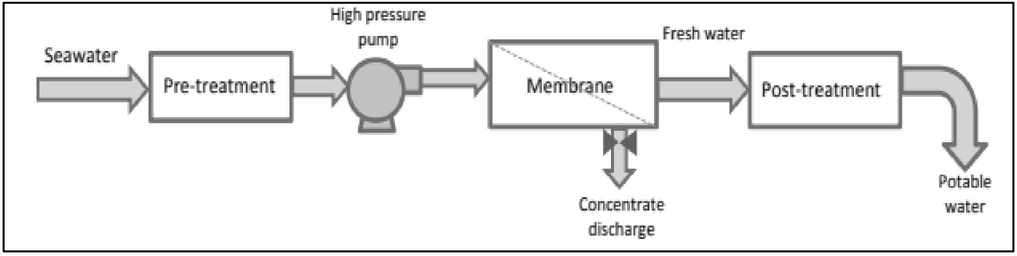
1.2- Classification of Seawater Desalination Methods

In the field of water management, a comprehensive understanding of seawater desalination methods is essential. These techniques, ranging from distillation to advanced membrane processes like reverse osmosis, offer diverse solutions for converting seawater into freshwater. By selecting suitable methods, communities can ensure a sustainable and reliable freshwater supply, addressing the pressing issue of global water scarcity (Farahani & all, 2020, p 05).

I. Reverse Osmosis (RO) Desalination:

In order to render seawater or brackish water suitable for drinking, industrial usage, or agricultural uses, salts and other pollutants are removed by the Reverse Osmosis (RO) desalination process. In areas with little access to freshwater supplies, it is an extensively utilized method for addressing water scarcity.

Fig.1.– Basic process of reverse osmosis



Source: Banat, F. (2007) Economic and technical assessment of desalination technologies. Available from: https://desline.com/Geneva/Banat.pdf [Accessed September 2023].

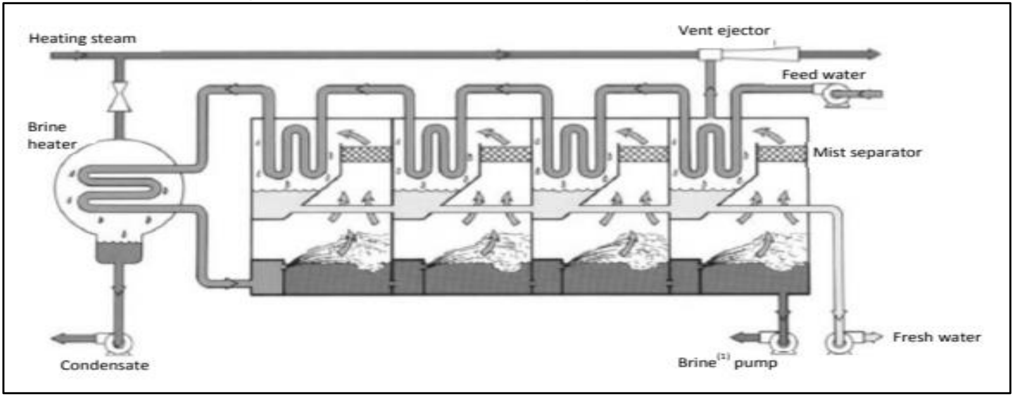
This technology has the following characteristics:

- Production: A sizable RO desalination facility may be able to produce 100,000 cubic meters (100 million liters) of fresh water each day.
- Effectiveness: RO desalination facilities use between 3 and 5 kilowatt-hours (kWh) of energy every cubic meter of freshwater produced.

II. Multi-Stage Flash (MSF) Distillation:

Using heat energy, the thermal desalination process known as Multi-Stage Flash (MSF) distillation turns brackish or seawater into fresh water. This process has been around for a while and is particularly popular in areas with limited access to freshwater. It produces drinkable water from saltwater sources.

Fig.2. Basic process of multi-stage flash evaporation



Source: Banat, F. (2007) Economic and technical assessment of desalination technologies. Available from: https://desline.com/Geneva/Banat.pdf [Accessed September 2023].

