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Financing of Water Infrastructure in Algeria and sustainability. « Case study of the Wilaya of Tlemcen »

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TLEMCEN, ALGERIA

Declaration

I' Ayoub BELARBI, hereby declare that this thesis titled **“Financing water infrastructure in Algeria and sustainability. Case study of The wilaya of Tlemcen»** is my original work, realized to the best of my knowledge and has not been submitted to the university or any other institute or published earlier for the award of any degree or diploma also declare that all information, material and results from other works presented here, have been fully cited and referenced in accordance with the academic rules and ethics.

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Certificate of Approval

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Dedication

I offer this modest work:

To my dear parents and my own family

But no dedication would bear witness to my deep love, my immense gratitude and my utmost respect, for I could never forget the tenderness and devoted love with which they have always surrounded me since childhood.

I also dedicate this modest work:

To all my friends and loved ones, and to all the people who have given me encouragement and taken the trouble to support me during this year of training.

To my dear trainers, without exception

To all my friends in the class of 2022/2024

And to all those I hold in high esteem

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Abstract

Between 1990 and 2003, Algeria experienced a major water shortage, mainly due to two factors: the last two decades of drought and the climatic and environmental changes that have affected the country.

In 2002, Algeria created a special Ministry of Water Resources (MRE). The latter has followed a very sound political and economic approach to rectifying this situation.

As part of the partnership between Algeria and the European Union, an Association Agreement (AA) was signed on September 1, 2005.

The Agreement stipulates environmental protection, and deepens cooperation in key sectors such as water, the marine environment and climate change.

In this context, Algeria has invested heavily in water infrastructure (dams, treatment plants, desalination plants and purification plants) and all the infrastructure needed to improve water yield, both qualitatively and quantitatively.

The aim of the study is to show you the funding granted to this sector between 2007 and 2023 in the Wilaya of Tlemcen (ALGERIA).

key words

Financing, water policy, water infrastructure, sanitation, desalination, dam, sewage treatment plant

Résumé

L'Algérie a connu entre 1990 et 2003 un grand manque d'eau due essentiellement à deux facteurs qui sont : les deux dernières décennies de sécheresse et les changements climatiques et environnementaux qui ont touché le pays.

En 2002 l'Algérie a créé un ministère spécial des ressources en eau « MRE ». Ce dernier a suivi une très bonne politique et économique pour le redressement de cette situation.

Dans le cadre du partenariat entre l'Algérie et l'Union européenne, un Accord d'Association (AA) a été signé le 1^{er} septembre 2005.

L'Accord a stipulé la protection de l'environnement, il a approfondi la coopération dans les secteurs clés, surtout comme l'eau, le milieu marin et dans les domaines des changements climatiques.

Dans ce contexte l'Algérie a beaucoup investi dans les infrastructures hydrauliques comme (les barrages, les stations de traitements, les stations de dessalements et les stations d'épurations) et tous les infrastructures pour améliorer le rendement de l'eau de point de vue qualitative et quantitative.

Notre étude a pour objective de vous montrer le financement accordé à ce secteur entre 2007 – 2023 dans la wilaya de Tlemcen (ALGERIE)

Mots Clés

Financement, la politique de l'eau, infrastructures hydrauliques, assainissement, dessalement, barrage, station d'épuration

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List of abbreviations:

NGO: Non-governmental organization

OECD: Organisation for Economic Cooperation and Development

ONS: National Statistics Office(NSO)

WWR: Warm Winter Risks

WHO: World Health Organization

UNEP: United Nations Environment Program

UNO: United Nations Organization

STEP: Wastewater Treatment Plant

SDG: Sustainable Development Goals

GDP: Gross Domestic Product

MDB: Multilateral Development Banks

GHG: Green House Gases

ODA: Official Development Assistance

GWP: Global Water Partnership

AA: Agreement and Association

EU: European Union

AEP: Drinking Water Supply(DWS)

GIRE: Integrated Water Resource Management(IWRM)

PNE: National Water Program(NWP)

MTH: Water-Borne Disease(WBD)

SWE: Walloon Water Company(WWC)

ISO: International Organization for Standardization

MRE: Minister for Water Resources(MWR)

SWOT: strengths, weaknesses, opportunities and threats.

