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THE CONTRIBUTION OF WATER RESOURCES TO SUSTAINABLE LOCAL DEVELOPMENT: INSIGHTS FROM TLEMCEN

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ABSTRACT:

The article discusses the importance of water for human and environmental well-being, as well as the challenges and opportunities of water management in the context of sustainable development. The article focuses on the case of Tlemcen, a region in Algeria that has rich and diverse water resources, and how local authorities have implemented various projects to improve water services, reduce environmental impact, and enhance agricultural production. The article concludes by recommending further investment in water infrastructure and practices to ensure the long-term security and benefits of water for the region and the world.

Keywords: water resources, water services, sustainable development, local authorities, Tlemcen.
JEL Classification Codes: Q25, Q28, R11

INTRODUCTION:

Water is an indispensable natural resource, playing a pivotal role across the social, economic, and environmental dimensions of societies. Its significance lies in being a fundamental raw material for diverse production, industrial, and domestic processes, making it a central concern for countries and international organizations committed to preservation. The post-2015 development plan underscores the need for increased investments in water resources infrastructure, with a focus on effective management, quality control, and meeting basic population needs for drinking, irrigation, and sanitation. Algeria, aligning with these global objectives, has instigated reforms in the water resources sector, especially in the aftermath of oil price recovery. Through extensive national investments and projects, the country aims to optimize water resource utilization, prevent deterioration, and provide essential services to the population, thus fostering sustainable local development.

The core question of this study centers on the role of the water resources sector in sustainable local development, with a specific focus on the case of Tlemcen Province in Algeria. To address this central inquiry, our study will delve into various aspects, including the economic value, use, security, and integrated management of water. Additionally, we will explore the role of water in achieving

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sustainable development, examine the challenges surrounding water, and shed light on sustainable local development in Tlemcen by uncovering the crucial role played by the water resources sector.

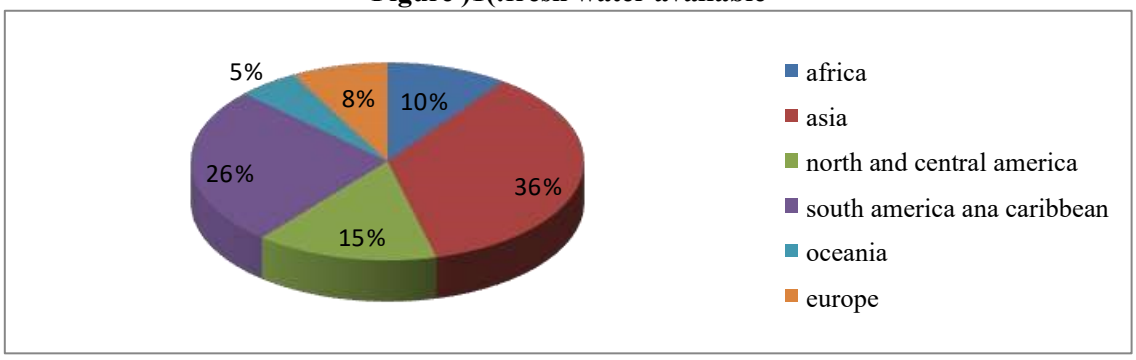
1. Water: Its Economic Value, Use, Security, and Integrated Management

Water, the 'blue gold', is vital for the health of ecosystems, societies, economies, and industries. It is also a human right that many people lack (OCDE, 2022). Water plays a crucial role in promoting sustainable growth, livelihood, justice, food security, and labour. However, the distribution and quality of water sources are severely unequal. Sustainable development depends on ensuring fair and secure access to water for everyone (United Nations, 2023).