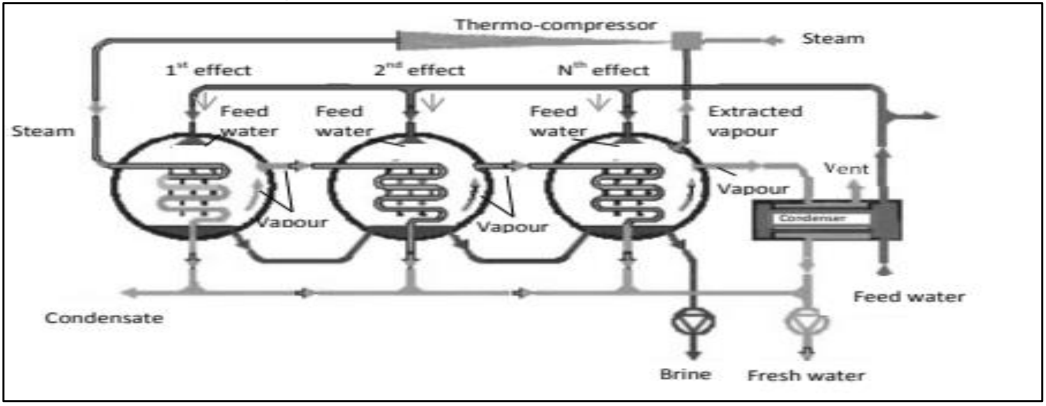
Multi-Stage Flash has the following characteristics:

- Production capacity: An MSF desalination plant may be able to produce 80,000 cubic meters (80 million liters) of freshwater each day.
- Effectiveness: MSF desalination facilities typically use between 9 and 14 kWh to produce each cubic meter of freshwater.

III. Multi-Effect Distillation (MED):

The thermal desalination method known as Multi-Effect Distillation (MED) is used to create fresh water from salty sources like saltwater or brackish water. In areas with a lack of water, MED is an often used technology, particularly when a cheap heat source is available. It works using the concepts of condensation and evaporation in phases, with each stage acting as a distinct "effect.

Fig.3. Basic process of multi-effect distillation



Source: Banat, F. (2007) Economic and technical assessment of desalination technologies. Available from: https://desline.com/Geneva/Banat.pdf [Accessed September 2023].

" Multi-Effect Distillation has the following characteristics:

- Production: A medium-sized MED desalination plant has a daily capacity of 50,000 cubic meters (50 million liters) of freshwater.
- Effectiveness: MED desalination facilities typically use 5 to 8 kWh of electricity every cubic meter of freshwater generated.

Table 1. Comparison of the three major desalination technologies

	RO (membrane-based technology)	MSF and MED (thermal-based technologies)
Strengths	• lower energy requirement • higher water recovery	• relatively simple to operate • capable of producing high-purity water

Weaknesses	• membrane susceptible to fouling • requirement for thorough seawater pre-treatment	• higher energy requirement • lower water recovery

Source: Banat, F. (2007) Economic and technical assessment of desalination technologies. Available from: https://desline.com/Geneva/Banat.pdf [Accessed September 2023].

IV. Electrodialysis Desalination (ED):

In order to make water appropriate for various applications, such as the manufacture of drinking water and industrial processes, salts and other charged ions are removed from the water using the electrochemical process known as electrodialysis (ED) desalination. Ion-selective membranes and the use of an electric field are key components of ED desalination, which uses them to separate ions from water. Electrodialysis (ED) Desalination has the following characteristics:

- Production: An ED desalination plant may be able to produce 30 million liters (30,000 cubic meters) of freshwater each day.
- Effectiveness: ED desalination units typically use 2 to 4 kWh to produce 1 cubic meter of freshwater.

It's vital to keep in mind that these figures are fictitious and intended to illustrate the typical capacities and efficiency ranges of various desalination processes. Desalination plants' actual capacities and energy requirements can vary greatly depending on a variety of factors, including the size of the plant, its location, recent technological developments, and its particular operational circumstances. Desalination will become a more viable option to meet freshwater demands in water-scarce locations as technology advances and desalination processes become more efficient and cost-effective.

2- Seawater Desalination Globally

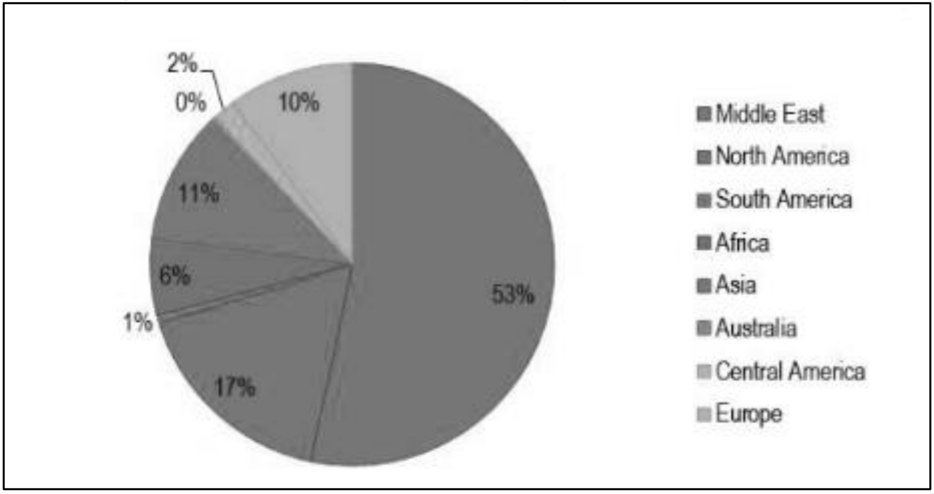
Seawater desalination is a common procedure in many parts of the world, especially in places where freshwater sources are few or nonexistent. Here are some rough figures and statistics about seawater desalination around the world:

I. **Capacity**: Around 100 million cubic meters per day (Mm3/d), or 100 billion liters per day (Bld), was thought to be the installed capacity of all seawater desalination plants globally. Hundreds of desalination units operating in many nations together make up this capacity.

II. **Significant Desalination Users**: Desalination is a major source of water for some nations. Examples worth mentioning are Saudi Arabia With an estimated capacity of more than 5 Mm3/d, Saudi Arabia is one of the biggest users of desalination followed by an Another important customer which is the United Arab Emirates (UAE), which has a capacity of about 4 Mm3/d, the UAE operates some of the largest desalination plants in the world for example the Jebel Ali Desalination Plant in Dubai, for example, has a capacity of over 470 million gallons (approximately 1.8 million m^3) of freshwater per day. we can mention the USA also Particularly in states with a capacity of above 4 Mm3/d, such as California, Florida, and Texas and To clarify further The Claude "Bud" Lewis Carlsbad Desalination Plant in California is one of the largest seawater desalination facilities in the Western Hemisphere, producing approximately 50 million gallons (over 189,000 m^3) of freshwater per day (Konstantinos Zotalis & all, 2014, p 1135).

III. **Regional Distribution**: Due to its arid climate and scarcity of freshwater supplies, the Middle East, particularly the Arabian Gulf region, is the industry leader in seawater desalination. North Africa, Southern Europe, and portions of Asia are other areas with sizable desalination capabilities (Konstantinos Zotalis & all, 2014, p 1135)..

Fig.4. World desalination plants per geographical area (%)



Source: Konstantinos Zotalis & all, (2014), Desalination Technologies: Hellenic Experience, water, vol 06, p 1136

IV. **Growth Trend:** Over time, seawater desalination has increased steadily as more nations examine and carry out desalination projects to address issues with water scarcity. Global desalination capacity was predicted to grow by 3-4% yearly in 2019.

V. **Energy Consumption:** For every cubic meter of freshwater produced, saltwater desalination plants use on average 3 to 5 kilowatt-hours (kWh) of energy. The energy footprint of desalination is being diminished, nevertheless, because to improvements in energy-efficient technology and the utilization of renewable energy sources.

VI. **Desalination by Reverse Osmosis:** With about 60% to 70% of the world's total desalination capacity, reverse osmosis is the predominant desalination technique. It is more popular since it uses less energy than thermal desalination techniques.

3- Seawater desalination & sustainable development

The economy has suffered as a result of water stress in a coastal area that is dealing with acute water scarcity. The region relied heavily on diminishing freshwater resources prior to the advent of saltwater desalination, which led to a 20% decrease in agricultural yields, a 15% decrease in industrial output, and a 10% decrease in regional GDP. Due to job losses in the agricultural and industrial sectors, high unemployment rates and poverty levels were widespread. Additionally, the environment was harmed because decreasing river flows damaged aquatic ecosystems and groundwater overpumping caused land subsidence.

The area underwent a radical change after the installation of a cutting-edge saltwater desalination plant with a 50 million cubic meters (m3) yearly freshwater production capability. This new water source not only eliminated the water shortage but also increased agricultural yields by 10%, industrial production by 20%, and the region's GDP by an astounding 15%. 5,000 new jobs were created by the revived economy, which also helped to lower unemployment and raise living standards. In addition, the environment benefited from less stress on rivers and groundwater, which led to aquifer levels being restored and healthier river ecosystems.

In this case, the implementation of seawater desalination resulted in a number of substantial gains, illustrating the technology's ability to advance sustainable development by addressing water scarcity, fostering economic growth, and enhancing environmental health.