EPA: Environmental Protection Agency

EPIC: Public Industrial and Commercial Company(PICC)

AGIRE: National Agency for Integrated Water Resources Management(NAIWR)

DGIRE: Integrated Water Resources Management Department(IWRMD)
SWIM: Sustainable Water Integrated Management
SDAGE: Water Development and Management Master Plans (WDMMP)
ABH: River Basin Agency(RBA)
PNAE-DD: National Action Plan for the Environment and Sustainable Development(NAPESD)
SNE: National Water Strategy(NWS)
SNDAGRE: National Master Plan for Water Resources Development and Management(NMPWRDM)
GPI: Great Plains Industries
SDEM: Sea Water Desalination Plant(SWDP)
CC: Captans Fields(CF)
SNAT: National Land Use Planning Schemes(NLUPS)
ACL: Agglomeration Chief Places (ACP)
PMH: Small and Medium Hydraulics (SMH)
RGPH: General Population and Housing Census(GPHC)
PDAU: Master Plan for Development and Urbanization(MPDU)
GUT: Tlemcen Urban Group(TUG)
PVC: Polyvinyl chloride
DRE: Water Resource Department(WRD)
AEC: Algerian Energy Company

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GENERAL INTRODUCTION

GENERAL INTRODUCTION

At both international and local levels, the relationship between cities and water is taking on a new context: awareness of the fragility of this resource, a collective good and an essential element in the life of societies. Urban growth in Algeria and the introduction of more stringent health standards have led to a proliferation of water circulation, collection and treatment facilities, whose effectiveness is undermined by extreme climatic events, despite their ever-increasing cost. As a result, new experiences in urban policies are now guiding water management in the direction of resource saving and a new perspective [1].

What's more, the response given by managers and operators is essentially based on a quantitative logic of network multiplication, increased equipment capacity and ever larger pipe dimensions [2].

What goes on beneath cities like Tlemcen, reproducing underground communication routes, these new arteries, is also thought of as the circulation of blood, visible only to the initiated, those confreres of modernism who are doctors [3].

In Algeria, water resources have become scarce and fragile as a result of a number of factors that have accentuated and aggravated the situation of water stress, notably climatic hazards such as the climate changes that have affected the country over the last two decades, which have had a negative impact on the availability of water resources in Algeria. The considerable and perpetual increase in water requirements due to a rapidly growing population.

In Algeria, there are a number of challenges and constraints hindering the proper management of this scarce, limited commodity, and at the same time affecting water security:

1. The considerable drop in rainfall over the last three decades with a peak in droughts recorded in 2001-2002. [4]
2. The challenge of adjusting water supply to demand.
3. Population growth, expansion of agricultural land and industrial activities.
4. Overexploitation of groundwater as a result of increasing demand for water for industrial purposes requires the mobilization of surface water while guaranteeing the supply of fresh water.
5. The critical situation of the Algerian water balance is due to climatic characteristics ranging from arid to semi-arid, resulting in a reduction of this resource in the face of growing water demand due to population growth (the Algerian population has risen from 9 million inhabitants in 1962 to 43 million in 2019, i.e. an almost five-fold increase).
6. Bad habits and behaviors of water consumers and the absence of rational domestic water consumption have a negative impact on water resources (resource scarcity).
7. In Algeria, water resources are under phenomenal pressure due to the increase in the urbanization rate, which rose from 30% to 73% over the specified period from 1962 to 2019.

After the general introduction, our dissertation is structured in three parts:

I) The first part, entitled "Bibliography", provides a general overview of the bibliography used in this modest work;

II) The second part, entitled "Water policy in Algeria", comprises 2 chapters:

Chapter 1: Supporting the Ministry of Water Resources in its Integrated Water Resources Management Policy;

Chapter 2: Water policy in Algeria;

III) And the third part entitled "Water policy in the wilaya of Tlemcen and financing" which is divided into 3 chapters;

Chapter 1: Water policy in the wilaya of Tlemcen;

Chapter 2: Water policy in the Tlemcen district

Chapter 3: Financing chapters in the wilaya of Tlemcen.

Finally, we summarize this work with a general conclusion and outlook.