1.1 The Economic Value of Water:

Water has multiple values, and its economic value is only one among them. Different stakeholder groups and different contexts may have different value perspectives on water. UNESCO (2006) suggests that these perspectives can include environmental, social, public health, economic, production, political and gender-related values. Moss et al. (2003) provide a list of these perspectives. The economic value of water refers to the willingness to pay of a rational user of a water resource, whether it is supplied publicly or privately. However, many people value water for non-economic reasons and are reluctant to pay for it. This is reflected in the policies of many governments that do not charge or price water due to political, cultural and social factors. Water's economic value can be very high because of its scarcity and its versatility for various uses. In ordinary households, water is a consumer good that is used for drinking, cooking, sanitation, hygiene, cleaning, car washing, and landscape irrigation, especially in dry regions. During the summer in dry regions, the majority of household water use is for outdoor irrigation (Frank A. Ward, 2002). The following figures show available fresh water and global water reserves.

Figure)1(:fresh water available



Note. From "Water Security in a Changing Environment: Concept, Challenges and Solutions" by B. K. Mishra et al., 2021, Water, 13 (490), p3 .

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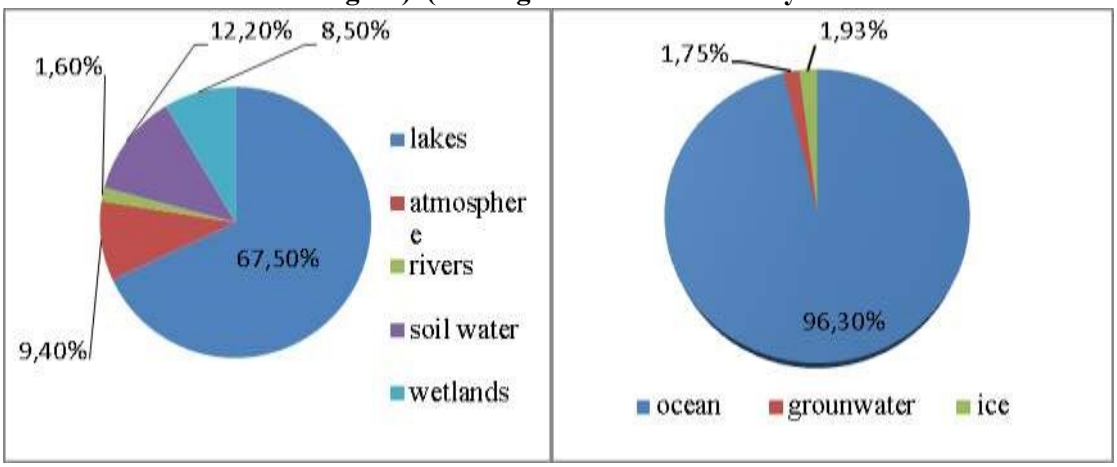
Figure)2(: The global water inventory



Note : From "Introduction The Global Water Cycle Surface Water and Groundwater Water Chemistry and Water Pollution Aquatic Biology Water Resources" by SJ Marshall. University of Calgary, Calgary, AB, Canada 2013 Elsevier p02

1.2 Use water:

Water is essential for life and development. It affects various sectors and processes. We will explore how water is used and managed in different areas: agriculture, energy, recreation, aquaculture, and urban.

Agriculture: According to the Food and Agriculture Organization (FAO), irrigation water use includes water artificially applied to farms, orchards, pastures, and horticultural crops, as well as water used to irrigate pastures, apply chemicals for frost and freeze protection, cool crops during production, harvest them, and leach salts from the root zone of crops. In fact, irrigation is the largest category of water use globally (FAO, 2016).

Energy: Energy can be obtained from the force or motion of running water. There are several types of waterpower that are used or developed. While many of them are mainly used to generate electricity, some are only mechanical, such as hydropower, pumped-storage hydropower, conventional hydroelectricity (hydroelectric dams), and tidal power (Twidell & Weir, 2015). **Recreation:** Water activities involve some degree of exercise as well as visiting areas that contain water, such as parks, wildlife reserves, wilderness areas, public fishing areas, and water parks. Some of the activities that imply the use of water for this purpose are fishing, boating, sailing, canoeing, and swimming, as well as many other recreational activities that depend on water. **Aquaculture:** Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans, and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, and so forth. It also implies individual or corporate ownership of the stock being cultivated. This activity uses part of the water bodies to develop activities.