3-1 The economic impact Seawater desalination

Seawater desalination can have significant economic impacts, both positive and negative, depending on various factors such as location, technology used, energy costs, and the overall water demand and supply situation in the region (Veera

Gnaneswar Gude, 2016, p 91). Some of the key economic impacts of seawater desalination include:

I. Job Creation:

- Large desalination projects can generate significant employment opportunities. For example, during the construction phase of a 100,000 m³/day desalination plant, it may employ 300-500 workers directly and create additional indirect jobs in related industries.
- Ongoing operation and maintenance of such a facility may require 50-100 skilled workers.

II. Local Economic Growth:

- The capital investment required for a desalination plant can range from $100 million to over $1 billion, depending on capacity and technology.
- This investment stimulates local economies through purchases of construction materials, equipment, and services, as well as payments to local labor forces (Ihsanullah Ihsanullah & all, 2021, p 146585)..

III. Infrastructure Investment:

- The construction of desalination plants necessitates infrastructure development. For instance, pipelines and distribution networks might cost $20 million to $100 million or more, depending on the project's size and complexity.
- These infrastructure investments create jobs and boost local construction industries.

IV. Cost of Desalinated Water:

- The cost of desalinated water typically varies from $0.50 to $3 per m³, depending on factors like energy prices and technology efficiency.
- Large-scale desalination plants with efficient processes tend to have lower water production costs.

V. Revenue Generation:

- Desalination facilities can generate revenue by selling excess freshwater. For example, a plant producing 100,000 m³/day may sell surplus water to neighboring regions or industries, generating several million dollars in annual revenue (Ihsanullah Ihsanullah & all, 2021, p 146585).

3.2- Seawater desalination social impact

Desalination of seawater can have a variety of social effects on groups of people and societies, both good and bad. Access to water resources, the cost of desalinated water, community involvement, and environmental concerns all have an impact on these effects. Some of the major social effects of seawater desalination are listed below:

Table 2. The major social effects of seawater desalination

Improved Access to Clean Water	In areas with limited water supplies, seawater desalination can offer a dependable source of hygienic and secure drinking water. By lowering the danger of waterborne illnesses and enhancing general health, this can considerably benefit public health.
Water Security	By reducing reliance on unpredictable rainfall or depleting groundwater and diversifying water sources, desalination improves water security. By maintaining constancy in the water supply, the community may feel more secure and worry less about running out of water.

Community Resilience	Communities may withstand droughts and other water-related crises with the aid of seawater desalination, which also guarantees a steady water supply in times of shortage. This resilience can encourage sustainable growth and lessen the demand for emergency water supplies.
Economic Opportunities	Desalination plant construction and operation can generate employment opportunities and boost the local economy. Increased employment prospects in plant building, operation, maintenance, and allied industries may be advantageous to the local community.
Equity and Social Justice	Water scarcity in some areas disproportionately impacts weaker populations. If planned and carried out carefully, seawater desalination facilities can reduce water inequality and provide fair access to clean water for all societal members.

Source: Veera Gnaneswar Gude (2016) Desalination and sustainability – An appraisal and current perspective, Water Research, 89 (01), p 92.

Stakeholders must interact with local people, conduct rigorous environmental and social impact analyses, and develop inclusive and sustainable water management methods in order to address the social effects of seawater desalination. Desalination operations can be integrated with other water supply methods, such rainwater collection and water recycling, to create a more thorough and ethically sound strategy for managing water resources.

3.3- Seawater desalination environmental impact

When developing and carrying out desalination projects, it is important to carefully assess the potential environmental effects of seawater desalination (Veera Gnaneswar Gude, 2016, p 92). The following are the primary environmental issues raised by seawater desalination:

I. Marine Ecosystem Disturbance: Marine ecosystems may be harmed if seawater is used for desalination. Plankton, fish larvae, and other small marine life can become trapped in and harmed by the high quantities of water pulled into the desalination plant. The biodiversity and local food webs may be impacted in a cascade manner by this (Ihsanullah Ihsanullah & all, 2021, p 146585).

II. Brine Discharge: A byproduct of the desalination process called concentrated brine is released back into the ocean. The brine contains additional chemicals required in the desalination process and is frequently significantly saltier than the nearby saltwater. Ecosystems and marine life nearby the discharge point might be harmed by improper discharge techniques.

III. Energy Consumption: Seawater desalination requires a lot of energy, and the type of energy utilized may have an impact on the environment. When power for desalination is produced using fossil fuels, this can increase air pollution and greenhouse gas emissions, which will worsen the effects of climate change.

IV. Habitat Destruction: Desalination plant development, along with the associated infrastructure, has the potential to modify and destroy habitat. The construction could have an impact on coastal ecosystems including mangroves and wetlands, which would result in the loss of crucial habitat for many different species.

