

Water Resources in Algeria: Factors of the Problem and the Adopted and Possible Solutions

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Abstract

The importance of studying the subject of water resources in Algeria has emerged due to several social and natural factors. These include the significant increase in demand for this valuable and strategic resource for development, as well as the decline in water reserves due to irregular climatic conditions (drought), increased agricultural water usage, and the absence of rational, sustainable, effective, and efficient management. Additionally, the relative rise in population growth has led to increased consumption of drinking water and increased water pollution due to industrial waste and environmental degradation from various economic activities in general. All these factors highlight that the water problem in Algeria manifests differently across regions. Therefore, as a result of these factors, it is necessary to reconsider the water resources management plan by developing an effective and purposeful national water strategy to preserve these resources, ensure their sustainable and efficient use, and meet the requirements of the principle of sustainable development. This should also take into account the economic cost of water and ensure sustainable human development.

Keywords: Water, Water Strategy, Water Resources

Jel Classification Codes : Q25; Q55

1. Introduction :

Algeria is characterized by a diversity of surface and groundwater resources. Given its vast area and geographical, natural, and topographical diversity, water issues become more acute due to the climatic characteristics of most regions in Algeria, which range from arid to semi-arid, resulting in scarce water availability. Surface water is limited, mainly concentrated in the northern part of the Atlas Mountain range, estimated at about 20 billion cubic meters, with only 75% of it being renewable and 25% comprising non-renewable water resources in the northern Sahara. The number of surface water streams in Algeria is estimated at around 30, most of which are in the Tell region and flow into the Mediterranean Sea. These streams are characterized by their irregular flow, with a capacity estimated at about 12.4 billion cubic meters. The other streams are irregular and seasonal.

Since independence, the water resources sector in Algeria has undergone several stages reflecting the water policy pursued by the Algerian state. This is evident through development programs and plans, including laws aimed at providing adequate protection for this precious resource. However, mismanagement and exploitation by successive officials on one hand, and on the other hand, population growth exacerbating the crisis due to increased demand for water to meet household, industrial, and agricultural needs.

The water sector in Algeria has witnessed significant development in terms of large-scale projects aimed at securing the supply of safe drinking water to the population and other sectors, and avoiding the water crisis that the country experienced in the 1990s, caused by drought. Approximately \$20 billion has been allocated to this sector financially.

By the late 1990s, the state initiated a radical change in its water policy, based on dividing the national territory into a set of hydrographic (Ordinance, 1996) basins and establishing, for the first time, a ministry responsible for water (Executive Decree, 2000) resources. Its mission is to continuously study and evaluate water resources in quantity and quality, and to implement and develop appropriate policies to correct imbalances and confront future challenges.

The problem of the study: This study aims to answer the following fundamental question: What are the factors constituting the problem of water resources in Algeria, and the adopted and potential solutions?

To address the problem of this study, the subject was divided into the following axes:

The First Axis: Factors of the Water Issue in Algeria

The Second Axis: the Solutions Adopted and Possible for the Water Problem in Algeria

In order to answer the posed problem, the historical and descriptive analytical approach will be used.