Urban: Urban water use is generally determined by population, its geographic location, and the percentage of water used in a community by residences, government, and commercial enterprises. It also includes water that cannot be accounted for because of distribution system losses, fire protection, or unauthorized uses. For the past two decades, urban per capita water use has levelled off, or has been increasing (Gourbesville, 2016).

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1.3 Water security:

"The consistent availability of water of appropriate quantity and quality for health, livelihoods, and production, along with a manageable level of water-related risks" is the definition of water security (Nafath-ul-Arab., et al, 2021, p. 217). Sustainable development requires a world that is secure in its water resources. Water security also means taking into account the negative effects of poor water management on the environment (Nafath-ul-Arab., et al, 2021, p. 217). Water is necessary for the economy to grow and to create and maintain jobs in the many industries that depend on it, including building, transportation, energy, forestry, fisheries, agriculture, and industry. Over 75% of jobs rely on water in one way or another (United Nations, 2016). Enhancing living standards, promoting social inclusion, and generating employment are all facilitated by sustainable water management and the provision of infrastructure for access to a clean, safe water supply and proper sanitation. Ignoring water problems will hurt the economy and eventually put people's livelihoods in jeopardy. Water security requires (Gourbesville, 2019):

- Safe, sufficient, and affordable water for basic needs, health, and hygiene.
- Protection of livelihoods, rights, and values related to water.
- Preservation and protection of ecosystems that provide and depend on water.
- Water supplies for various socio-economic activities.
- Collection and treatment of used water to prevent pollution.
- Collaboration and cooperation on trans boundary water issues.
- Resilience to water-related hazards and uncertainties.
- Good governance and accountability for water management.

1.4 Integrated water management:

The aim of integrated water resource management is to foster the joint planning and use of water, land and related resources. This approach seeks to enhance the economic and social benefits for all stakeholders in a fair way, while protecting the essential ecosystems (Global Water Partnership, 2020).

The integrated water resources management policy aims to ensure that everyone has fair and adequate access to water, that water is used in an environmentally friendly and future-oriented manner, and that water is valued and priced according to its scarcity and importance. These goals are based on the four principles established in the 1992 Dublin meeting (TAYLOR,P & GABRIELLI, E, 2005), which emphasised the finite and vital nature of water, the need for inclusive and collaborative water governance, the crucial role of women in water management, and the economic and social dimensions of water use (Kostianoy, 2021).

2. The role of water in achieving sustainable development

Sustainable development is the approach that balances the current and future human needs with the protection and preservation of the natural environment and its resources, or in other words, it is the care and stewardship of the environment and its resources to guarantee their availability and quality

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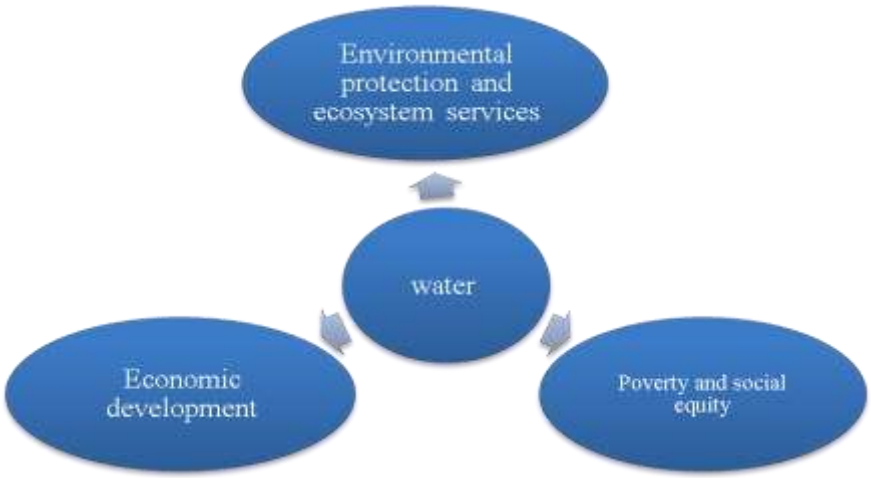
for the well-being of future generations (World Commission on Environment and Development, 1987).