PART 1
BIBLIOGRAPHY

I) URBAN CITIZENSHIP:

1) Embodied intersections of urban citizenship:

Water is of vital importance, as the presence or absence of drinking water reveals the workings of power on the planet. According to geographers and other social scientists, citizenship is associated with water scarcity in cities of the South, where water problems frequently manifest themselves (Castro 2004, 2007, 2008; Gandy 2004; Bakker 2010; Anand 2011; Ranganathan 2014; von Schnitzler 2016). Access to water distinguishes individuals from citizens, as those who see themselves as true urban residents benefit from water from the state, while others do not. To understand the disorganized realities and complexities of the relationship between water and citizenship, it is necessary to specify the disparities linked to access to water in order to identify the power relations and citizen behaviors in each situation [5].

Urban citizenship is directly associated with land ownership or legal tenancy, as these identities provide a link with the city's official management institutions, including water facilities. Property status is frequently transformed into a means by which human rights over water are manifested through access to the public water network: those who own or rent recognized property have access to municipal water, while unauthorized squatters (slum dwellers) have no formally recognized status to constitute a component of the public water system.

Facilities offering safe, clean water, and the lack of them, create zones of difference and abjection (Lemanski 2019). Because of the vital necessity of water, the daily battle to procure and obtain food becomes a testament to the precarious status of poor urban dwellers. Thus, water occupies a primary place in the link of disadvantaged urban populations with the state, and consequently, in the daily lived experiences of urban citizenship (Rodina 2016; Rodina and Harris 2016; von Schnitzler 2016). Water supply policy and practice frequently present contradictions. In recent years, given the promotion of the human right to water by the United Nations and non-governmental organizations (NGOs) (Sultana and Loftus 2012, 2020; Mehta et al. 2014), it is crucial to examine how these political discourses are put into practice.

For example, von Schnitzler (2016) argued in research conducted in South Africa that citizenship manifests itself in the claims to dignity and humanity that water enables.

In research conducted in India, it was observed that lack of access to water disrupts individuals in the face of the daily negotiations and struggles for water that characterize the daily lives of poor urban dwellers (Anand 2012) [5].

2) Stakeholder engagement in water governance as social learning:

The Organisation for Economic Co-operation and Development (OECD) in 2015, in its Principles of Water Governance, highlights the need to encourage stakeholder involvement in water management procedures (OECD, 2015). In various situations, this involvement has become essential for water-related projects, mainly in response to the requirements of long-term sustainability and resilience. Moreover, it fosters the creation of intangible assets that are as vulnerable as they are powerful, such as trust, adoption and acceptability (Von Korff, Daniell, Moellenkamp, Bots and Bijlsma, 2012).

Although international and regional agreements such as the Aarhus Convention or the Dublin Principles for Global Water Resources Management require the involvement of citizens and the establishment of public participation mechanisms in the decision-making process, the weight of these institutional requirements, their interpretation and application vary. Much research has also shown that multiple participatory methods fail to make policies and practices more informed and effective (Behagel & Turnhout, 2011; Edelenbos & Klijn, 2006; GWP, 2000), whether due to a lack of resources or poor organizational planning. In order for these processes to reach their optimal potential.

Despite these concerns, stakeholder participation is often a necessity for policy-makers, authorities or public services to establish a dialogue with citizens or members of the public involved in the decision or outcome, even though they are not usually involved. Considered an essential part of the decision-making process [6].

3). Stakeholder involvement in decision-making

According to Brun, 2003; Collins and Ison, 2009; Fung, 2006; Hurlbert and Gupta, 2015; Ison, Röling and Watson, 2007; Mostert et al., 2007; Reed, 2008; Voinov et al., 2016), Arnstein's (1969) scale has been widely discussed in the literature to determine degrees of citizen engagement in decision-making, based on power. We won't go into these discussions here, but it's important to note their insistence on the need for conceptual clarity. Each form of participation presents distinct outcomes and impacts (Fung, 2006; Reed, 2008), which vary depending on the context and the type of problem involved (Hurlbert and Gupta, 2015).