V. Land Use and Water Footprint: Desalination facilities may require considerable changes to the coastline and demand a sizable amount of land. Brine production and seawater extraction can also affect the regional water balance and change the behavior of coastal groundwater aquifers (Ihsanullah Ihsanullah & all, 2021, p 146585)..

VI. Intertidal Zone Disturbance: Intertidal zones, which are environmentally delicate regions where land meets the sea, can be disturbed by seawater intake and discharge systems. Diverse marine creatures depend on these zones as critical habitats, and their disruption may have a harmful effect on nearby ecosystems.

Improved saline disposal techniques, the utilization of renewable energy sources, the deployment of fish-friendly intake systems, and cautious site selection to avoid impacts on delicate coastal areas are all attempts to solve these environmental concerns. Desalination technology is constantly being improved and researched with the goal of minimizing the environmental impact of these facilities without compromising their ability to supply crucial freshwater sources to areas with a shortage of water.

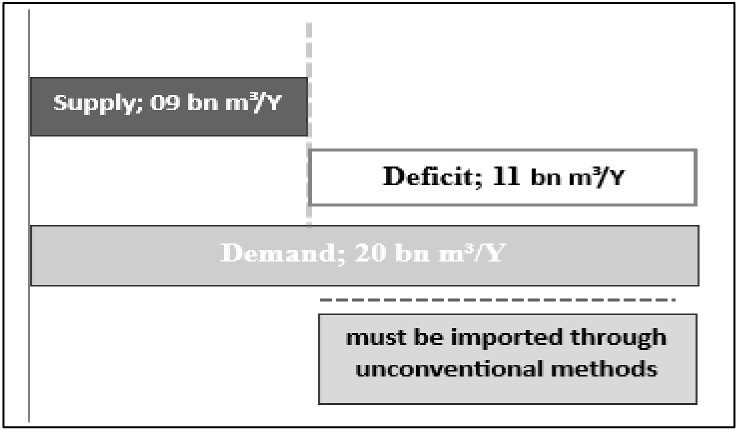
4- The Role and Positioning of Water Desalination in Algeria's National Water Resources

According to Article 2 of Law No. 05-12 dealing to water, which was passed on August 4, 2005, the provision of potable water to the people in sufficient quantities and at the requisite quality constitutes a key component of the national water policy. In light of this, the Algerian government is making great efforts to fulfill 60% of the country's drinking water needs by the year 2030 using seawater desalination methods.

4.1- Supply and demand for water in Algeria

Recent data released by the Ministry of Water Resources in Algeria reveals a concerning disparity between water supply and demand. The nation can reliably provide 9 billion cubic meters of water annually from conventional sources, whereas the current demand exceeds 20 billion cubic meters annually (AitMimoune Hamiche & all, 2018, p 28). This widening gap places Algeria among countries grappling with water scarcity issues, classifying it as a nation experiencing water poverty.

Fig.5. The imbalance between supply and demand for water in Algeria



In this complex scenario, Algeria's water resources allocation plays a pivotal role. A substantial 70% of the available water supply is dedicated to the agricultural sector, crucial for sustaining vital farming activities. The remaining 30% is split between residential and industrial usage, catering to the fundamental needs of households and businesses. However, official statistics indicate challenges in water distribution, evident in the declining per capita allocation from 500 cubic meters to 450 cubic meters. This decrease underscores the strain on existing water resources, emphasizing the urgent need for efficient water management practices (AitMimoune Hamiche & all, 2018, p 28).

Further exacerbating the situation is the agricultural sector, the largest consumer of water, where only 17% of cultivated lands are irrigated. This stark statistic highlights the necessity for optimizing irrigation methods and advocating water conservation techniques. A strategic and comprehensive approach becomes imperative, necessitating efficient water distribution, the promotion of water-saving technologies, and the encouragement of sustainable agricultural practices (AitMimoune Hamiche & all, 2018, p 30). By striking a balance between various sectors and implementing innovative water management strategies, Algeria can endeavor to ensure a stable and equitable water supply for its burgeoning population and diverse economic activities.

4.2- Evolution of desalination programs in Algeria

In response to the evolving dynamics of water supply and demand, the Algerian government has significantly augmented its investments in the desalination industry, a strategic imperative dictated by the exigencies of the situation. Between 2005 and 2021, a total of 14 desalination facilities were meticulously commissioned, fostering a collaboration between governmental entities and private investors. These facilities, boasting a combined production capacity of 2,090,000 cubic meters per day, represent a concerted effort to address the escalating demands for fresh water through technologically advanced and sustainable means.