Sustainable development is a concept that emerged from the 1992 UN Conference in Rio de Janeiro, and it has three main characteristics: continuity, justice, and comprehensiveness. It aims to meet the needs of present and future generations, respect the rights of others to natural resources, and coordinate policies across different sectors of the state. Water is a vital element of sustainable development, as it is essential for human life, economic growth, and environmental protection. Water has a key role in three core aspirations: addressing the needs and rights of the world's poorest people, supporting sustainable prosperity for all, and defending future progress. Access to water, sanitation, and hygiene is crucial for poverty reduction, dignity, and equality, while protecting water resources and ecosystems is necessary for maintaining life and economic activity. (MESBAH,Y & BOUDAOUD,S, 2022; United Nations, 2015). Water is not only a basic human need, but also a key factor for achieving sustainable development in its social, economic, and environmental dimensions. Figure 3. shows how water relates to the three main characteristics of sustainable development:

Figure(3(: water and the three dimensions of sustainable development



Source: prepared by researches base to (United Nations, 2015)

SDG 6 aims to achieve universal access and sustainable management of water and sanitation, covering aspects such as drinking water and sanitation, water resources management, water quality, integrated water resources management, and water-related ecosystems and enabling environment. As part of the 2030 agenda for sustainable development, countries agreed to systematically track and report on their progress towards the SDG 6 goals and targets, using a set of global indicators. The IMI-SDG6 initiative of the United Nations assists countries in their monitoring and reporting activities (Bonazzi, 2023). The table below presents the SDG 6 targets and indicators:

Table (1): SDG 6 targets and indicators

	targets	indicators

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6-1	By 2030, achieve universal and equitable access to save and affordable drinking water for all	Proportion of population using safely managed drinking water services
6-2	By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water
6-3	By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Proportion of wastewater safely treated Proportion of bodies of water with good ambient water quality
6-4	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity 65and substantially reduce the number of people suffering from water scarcity	Change in water-use efficiency over time Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
6-5	By 2030, implement integrated water resources management at all levels, including through trans boundary cooperation as appropriate	Degree of integrated water resources management implementation Proportion of trans boundary basin area with an operational arrangement for water cooperation
6-6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	Change in the extent of waterrelated ecosystems over time

Source: Oriana Romano, Water Reuse within a Circular Economy Context, GLOBAL WATER SECURITY ISSUES SERIES, © UNESCO / UNESCO i-WSSM 2020 p40

3. Challenge of water

Over the last century, global water use has grown sixfold and continues to rise by about 1% annually due to increasing population, economic development and changing consumption patterns. The Organisation for Economic co-operation and development estimated in 2012 that global water demand would grow by 55% from 2000 to 2050, driven mainly by rising demands from manufacturing (+400%), thermal power generation (+140%) and domestic use (+130%). Another study predicted that the world would face a 40% global water shortfall by 2030 if current trends persist. (Michela Miletto, 2020)

The figure below shows the global water demand in the baseline scenario for 2000 and 2050:

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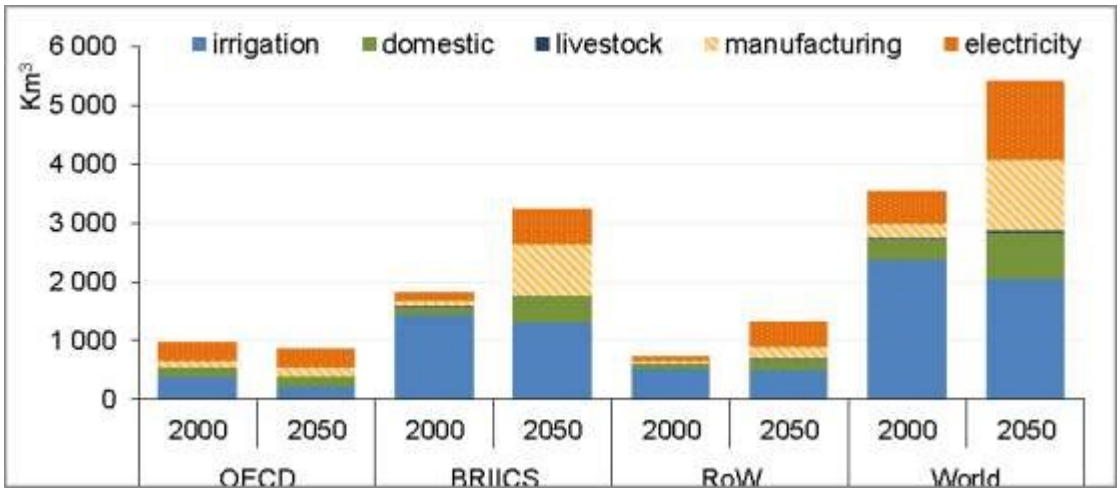
Figure)4(:Global water demand: Baseline scenario, 2000 and 2050



Source: meeting the water reform challenge, OECD studies on water 2012 p03

Economic development causes pollution, which contaminates various water bodies by careless disposal of domestic, agricultural and industrial waste. This degrades the biological and chemical properties of many rivers. Polluters are taxed. (Jayawardena, 2012) Climate change, which directly and indirectly affects water availability, water quality, extreme events, water demand, energy production, food security, the economy, and other aspects, is altering the climate and will continue to do so, impacting societies and the environment. Climate change will also affect the occurrence of water-related diseases and the achievement of other Sustainable Development Goals (Michela Miletto, 2020).

The figure below shows the main climate risks identified in Paris:

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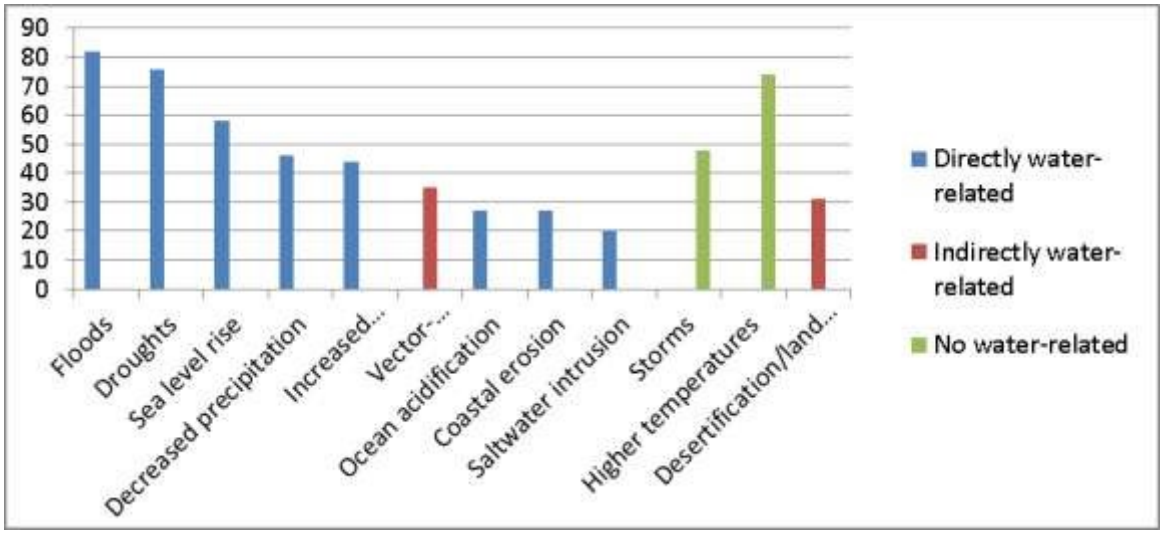
Figure)5(: Key climate hazards identified in Paris



Source: water and climate change The United Nations World Water Development Report 2020 , Paris UNESCO 2020 p49

4. Sustainable Local Development in Tlemcen: Unveiling the Crucial Role of the Water Resources Sector

Positioned prominently within Algeria, Tlemcen plays a vital role on the national stage. As a coastal border state, it is bordered to the north by the Mediterranean Sea, adjacent to the state of Ain Temouchent to the northeast, sharing its western border with Morocco, and connecting to the state of Naama to the south. Tlemcen experiences a Mediterranean climate characterized by cold winters and hot, dry summers, with rainfall occurring irregularly and ranging between 200 to 500 mm per year.