2. The First Axis: Factors of the Water Issue in Algeria

- **The Natural Factors**

First: Topographical nature

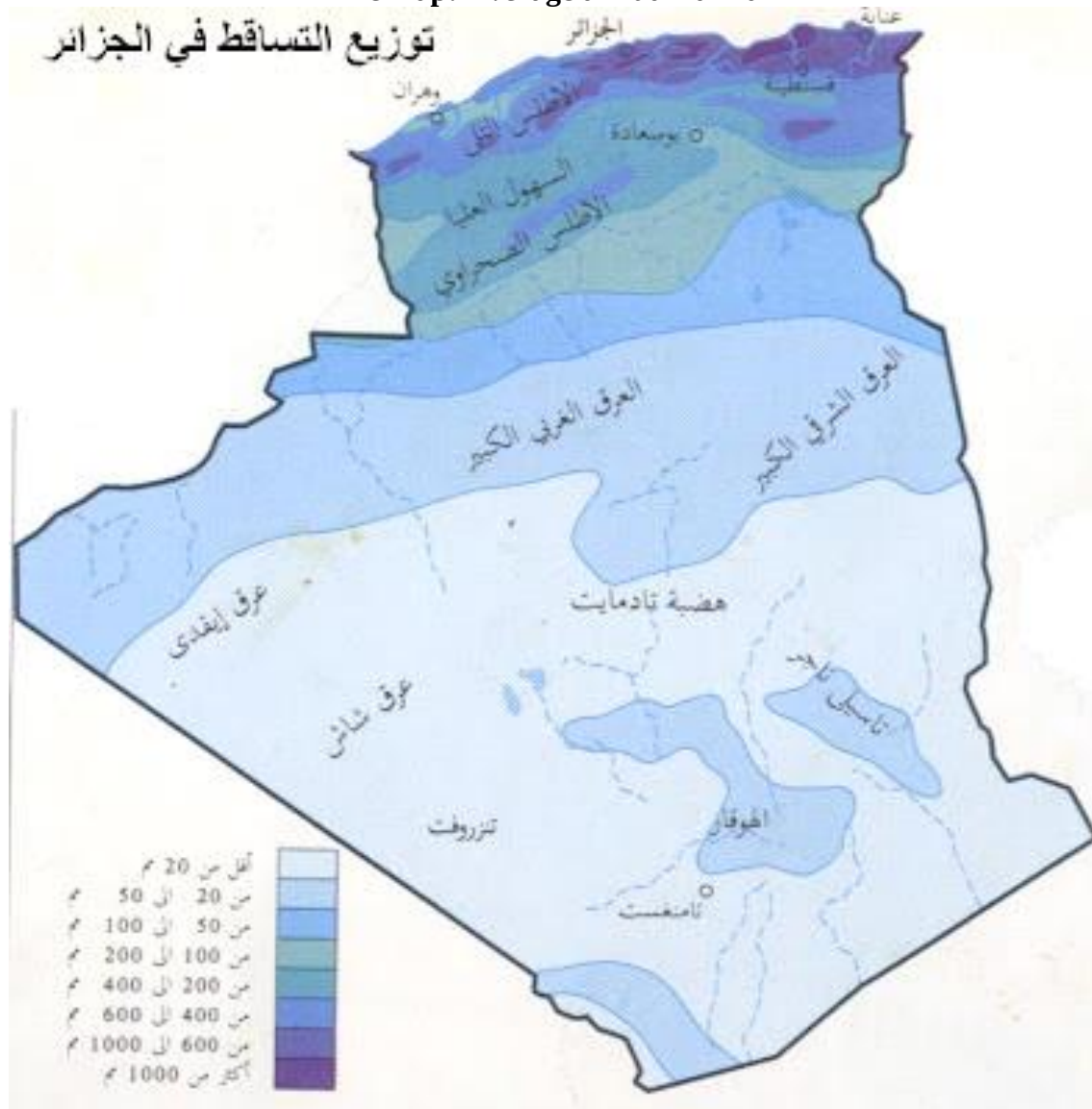
- **Geography:** Algeria is the largest country in Africa with an area of 2,381,741 square kilometers. It is close to the equator, located between latitudes 18° and 38°, and longitudes 9° west and 12° east. Northern Algeria has a recent tectonic formation and southern Algeria (Boufatit Abdelaziz , 1998), the Saharan region, has an ancient structure. The landscape varies from north to south, transitioning from rugged terrain and surface features to two distinct regions: (Despois, J., & Raynal, R ,1975)

A. The Northern Region: It is a hilly range in the north consisting of two parallel mountain ranges stretching for 1000 km from east to west, interspersed with a series of coastal plains. To the south of it lies a range of the Saharan Atlas, separated by internal plains and high plateaus.

B. The Southern Region (Desert): It is characterized by a predominantly low-lying tropical surface, with the desert covering an area of approximately 2,000,000 square kilometers. The Algerian desert can be divided into four regions:

- The northeastern depression, which features salt flats such as Chott Melrhir that is 35 meters below sea level.
- The rocky plateau area on the northern edges and in the center around the Hoggar Highlands (such as **the Tadmit Plateau**) with an elevation of 762 meters.
- Erosional plains covered with sand, which occupy the largest area in the desert.
- The elevated mountain ranges in the southeastern corner are the Hoggar Mountains, with the highest peak being "Mount Tahat Atakor," which reaches an elevation of 2918 meters.
- **Climate:** Algeria encompasses three distinct climatic regions. The Mediterranean climate covers the northern coastal edges, accounting for 4% of the country's total area. This region is characterized by relatively high humidity, with cold, rainy winters and hot, dry summers. It receives the highest amount of annual rainfall, with an annual average ranging between 600 and 1200 mm. However, this amount varies from season to season and year to year, especially with the emergence of the issue of climate change. In the central part of the country, there are semi-arid highlands that feature a semi-dry continental climate, combining characteristics of both wet and dry climates, with an annual rainfall ranging between 400 and 600 mm. This is a transitional climate zone, where about two-thirds of the arable land is concentrated. Meanwhile, the desert climate dominates the majority of the country, occupying 87% of the total area, located in the south. This region is characterized by high thermal amplitude and scarce rainfall, with an annual average of less than 200 mm. (FAO,2015)

The map: Average annual rainfall



Source: Mosbahi Z, 2019. Algeria Country Commercial Guide: Algeria – Public Works, Infrastructure Development, and Water Resources <https://water.fanack.com/ar/algeria>

Second: Drought status

- **The concept of climatic drought**

Drought is a natural phenomenon associated with weather conditions, occurring due to a decrease or absence of rainfall in a specific region compared to its average, often linked to rising temperatures and increased evaporation rates. This leads to a decline and scarcity of water resources, resulting in negative impacts on the ecosystem and agriculture. Drought periods can last several months or even years. There are three main types of drought: meteorological drought, agricultural drought, and hydrological drought, with meteorological drought being the controlling factor for the other two types. (Hajla Ali , 2015)

Climate Drought in Algeria

Algeria has been experiencing a severe drought for the past three years, with the most intense period being the summer of 2021. This situation has led to a reduction in the storage capacity of existing dams by 80% of their total capacity and has depleted groundwater resources. There is also a crisis in the supply of potable water in at least 10 provinces in northern and central regions of the country. The beginning of the winter season in 2023 was characterized by low precipitation rates and a continuous increase in temperatures, clearly indicating the onset of drought. According to climate experts, Algeria is expected to experience a decrease in rainfall by about 5% to 13% and an increase in temperature by 0.6°C to 1.1°C by 2025. (Ghergheb, M., & Ferhat, 2021)

Third: Limited Water Resources

Algeria is characterized by limited, irregular, and unevenly distributed natural water resources, estimated at approximately 19.2 billion cubic meters per year. Of this amount, 13 billion cubic meters are in the northern region, while 5.2 billion cubic meters are in the southern region.

One of the most important sources of natural water resources is rainfall, which varies from one region to another. The average annual rainfall across the country is about 12.4 billion cubic meters, with 85% of this amount being subject to evaporation and the remaining 15% representing the available water resources (Ministry of Regional Planning and Environment, 2001). This includes surface water resources (12.4%) and groundwater resources (2.6%).

Since 2021, Algeria has been hit by a severe drought, the most significant in nearly three decades, leading to a reduction in the levels of the country's reservoirs. This has caused a scarcity of potable water, forcing provincial water management departments to reduce the water supply program for neighborhoods and homes to once every two days. Some provinces have experienced water shortages lasting from 15 days to a full month.

Demographic and Economic Factors

Demographic and economic factors play a significant role in the increasing rates of water resource usage. The relationship between these factors is directly proportional. The growing demand for water is linked to urban expansion, the development of economic activities, and water consumption services (such as agriculture, industry, and tourism).

Firstly: Increased Domestic Demand

Providing adequate and high-quality potable water to the population is a fundamental part of the national water policy (According to Article 2 of Law 05-12, 2005). Demographic growth in Algeria is a significant factor affecting the increase in drinking water consumption, and consequently, the demand for freshwater resources for purposes such as drinking, cooking, and domestic use. A study conducted by the National Water Resources Agency on the quality of consumed water revealed that 40% of it is of good quality, 45% is of satisfactory quality, while 15% is of poor quality. (Salous, Mubarack, 2003)

Table (1): Development of Housing Connection Rates to Potable Water Supply Networks

2019	2015	2014	2012	2010	1999	Years
4300 0	3954 3	3876 0	37260	35856	3034 6	³ 10Population Count
10	3.6	3.6	3.0	2.75	1.25	Volume of Drinking Water (in billion cubic meters)
180	175	172	170	168	123	Daily Supply Rate (in liters/day per person)
98	98	97	95	92	78	Connection Rate (%)