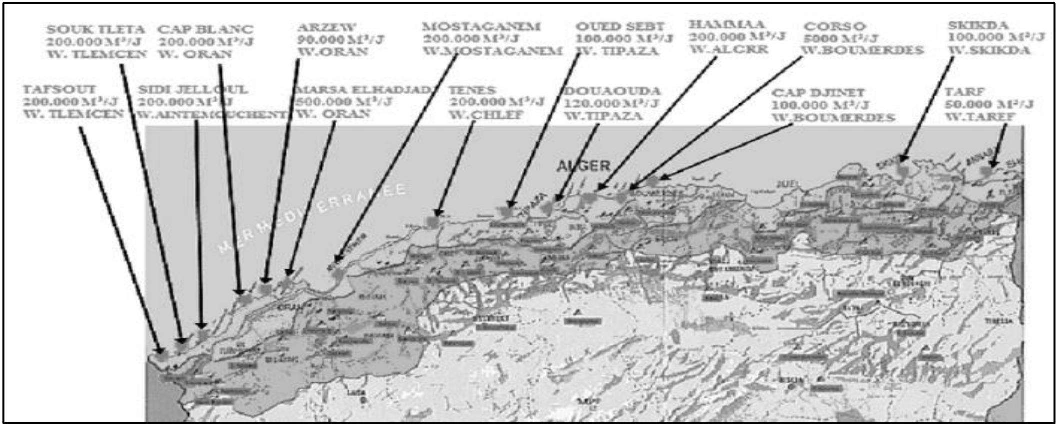
Table 3. Table Desalination plants in Algeria between 2005-2021

Location	**m³/day**	**Process**	**Commissioning**
Chlef (Tenes)	200 000	RO	2015
Tlemecen (Souk Tleta)	200 000	RO	**2011**
Tlemecen (Honaine)	200 000	RO	**2012**
Alger (Hamma)	200 000	RO	**2008**
Alger (Staouali)	5000	RO	**2021**
Alger (Ain El Benian)	10 000	RO	**2021**
AinTemouchent (BeniSaf)	200 000	RO	**2009**
Oran (Kahrama)	90 000	MSF	**2005**

Oran (Bousfer)	5500	RO	**2005**
Oran (maktaa)	500 000	RO	**2016**
Skikda	100 000	RO	**2009**
Mostaganem	200 000	RO	**2010**
Boumerdes (Cap Djinet)	100 000	RO	**2010**
Tipaza (DouaoudaFouka1)	200 000	RO	**2008**

Source: Youcef Himri & all (2022) Overview of the Role of Energy Resources in Algeria's Energy Transition, Energies, 15 (4731), p 11.

Fig.6. The geographic distribution of desalination plants

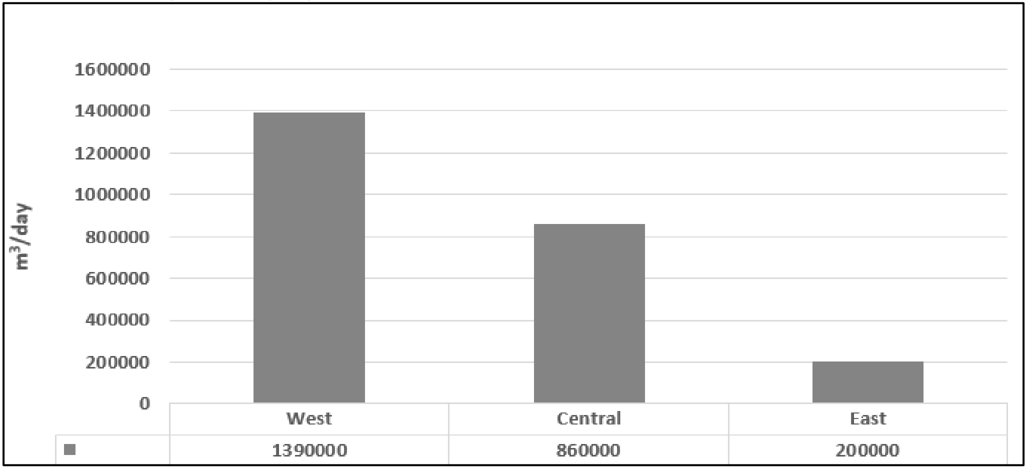


Source: Youcef Himri & all (2022) Overview of the Role of Energy Resources in Algeria's Energy Transition, Energies, 15 (4731), p 11.