4.1 Water resources in Tlemcen :

Table (2): Dams

place	Capacity(hm^3)
Hamm am Boughrara Dam	177
Beni Bahdal Dam	56
Sidi Abdali Dam	106
Mefrouch dam	15
Sakak Dam	27

Source: Prepared by researchers based on the Directorate of Water Resources Tlemcen

As shown in the table above Tlemcen is equipped with five significant dams, and in terms of unconventional water resources, the municipality of Honaine Tafsout hosts a seawater purification plant. This facility processes approximately 200,000 cubic meters per day, providing treated water to 28 municipalities across Tlemcen.

4.2 Financing the water resources sector:

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Table(3): Decentralized sectoral programmes in the field of water resources in Tlemcen period 2015 2021(unit $10^3 DA$)

	Subsector Small and Medium Irrigation	Subsector great Irrigation
2015	630000	950000
2016	0	780000
2017	0	1108000
2018	0	1779000
2019	1000000	7863000
2020	0	99500
2021	0	450000

Source : programming and budget follow-up directorate Tlemcen

Algeria is actively engaged in the sustainable utilization and management of water resources, aiming to supply the population with potable water in both quantity and quality. This involves mobilizing and distributing water to meet the diverse needs of the population in areas such as agriculture, livestock, and industry. The preservation of water resources is a priority, achieved through the filtration of sewage from homes and factories, as well as the exploration of surface and groundwater sources to enhance water reserves. Table 3 illustrates the allocation of funds to the state of Tlemcen across two sub-sectors: Sector 32 - large irrigation and Sector 33 - small and medium irrigation.

A notable trend is observed in the distribution of funds for large irrigation, with an increase in the volume of allocated amounts starting from 2016. The peak amount reached in 2019 was estimated at 7,863,000,000 DA, followed by a decrease in the year 2020.

Table(4): The length of the water network

Years	network length(ML)	Binding ratio (%)
31/12/2015	1045008	95
31/12/2016	1045008	95
31/12/2017	1372057	97
31/12/2018	1801958	97
31/12/2019	1392382	98
31/12/2020	1954392	98.5
31/12/2021	2736148	99

Source: Prepared by researchers based on the Directorate of Water Resources Tlemcen