Source : (Source: Amal Younes, 2016) <https://www.echaab.dz/2024/01/3>

Despite the fact that 90% of households in Algeria are connected to the national water supply network, there remains a significant disparity between urban and rural areas. In urban areas, 95% of households are connected, while only 70% of households in rural areas have access to water taps and face interruptions in water supply due to leaks and faults in the network. (<https://www.aps.dz/ar>)

Secondly: Increased Agricultural Demand

The agricultural sector in Algeria alone consumes about 66% of the water resources drawn from rivers, lakes, and groundwater basins, necessitating a serious exploitation of wastewater. (Nawal Baghli Merabet, 2020) Agriculture in Algeria relies heavily on traditional techniques, primarily dry farming, where farmers depend on seasonal rainfall to cultivate crops and meet their agricultural needs. This is especially true for cereal crops in the northern regions of the country.

In this context, Professor Ahmed Kettab (Ahmed Kettab ,2020), an international expert in water and environment, confirmed that studies and research on water resources have found that 8,000 cubic meters of water per hectare are lost annually in Algeria due to traditional irrigation. Additionally, 50% of the water used in drip irrigation is wasted and does not benefit the crops. (Africa News , www.echaab.dz/31/01/2024)

Increasing Industrial Demand

The industrial sector is considered the second-largest consumer of water after the agricultural sector in many countries. It has been found that 20% of the fresh water used globally goes to industrial use. This includes: (Ministère de l'Aménagement du territoire et de l'environnement, 2001)

- **Simple use that does not alter the chemical composition of water:**

This involves using water in power generation plants, where water is primarily used for cooling. This represents approximately 50% of industrial water consumption.

- **Complex use that alters the chemical composition of water by adding pollutants:**

This includes industries such as petrochemicals, mining, leather, iron and steel industries, electronics manufacturing, and soft drink production.

In Algeria, the country relies on non-traditional and non-renewable water resources to meet the needs of the industrial sector. In the year 2000, the consumption of water resources for industrial use in Algeria was estimated at about 0.26 billion m³/year. By 2007, this had increased to about 1 billion m³/year due to the expansion of the industrial base. It is expected to reach about 2 billion m³/year by 2030. Extractive industries are the largest consumers of water resources, using about 0.2 billion m³/year for energy production, which represents 4.7% of total industrial use. (<https://www.aljazeera.net/where/algeria>)

For example, the El Hadjar complex in the city of Annaba consumes twice as much water as the residents of Annaba. (Abderrahmane Salem, 2003)

Other Factors

First: The Technical Aspect

A - Lack of Information on Water Resources: Poor Water Consumption in Algeria

Despite the presence of a national policy in Algeria for water resource management, the decisions remain insufficient to achieve effective and logical management that aligns with contemporary challenges and global changes. The lack of crisis foresight and future planning has exacerbated the water crisis in the country. This issue persists despite warnings from specialists and technical experts since 2017, as Algeria relies only on temporary solutions. This was confirmed by Professor Ahmed Kettab, an international expert in water and environment, to "Echorouk Online." In 2021, almost all the dams were emptied of their levels without any proactive or foresight studies. (www.aljazeera.net/where/algeria)

Algeria also faces the problem of water leaks, which negatively affect water security. The national water distribution network suffers from significant deterioration. Studies have shown that more than 30% of the water is lost due to leaks in the network, resulting in enormous costs for the state treasury and significant problems for citizens, such as continuous interruptions in water supply.

In addition to this, there are issues of theft and unauthorized tapping into the water pipes without billing. Since the beginning of September 2021, maintenance operations have recorded 28 incidents of cable and circuit breaker theft during excavation works, leading to a total production shortfall of 112,000 cubic meters. This translates to daily losses of 5,000 cubic meters per day. (<https://www.algeriedirect.dz/vue> le oct2023)

Second: The Environmental Aspect

A - Water Pollution Phenomenon

Water resources in Algeria suffer from multiple types of pollution (biological, chemical, and physical). Industry is the main source of this pollution, in addition to wastewater from residential areas and agricultural runoff containing significant amounts of pesticides, salts, fertilizers, and some

solid waste that is dumped into rivers and seas. In the absence of sewage treatment and purification networks, the quantity of available water is continuously decreasing.