The placement of desalination plants in Algeria correlates with the severity of damage caused primarily by drought. About 70% of these plants are situated in the western regions, which have historically suffered significant damage due to prolonged dry spells. Another 20% is allocated to central areas, where the impact of drought has been notable, albeit to a lesser extent. The remaining

10% of desalination plants are concentrated in the eastern part of the country, indicating the efforts to address water scarcity in areas affected by the adverse consequences of drought (Nadjib Drouichea & all, 2022, p 90).

Fig.7. The geographic distribution of desalination plants production



This distribution strategy underscores the government's commitment to mitigating the damage caused by water shortages, ensuring that desalinated water resources are allocated proportionally to regions facing the most significant challenges from drought.

5- Prospects and Challenges in Algeria's Water Desalination Industry

In the initial phase of its program, the Algerian government's goal is to expand the number of seawater desalination plants to 19 by 2024. As part of this effort, 11 plants have already been completed along the coastline, boasting a collective daily production capacity of 2.11 million cubic meters. Additionally, within the emergency plan framework, the government has successfully finished constructing three more stations, each capable of producing 70,000 cubic meters of water per day. These accomplishments mark significant strides toward ensuring a more stable and substantial supply of clean water for the country (Nadjib Drouichea & all, 2022, p 91).

5.1- Focusing on major projects

Since 2021, the Algerian government has been rapidly building five major desalination plants in key states: TARF, Bejaia, Boumerdes, Tipaza, and Oran. Each plant can produce 300,000 cubic meters of water daily. This urgent initiative aims to address water scarcity in these areas, especially in densely populated cities and important industrial regions. By strategically placing these plants, Algeria is ensuring a more stable and equitable water supply, catering to both current and future needs. This effort reflects the government's commitment to securing clean water for its citizens.

Table 4. Development in Production between 2020 & 2024

	%	**Production** (m³/day)
2020	**30**	**2 100 000**
2022	**40**	**2 310 000**
2024	**60**	**3 300 000**

Algeria's water landscape is undergoing a transformative shift, marked by a significant investment in desalination projects. Official data reveals that presently, 17% of the nation's water requirements are met through desalinated water sources. However, the government's ambitious plan outlined in the National Water Strategy (2021-2030) showcases a progressive roadmap. By 2022, this figure is slated to rise to 22%, indicating a rapid escalation in desalination infrastructure.

The core objective of the National Water Strategy is striking: to fulfill up to 60% of Algeria's drinking water needs through desalination by 2030. This visionary approach not only reflects the government's commitment to ensuring water security for its citizens but also acknowledges the pressing challenges posed by climate change, population growth, and increasing urbanization.

This strategy represents a holistic commitment, embracing cutting-edge technology, sustainable practices, and a comprehensive understanding of environmental implications. Desalination, once a novel solution, is now the cornerstone of Algeria's water security paradigm. As the nation progresses towards 2024, where 42% of its water needs are anticipated to be met through desalination, the landscape of water accessibility and availability is poised to undergo a revolutionary transformation.

This strategic shift is not merely a numerical goal but signifies a pivotal change in how Algeria approaches its water resources. By harnessing the vast potential of its coastal proximity, Algeria is embracing innovation and sustainability. This shift is not only about meeting immediate needs but also ensuring resilience in the face of future challenges. The strategy stands as a testament to the nation's forward-thinking approach, reflecting a blend of environmental stewardship, technological advancement, and a profound commitment to the well-being of its citizens. As Algeria moves towards 2030, the journey towards meeting 60% of its drinking water needs through desalination represents a beacon of progress and a model for sustainable water management on the global stage. In light of the foregoing analysis, it is evident that:

- The policy involves building large centralized water stations for high production, instead of smaller distributed stations producing less than 100,000 m3/day. This concentrates production in drought-affected areas, streamlining maintenance and network control. However, a drawback is fluctuating daily water distribution due to necessary station equipment maintenance.
- The shift involves transitioning from partnership agreements to self-construction. The Algerian Energy Company, owned by "Sonatrach", now handles study, construction, and operation tasks. This marks a departure from previous years when the government relied on partnerships with international institutions and joint capital.

The government aims to reduce construction costs and total/unit production costs per cubic meter through this approach.

- **5-2 The problem of the contradiction between social and economic pricing of water**

The issue of aligning social and economic pricing of water in Algeria poses a complex challenge, requiring careful examination. The Algerian government's policy of subsidizing essential commodities, including water, reflects its commitment to ensuring affordable access to this vital resource. However, the current pricing structure, as stipulated by Law No. 05-13 of 2005, leads to a significant financial deficit, exacerbated by network problems where 40% of water goes unaccounted for.