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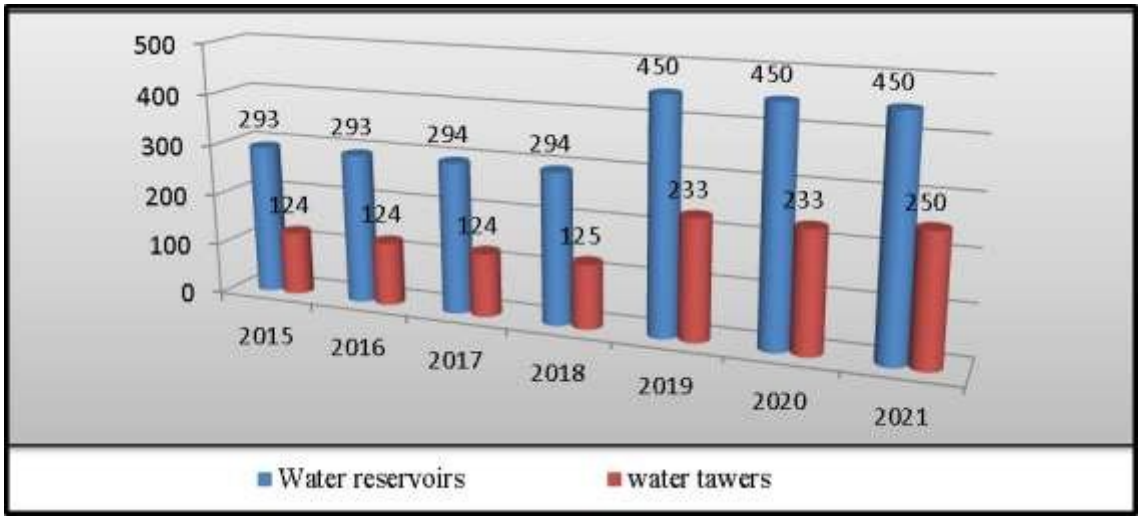
Table 4 illustrates the evolution of the water network's length over time. Notably, there is a consistent increase in the length of the drinking water supply network from one year to the next. This upward trend has contributed to a significant improvement in the supply rate, reaching 99% in 2021. The expansion of urban areas in the state, coupled with the implementation of renewal projects for distribution channels, has played a crucial role in achieving this progress. This aligns with the government's strategic efforts toward sustainable development, particularly in the water sector, as part of comprehensive plans and projects aimed at ensuring local water needs are met and enhancing the infrastructure for water supply and distribution.

Figure (6): number of water reservoirs and towers used



Source: Prepared by researchers based on the Directorate of Water Resources Tlemcen

The utilization of water reservoirs and towers in the Tlemcen city has witnessed a significant shift since 2015. Initially relying on 293 reservoirs, the city has expanded its infrastructure, boasting 450 reservoirs by 2021. Similarly, the number of water towers has seen a notable surge, escalating from 124 in 2015 to 250 in 2021. This uptick reflects the growing population and increased construction within the city's territory, highlighting a commendable enhancement in water service provision and the fulfillment of citizens' needs.

Table (5): Binding ratio sanitation:

Years	network length(ML)	Binding ratio(%)
31/12/2015	1900126	94
31/12/2016	1982126	95
31/12/2017	1986127	95.5
31/12/2018	1997864	95. 5
31/12/2019	2003975	95.6
31/12/2020	2006003	95..7
31/12/2021	2008574	95.7

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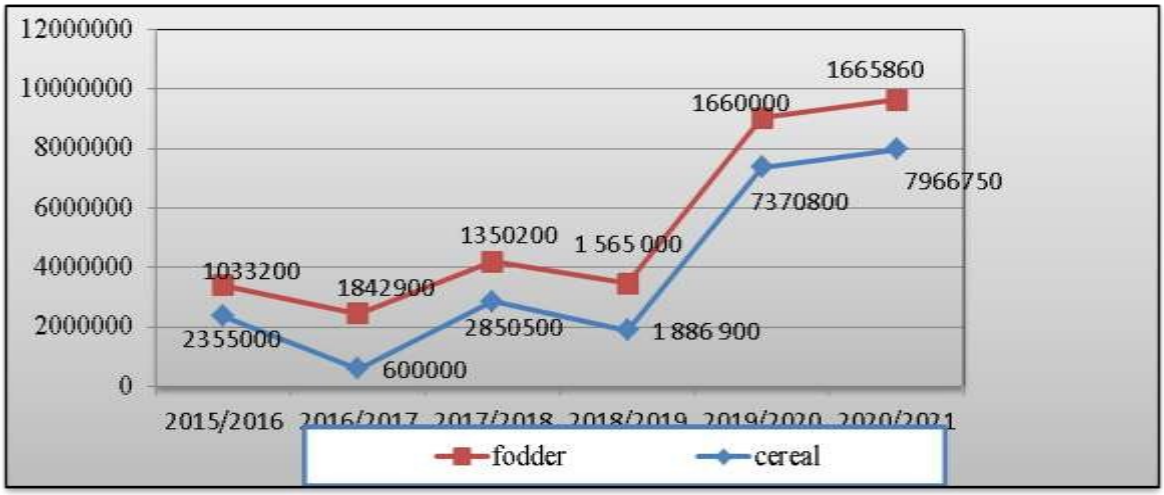
Source: Prepared by researchers based on the Directorate of Water Resources in Tlemcen city