According to the definition proposed by Rowe and Frewer (2004, p. 253), participation is “the way in which members of the public are engaged in the agenda-setting, decision-making and policy-making processes of responsible organizations”. They distinguish public consultation as a dynamic process of information exchange and discussion between relevant stakeholders. They argue that public engagement encompasses communication, commitment and public involvement (p. 254), the differences depending on the information relationships between the process promoter and the participants, as well as the performance of the arrangements put in place. Consequently, engagement is a dynamic and active process that gives stakeholders the opportunity to be “authorized” to contribute to the decision-making process.

According to the OECD (2015, p. 32), the concept of engagement is generalized, while that of stakeholder engagement refers to the opportunity for those with an interest to contribute to decision-making and implementation processes. In this framework, stakeholders are differentiated from the mere “public” and can encompass government entities, private actors, regulators and non-governmental organizations.

3) Social learning

Social learning has emerged as a frequently used concept in the literature concerning stakeholder involvement and dedication, although its interpretation and application differ (Blackmore, Ison and Jiggins, 2007). This concept, originally developed by Bandura (1977) to describe the process of personal learning in a social setting, has gradually evolved to include the process of learning within groups or collectives (Ison et al., 2007; SLIM, 2004b). In the context of environmental policy and water resource management (Colvin et al., 2014; Ison et al., 2007; Pahl-Wostl & Hare, 2004; Pahl-Wostl et al., 2008; Röling, 2002; Scholz, Dewulf and Pahl-Wostl, 2014; Woodhill and Röling, 1998). Some favor a more systemic and systemic approach to examining ecological issues, with the aim of addressing the complexity of water resource management and promoting beneficial transformations through social learning, consolidating their ability to transform into adaptive systems (e.g. Ison, Collins and Wallis, 2015).

We won't go into the complex controversies associated with this concept, however, one common thread emerges: the realization that complicated environmental contexts require shared learning and mutual understanding.

An essential element of social learning associated with stakeholder involvement is therefore this collective, rather than individual, process of acquiring and reproducing knowledge. This provides a broader base of experience on which to base decisions. In particular, we see social learning as a developing management device that aims to promote cooperation between stakeholders to optimize water resource management (Collins et al., 2007; Ison et al., 2007).

Joint action is not intended to replace, but rather to complement, existing mechanisms such as legislation, fiscal policies and education, particularly through the dissemination of information (SLIM, 2004b). In this context, social learning can be summarized in several crucial aspects (according to Collins & Ison, 2009):

- Goal alignment (expressed as a goal)
- Mutual exchange of information, which enables the origins of a situation and strategies for resolving it to be understood.
- Changes in behavior and actions resulting from new knowledge.
- Incipient assimilation of the transformation process.

This perspective on social learning implies that stakeholder involvement is designed to encourage cooperation and mutual learning. This offers an opportunity to examine water management and determine how it might move forward and metamorphose, including transformations in mentalities, beliefs, perceptions and, consequently, methods.

II) THE CONTRIBUTION OF WATER RESOURCE SYSTEM ANALYSIS TO THE DYNAMICS OF TERRITORIAL REBALANCING, THE CASE OF THE TAFNA SYSTEM, ALGERIA

Choices concerning water management have progressed from a simple solution for accessing water near its source, to complex issues related to water management and allocation in response to varied and competing demands in the natural, societal and political sectors (Islam and Repella, 2015).

Watersheds are a suitable socio-economic and political entity for planning and implementing management (Wang et al., 2016).

In terms of policy action and governance, water resource management requires innovative institutional collaborations and adjustments (Saguier et al, 2021). The current sectoral structure of institutions is at odds with the multifunctional nature of water: it is imperative to adjust management concepts and processes to foster greater involvement (Markowska et al., 2020).

To guarantee the sustainable use of water resources, it is crucial to mobilize all the stakeholders involved in a common basin (GERMAN et al, 2007). The aim is to apply the notions of “participation” and “integration” in watershed water resource management (Grill et al., 2015).

The integration of water resource management within the watershed requires the application of a methodological approach that includes all the appropriate steps for developing, implementing and monitoring the performance of the water supply system. The aim is to provide a technical, cost-effective and efficient response to customer requirements, while satisfying all the stakeholders involved. (Roissat et al., 2021; Baron and Allegro, 2019). Technical systems (surface and groundwater mobilizations, water treatment, ecosystem preservation, desalination, etc.), the identification of needs and requirements, the enduring obstacles to sustainable development and the level of stakeholder commitment make it possible to effectively resolve all the issues associated with participatory and integrated water resource management (Dacko, 2009).