The Ministry of Environment and Renewable Energies previously revealed the existence of 6,000 industrial units classified as "potentially polluting to the environment and rivers," in addition to 1,673 facilities that discharge polluted liquid waste into rivers. Of these, 1,343 have been inspected, but 772 facilities did not comply with the necessary conditions to ensure that rivers are not polluted, particularly by establishing treatment plants and avoiding the disposal of solid waste into water bodies.

Used water, of which about 70% is wasted, needs to be treated in a way that benefits the agricultural sector. Currently, the treatment processes focus on preventing environmental pollution by purifying the water and releasing it back into rivers, with very little being directed towards agricultural use. (Masoud Matar , 2024)

B - The Phenomenon of Dam Siltation

Dam siltation is a natural phenomenon, but it is a severe problem in Algeria. Silt accumulates due to a lack of maintenance, reducing the dam's storage capacity and sometimes threatening catastrophic events, such as dam collapses. It also decreases the storage capacity and promotes algae growth, which alters water quality and complicates its treatment before use.

An official from the Algerian Ministry of Water Resources revealed that a significant proportion of the country's dams are "filled with silt." He explained that the volume of silt deposits has reached approximately 1.2 billion cubic meters, representing about 13% of the total dam capacity. This leads to a loss of 30 to 40 million cubic meters of water annually. (eting between the Minister of Water Resources and the Minister of Agriculture and Rural Development, 2024)

3. Second Axis: The Adopted and Possible Solutions for the Water Problem in Algeria

A strategy has been developed to achieve water security in Algeria by 2024 and 2030. The aim is to secure the supply of water to coastal areas, as well as to areas within 150 km of desalination plants, where nearly 80% of the country's population is concentrated. This strategy primarily focuses on prioritizing the mobilization of sustainable water resources. It also includes securing water through seawater desalination, rationalizing consumption, and treating and reusing wastewater for agricultural irrigation. (Salah Lahalah, 2022)

First: Increasing Surface Water Storage Capacities

In this aspect, the construction of 5 new dams is being completed, with a total storage capacity estimated at 304 million cubic meters. These new dams will support the national dam inventory, which currently consists of 81 dams. Additionally, there are plans to rehabilitate 22 existing dams by removing silt and sludge, with the goal of recovering a total volume of approximately 150 million cubic meters. (Salah Lahalah , 2022)

in addition, there are 6 projects to construct additional dams, including:

- **Protection of the city of Annaba from flooding**

Dam	Completion	Progress: %
Suk Thlatha Dam, Tizi Ouzou:	December 2024	86
Boukhrofa dam	February 2025	80
Sidi Khalifa Dam	December 2025	25
Jadra Dam	April 2024	/
Bouhedid Dam	July 2024	45
Lazrak Dam in Khenchela Province	December 2024	
Kef El Dyr Transfer Dam	September 2024	70
Tablout Transfer Dam	The work has been completed	/

Source: Prepared by the researcher according to information documented by the Director General of the National Dams Agency, Masoud Matar

Second: Enhancing Groundwater Utilization

Groundwater in Algeria is one of the most important water resources for drinking, representing over 55% of the total water used for this purpose. The government has recorded the commissioning of 100 wells with a pumping capacity of 70,000 cubic meters per day, and another 75 wells with a pumping capacity of 60,000 cubic meters per day are expected to be completed.

Since 2021, following the issuance of a joint ministerial directive between the irrigation, agriculture and rural development, and interior and local communities sectors, over 35,000 licenses have been granted for well drilling aimed at irrigation. This is a result of administrative streamlining measures, including reducing the volume of documents required for license applications, shortening processing times, and establishing a unified counter for irrigation well licenses at each regional water resources directorate (SEAAL Alger, 2024)

Third: Wastewater Treatment

Using treated wastewater is considered a strategic option within a comprehensive vision to achieve water security and meet the growing water needs in the agricultural sector. Wastewater treatment

plants can provide significant opportunities for agricultural irrigation and other industrial uses. (Lamia Lhtihat , 2022)

According to Salah Lahla, Director of Operations at the National Office for Sanitation (ONA), the national fleet of wastewater treatment plants consists of 211 plants as of 2022. Among these, 170 plants are operated by ONA, 11 are managed by private operators such as SEAL, SDE, and SIAKO, and 30 are managed by municipalities and various water resources directorates. These plants have the capacity to treat 1 billion cubic meters annually. Furthermore, it is anticipated that by 2026, these plants will increase their treatment capacity to 1.4 billion cubic meters per year.