Analyzing the information from Table 5 reveals a consistent and successive growth in the length of the access network. This expansion is aimed at enhancing sanitation facilities, especially in remote areas, aligning with the new program addressing underserved regions initiated in 2020. Recognizing sanitation as a crucial indicator of human development, the efforts to improve these facilities extend beyond individual households, providing broader advantages to entire communities. Improved sanitation not only contributes to public health but also positively impacts livelihoods and dignity on a community-wide scale.

4.3 The development of agricultural production:

Cereal cultivation occupies a substantial portion of Tlemcen's total arable land, as indicated by the data in Figure 7. In the realm of cereal and fodder cultivation, the state witnessed varying quantities from the agricultural season of 2015/2016 to 2018/2019, with cereal production ranging between 2,355,000 and 1,886,000 quintals. Similarly, fodder production fluctuated between 1,033,200 and 1,565,000 quintals. However, there was a notable increase in production volume, with the peak production in cereals reaching 7,966,750 quintals and fodder reaching 1,665,860 quintals during the agricultural season of 2020/2021.

Figure (7): agricultural production in cereal and fodder Unit (quintals)



Source: prepared by researches based on agricultural services directorate in Tlemcen

As depicted in Figure 8, there's notable progress in the citrus and olives sector. The state recorded its highest production volume in the agricultural season of 2019/2021, reaching 750,000 quintals for olives and 757,240 quintals for citrus. This achievement is attributed to improved water delivery in farmlands.

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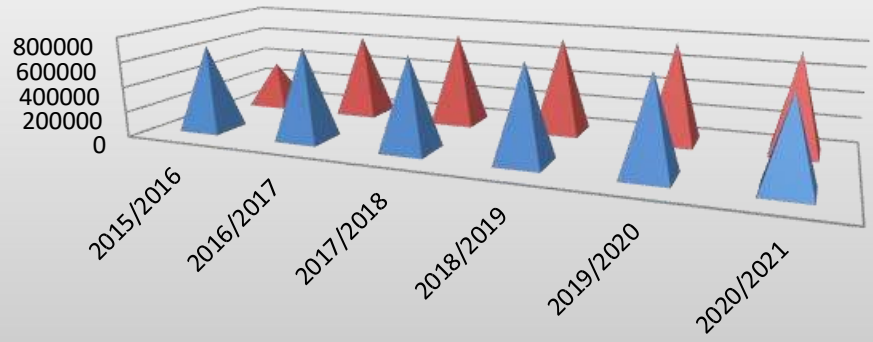
Figure (8): Olive and citrus production in Tlemcen



	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
olive	685000	730000	730000	750 000	750 230	681750
citrus	363930	657412	730830	757 240	784 560	774440

Source: prepared by researches based on agricultural services directorate in Tlemcen

Conclusion:

Water emerges as a fundamental resource essential for preserving human health and dignity, serving as a critical input across economic, social, and environmental sectors. The global concern surrounding water scarcity has spurred widespread contemplation, urging humanity and environmental organizations to safeguard this invaluable asset. Efforts are underway to repair water infrastructure, ensure equitable distribution, and secure its benefits for future generations. Key findings underscore water's dual economic and social value, with Tlemcen standing out for its abundant and diverse water resources. These resources in Tlemcen not only present opportunities for local development, particularly in drinking, irrigation, and animal husbandry but also reflect the positive outcomes of local authorities' focus on water-related projects. The attention to such initiatives has elevated public water services, reduced environmental impact, and bolstered the resilience of the water network, contributing to improvements in agricultural products like cereals, olives, and citrus. As a forward-looking recommendation, continued investment in sustainable water management practices and infrastructure development is crucial to ensure the ongoing well-being of communities, environmental conservation, and the preservation of water as a vital resource for future generations.

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