Comprehensive water resource management must ensure a fair progression of economic and social well-being, without jeopardizing the sustainability of vital ecosystems, either now or in the future (Duran-Sanchez et al., 2018; Dobner and Frede, 2016).

System performance is a criterion that determines and/or measures the product of the system's commitment. This characteristic is constructed on the basis of the results generated and the process of acquiring them. It can manifest itself in various facets and affect different aspects of the system, such as effectiveness or efficiency (Mwambo and Furst, 2019). Two methods are

usually used to identify and examine the water resources system: a structural perspective based on a set of components (subsystems) interacting with each other and with the integrated environment, according to function. A dynamic perspective is based on a series of processes (activities, functions) that interact with the environment following coordinates according to objectives or expected outcomes (Turner and Baker, 2019). [3]

This article focuses on the Tafna water supply system, examining its results in terms of meeting different needs and the commitment of the various stakeholders. The term “Wilaya” in Algeria refers to a province, with each Wilaya constituting a decentralized administrative territory comprising several communes.

Located in north-western Algeria, the Tafna system encompasses the entire Wilaya of Tlemcen and part of Morocco. It covers an area of 7,245 km², making it the largest water reserve in western Algeria. The western zone comprises the watershed of the Mouillah river, its major tributary, a large part of which is located in Morocco, and the Angad and Maghnia plains.

This system is integrated into its environment, with multiple interactions, bringing together players with often contradictory objectives when it comes to allocating water resources. These players often act on a sector-by-sector basis, without a global vision that takes administrative boundaries into account.

In the Wilaya of Tlemcen, the system comprises six large dams, some twenty small dams, three desalination plants, eight water treatment plants and around 180 wells and boreholes. The average annual exploitable volume of underground reserves is 100 Hm³, while the total capacity of surface water is 394 Hm³, with a regulated capacity of 203 Hm³. The three desalination plants of the Tafna system produce around 148 Hm³ per year.

Various communes in the Wilaya receive water flows from desalination plants, groundwater collection reservoirs and dams. The system also benefits from a water transfer from the Chott El Gharbi in the Wilaya of Naâma. In addition, three water transfers from the watershed are also distributed between the surrounding wilayas of Oran, Ain, Témouchent and Sidi Bel Abbès.

The administration of the system encompasses several players and stakeholders, who make decisions concerning investment planning, water allocations and environmental preservation. The

system comprises sub-systems that constantly interact, often in conflict, including mobilization, waste treatment and water transport.

Various factors need to be taken into consideration for system performance, such as meeting long-term needs, management challenges, global warming and safeguarding the environment, not to mention the functions of those involved in water resource management. This article, based on the ideas of totality, interactivity and sustainable development, proposes an analysis of water resource balances, the establishment of a responsibility matrix for the stakeholders involved, and the formulation of measures designed to optimize system operation.

The analysis process involves several phases, such as identifying the system and its components, studying its constraints and formulating its needs. It also includes identifying the stakeholders responsible for resource management and their respective relationships. The link between water and territory is considered by confronting the administrative boundaries of the Wilaya of Tlemcen with the hydrographic system and its components. [7]

III) OPPORTUNITIES AND CHALLENGES FOR WASTEWATER REUSE IN ALGERIA

In arid climates like Algeria's, water is a major issue. Water supply, especially in urban areas, is becoming increasingly complex and costly, both economically and ecologically (ONS, 2020). Algeria is also seeking to solve persistent flooding, contamination and scarcity problems using methods such as seawater desalination, increased drilling and inter-basin transfers. However, these actions could contradict Sustainable Development Goal 6, which seeks to ensure safe access to drinking water and sanitation while promoting sustainable management of water and ecological resources(www.unwater.org).

At present, Algeria generates 3.6 billion m³ of drinking water every year, which corresponds to an average daily supply of 65.7 m³ per person (around 180 liters per day) (MWRWS-a, 2020). In an environment marked by climate change and water stress, it is imperative to promote alternative water resources, including treated wastewater, to safeguard traditional resources (Mostefa-Kara and Arif, 2013).