In January, ONA announced plans to equip 16 ongoing wastewater treatment plants with tertiary treatment systems, which will enhance their capacity for reuse across various sectors.

Regarding sanitation, it is expected that 60 new treatment plants will be constructed, with a treatment capacity equivalent to 4 million residents. Additionally, 6,000 kilometers of wastewater collection pipes will be installed. There are also plans to protect 200 areas from flooding and to develop 300 kilometers of riverbeds.

Fourth: Seawater Desalination

In recent years, Algeria has implemented an effective policy for managing and rationalizing water resources by increasing the use of non-traditional water resources, particularly through seawater desalination. Major desalination plants have been established with a total capacity of 300,000 cubic meters per day, in two phases (2022-2024 and 2025-2030).

By 2022, production had surpassed 2.17 million cubic meters per day, following the commissioning of 12 seawater desalination plants along the national coast. Algeria aims to reach a production of 3.75 million cubic meters per day over the next two years, with the activation of 5 major plants currently under construction, each with a capacity of 300,000 cubic meters per day and a financial investment of 290 billion Algerian dinars.

By building and operating new desalination plants, the production capacity of desalinated water will significantly increase. In the short term, the focus will be on supplying 16 provinces with drinking water, with plans to extend coverage to 35 provinces.

Fifth: Collaboration Between Scientific Research and Technological Development and the Economic Sector

In response to President Abdelmadjid Tebboune's policy aimed at ensuring water security amidst climate changes and increasing challenges, Algerian authorities have decided to fund and support 18 research projects specializing in seawater desalination. They have announced the submission of 33 research projects to the agency, from which 18 projects were selected for collaboration with specialized companies and institutions.

These institutions include desalination plants, SEAL (a water distribution company), the Algerian Chamber of Fisheries and Aquaculture, ENGCB (a subsidiary of Sonatrach), Algerian Energy Company, the National Electrochemical Products Company, the National Desalination Agency, the

National Agency for Integrated Water Resources Management, and COSIDER (a construction company), among others.

The selected projects cover various topics in this field, including:

- Analysis and treatment processes related to seawater.
- Studies on membranes used in reverse osmosis technology.
- Evaluation of the environmental impact of wastewater from desalination plants on the marine environment of Algeria's coasts.
- Utilization of renewable energy.

4. Conclusion:

Algeria has implemented various water policies since independence, through developmental plans in the sector, changes in regulatory institutions, and legislation. In 1996, it undertook a radical change in its water policy with its five principles. The causes of the current water crisis in Algeria are multifaceted, with increasing population and economic growth over the years putting pressure on available water resources. Additionally, years of drought, particularly in the 1980s, have exacerbated the situation. One of the major issues has also been poor management of the sector since independence, characterized by instability, inefficiency, and lack of coordination.

Addressing the water crisis relies on rationalizing resource use, developing available water resources, and adding new water sources. Algeria has made significant efforts to overcome this crisis through major investments, institutional changes, and short-term emergency solutions.

Water and water security have become critically important issues in Algeria, especially in light of global climate changes, water scarcity, drought challenges, and water seepage into the sea. Consequently, decisions and directives at the level of the Council of Ministers aim to meet current water needs, address future water requirements, and preserve this vital natural resource.

Therefore, the measures taken to follow water governance principles, rationally exploit groundwater, preserve surface water, combat pollution, reduce wastefulness, and resort to non-traditional sources such as seawater desalination, coastal area utilization, irrigation system development, and wastewater treatment, are all points that could lead to a qualitative leap towards achieving water security.

The focus of the Council of Ministers on the water issue has allowed for a concentration on alternatives and strategic resources available for providing drinking water or irrigation. This includes relying on wastewater treatment technologies and their reuse for irrigation, establishing emerging institutions in this field to support the development of effective and proper water usage mechanisms, and expanding seawater desalination plants. Emphasizing water security and preemptive solutions for anticipated water problems, if current climatic conditions persist, reflects an awareness of the risks associated with water scarcity and its potential impact on various development projects.

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