Specifically, the Algerian government incurs a loss of $0.7 for every cubic meter of water produced, even when factoring in exchange rates. This economic shortfall, combined with a daily loss of $1,700,000 at prevailing production levels, emphasizes the urgency for a comprehensive solution. While the current expenditure might be justified in the short term due to exigencies, it jeopardizes the nation's economic sustainability in the long run.

Addressing this challenge requires a nuanced approach, balancing social needs and economic realities. A recalibration of policy frameworks, informed by thorough empirical research, is essential to bridge the gap between societal imperatives and economic viability in water pricing policies.

Conclusion

In the realm of Algerian water resource management, the National Water Strategy stands as a paramount initiative, delineating a visionary objective: to fulfill a substantial 60% of the nation's drinking water needs through desalination by the ambitious deadline of 2030. As of the current trajectory, with an impressive 42% of water needs projected to be met through desalination by 2024, Algeria is poised for a transformative shift in the landscape of water accessibility and availability. This strategic pivot not only reflects a proactive response to the pressing challenges of water scarcity but also signifies a pivotal step toward ensuring water security on a national scale.

However, amid these promising advancements, the financial aspect presents a notable challenge. The revelation that the Algerian government incurs a significant financial loss, estimated at $0.7 for every cubic meter of water produced, underscores the economic complexities associated with large-scale desalination projects. This economic inefficiency raises crucial questions about the fiscal sustainability and cost-effectiveness of desalination as a predominant water supply solution. Addressing this economic quandary demands meticulous financial planning, innovative economic models, and perhaps international collaborations to optimize operational costs and mitigate financial losses.

In light of these considerations, the successful integration of desalination into Algeria's water supply infrastructure necessitates a multifaceted approach. It mandates not only the resolution of economic challenges but also rigorous attention to environmental sustainability, socio-economic equity, and technological advancements. Emphasizing comprehensive research, policy refinements, and effective governance mechanisms will be instrumental in navigating these complexities. Furthermore, fostering international collaborations for knowledge exchange, technological innovation, and financial support can enhance Algeria's desalination endeavors.

In conclusion, while Algeria stands at the threshold of a transformative era in water resource management, marked by significant strides in desalination technology and policy formulation, the journey towards achieving the objectives outlined in the National Water Strategy demands persistent academic inquiry, meticulous financial strategies, and a steadfast commitment to environmental stewardship. Through strategic interventions, collaborative efforts, and innovative approaches, Algeria can not only overcome the challenges posed by its current desalination initiatives but also pave the way for a sustainable and water-secure future for its citizens.

Bibliography List :

1. AitMimoune Hamiche, A. Boudghene Stambouli, S. Flazi, A. Tahri H. Koinuma (2018) Desalination in Algeria: Current State and Recommendations for Future Projects, Thermo-Mechanics Applications and Engineering Technology- Spriger pub.
2. Australian Department of the Environment. (2002) Introduction to Desalination Technologies in Australia. Available from: https://www.dcceew.gov.au/sites/default/files/documents/desalination [Accessed September 2023].
3. Banat, F. (2007) Economic and technical assessment of desalination technologies. Available from: https://desline.com/Geneva/Banat.pdf [Accessed September 2015].
4. Ihsanullah Ihsanullah, Muataz A. Atieh, Muhammad Sajid, Mazen K. Nazal (2021): Desalination and environment: A critical analysis of impacts, mitigation strategies, and greener desalination technologies, Science of The Total Environment, vol 780, p 146585.
5. Konstantinos Zotalis, Emmanuel G. Dialynas , Nikolaos Mamassis and Andreas N. Angelakis (2014), Desalination Technologies: Hellenic Experience, water, vol 06, pp 1134-1150.

6. Lahmeyer International GmbH. (2003) Water Desalination. Available from: http://www.uwphoto.de/Dateien%20Info%20+%20Kontakt/desalinationbrochure.pdf [Accessed September 2023].
7. Nadjib Drouichea, Omar Rodriguez Villarrealb, Sara Ouali, Seif El Islam Lebouachera, Richa Soni (2022) Role of desalination technologies and water reuse in Water-Energy-Food nexus: an opportunity for Algeria, Desalination and Water Treatment, 261, pp 83-93.
8. Veera Gnaneswar Gude (2016) Desalination and sustainability – An appraisal and current perspective, Water Research, 89 (01), pp 87 -101
9. Youcef Himri, Shafiqur Rehman, Ali Mostafaeipour, Saliha Himri, Adel Mellit, Merzouk & Nachida Kasbadji Merzouk (2022) Overview of the Role of Energy Resources in Algeria's Energy Transition, Energies, 15 (4731).