The reuse of wastewater (REU) presents significant environmental and socio-economic benefits. It promotes water independence, the preservation of natural resources, and also contributes to urban resilience in the face of climatic uncertainties. At the local level, treated waste can be used for: i) the maintenance of public gardens (gardens, parks, sports fields), ii) road cleaning and vehicle cleaning, iii) providing water for public works, and iv) the purification of toilets and fire hydrants. (ONU-Habitat et OMS, 2021 ; PNUE, 2021).

There are two steps to implement the RUE:

- Strategic scale: i) ensure the coherence of water policy across various scales, ii) orchestrate interdisciplinary goals, and iii) ensure the sustainability of solutions.
- Operational level: this is conditioned by the capacities of the water treatment plants, the quality of the treated water, and the on-site operating conditions.

Two major factors determine a REU project:

- 1). Contextualization: it must consider local capacities and the degree of community involvement.
- 2) Operationalization: it must be based on the volume and quality of the available water pipelines, as well as the presence of appropriate infrastructure.

To conclude, the implementation of RUE requires: i) adequate standards and regulations, ii) appropriate infrastructure, iii) a specific budget, and iv) involved stakeholders possessing the required skills. (PNUE, 2021 ; ONU-Habitat et OMS, 2021 ; KUMAR et al., 2021).

In Algeria, rainwater from wastewater treatment plants (WWTPs) treated secondarily with activated sludge is primarily used for irrigation, in accordance with the required physicochemical and biological criteria. These are particularly found in the irrigation areas of the wilayas of Tlemcen, Oran, and Bordj Bou Arreridj. Numerous wastewater treatment plant projects are also under review in various wilayas of the country (such as Ghardaïa, Annaba, and El-Oued).

The objective of the national wastewater strategy is to extend their reuse for industrial and communal applications, while consolidating their incorporation into the urban water cycle and maximizing socio-environmental benefits (public health, job creation, safeguarding water quality, reducing water-related hazards). (MWRWS-b, 2020). [8]

III a) Strategy for the Reuse of Wastewater in Algeria (Infrastructure and Sanitation System)

Algeria has incorporated the principles of sustainable development into its national water policy since its adherence to the World Convention on Sustainable Development in 1995, particularly

Sustainable Development Goal 6. (ODD6). This includes actions to save water, such as waste recycling, in accordance with Law No. 05-12. The objective of the National Water Plan is to ensure systematic collection, treatment, and reuse of domestic and industrial wastewater, as well as rainwater and runoff, in order to minimize the degradation of invaluable resources.

In order to promote the reuse of wastewater, steps are being considered for the restoration and upgrading of wastewater treatment plants (WWTPs) through secondary and tertiary treatment methods, with the aim of increasing their long-term efficiency. Tertiary processes will make their application easier for garden irrigation, fish farming, and some industrial sectors. However, they will have to comply with strict sanitary standards to ensure potability, particularly through infiltration basins and the recharge of groundwater aquifers.

At present, 200 wastewater treatment plants and a network of 47,000 km make up the sanitation system in Algeria. The sewer connectivity rate is 91%. (MWRWS-a, 2020). Nearly 53% of the generated wastewater (480 hm³/year) undergo various treatment methods. (biologiques, chimiques, physico-chimiques). However, only 6% of this annual volume, or 20 hm³/year, is reused for irrigation. The rest is moved to areas of humidity, whether they are natural or artificial. (MWRWS-b, 2020).

Nearly 7,900 hectares of cultivated land (vineyards, olive trees, fruit trees, wheat, barley) are treated by treatment plants located mainly in northwestern Algeria. The increase in areas irrigated with treated wastewater is noted by the Ministry of Water Resources and Water Security (MWRWS), despite technical limitations (constant water quality control, strict sanitary standards, lack of suitable infrastructure) and social obstacles (vandalism, rejection of costs).

It is necessary to obtain official authorization, implement preventive measures, maintain the facilities, and regularly check the water quality, while adhering to Algerian standards (No. 17683) and good practices. It is imperative to prohibit certain applications, such as the irrigation of vegetable crops. (MWRWS-b, 2020).

It is crucial to implement preventive sanitary actions to ensure the protection of individuals who handle wastewater and cultivated soils. National standards govern the technical specifications of treatment systems, based on the final use intended for agricultural, municipal, or industrial applications (executive decree No. 10-23). Moreover, a 100-meter limit is imposed around irrigation areas, near hydraulic installations, roadways, and housing (Executive Decree No. 07-149) to ensure protection.

III b) Conditions for implementing the wastewater reuse strategy in Algeria (budget, acteurs).

The implementation of the WWR strategy is primarily based on the improvement of the sanitation system and the modernization of existing infrastructure. A specific evaluation program has been launched in several Wilayas/departments of the country for this purpose. Moreover, the MWRWS has encouraged academics and economic partners to conduct innovative research on unconventional resources, such as treated wastewater, while optimizing water use and the energy recovery of primary sludge (Aroua-Berkat, in preparation). Pilot projects for energy production (electricity and biogas) as well as interseasonal storage of treated wastewater are already underway in the wilayas of Algiers, Blida, and Annaba. (MWRWS-b, 2020). For example, as illustrated in Figure 3, the capacity of the Beni Messous wastewater treatment plant (Algiers Wilaya) will increase from 250,000 to 500,000 equivalent inhabitants. The resulting treated water will be used by the municipality for road cleaning and watering public green spaces, including forests. (MWRWS-b, 2020).

However, the spatiotemporal variability of the potential volume of treated wastewater remains difficult to control and predict, due to various natural factors (such as water stress and periods of drought) and anthropogenic factors. (comme le transfert depuis le site de production). According to the MWRWS, it is therefore complicated to assess and reconcile supply and demand, regardless of the final use. (MWRWS-b, 2020).

Approximately one-third (about 33%) of the budget allocated to sanitation is intended for the financing of WWR, which is under the responsibility of the National Sanitation Office (Executive Decree No. 01-102) and, to a lesser extent, the National Ministry of Irrigation and Sanitation (Executive Decree No. 05-183). The financial contribution from the agricultural sector as well as from other potential beneficiary sectors (such as local authorities and industries) is also considered. (MWRWS-b, 2020).

This budget is allocated for the construction and/or rehabilitation of existing infrastructures whose current capacity is deemed insufficient for several reasons identified by the MWRWS: i) a deficient organization (lack of collaboration and intersectoral coordination, non-compliance with standards), ii) technical failures (complex processes, absence of storage infrastructure), iii) low

support from end users (lack of communication and training), and iv) a lack of funding (water supply being a priority, with high operating costs compared to benefits). For example, the water sector is working on updating and reorganizing the legal and political framework to promote intersectoral consultation and public-private partnerships (Executive Decree No. 10-24).

IV) FINANCING AND FINANCIAL INFRASTRUCTURES.

THE JOINT USE OF PUBLIC AND PRIVATE RESOURCES:

There is a significant infrastructure deficit in developing countries. About one billion people do not have access to electricity, 2.4 billion use unimproved sanitation facilities, and 660 million do not have access to a source of drinking water. The majority of this deficit is concentrated in the poorest countries of Africa and Asia. At the current rate of investment, it seems unlikely that this gap will be closed. The available figures show that the investments made are well below the estimated needs. For example, Fay and his colleagues (2019) estimate the annual expenditures needed to be between 1.9 and 3.5% of GDP for Africa, between 3.7 and 4.7% of GDP for South Asia, and between 2 and 3.2% of GDP for Latin America.

These percentages are well below the estimated average needs, which stand at 9.2% for Africa, 7.5% for South Asia, and 4.5% for Latin America. (Rozenberg et Fay, 2019). Excluding China, the Asian Development Bank (2017) estimates the investment gap at 5% of GDP for developing Asian countries. Using survey data from 1.6 million households in 14 Latin American countries between 1992 and 2012, Fay and Straub (2019) show that, according to current trends, it would take between three and more than nine decades to connect the poorest 10% of households to a water supply system.

This situation is partly due to the inability of the poorest countries to mobilize the necessary resources to provide essential services to their population. They often depend on significant concessional loans from international institutions and bilateral donors. However, given the scale of the required investments, these actors also fail to bridge the financing gap. For example, in developing Asian countries, multilateral development banks (MDBs) have only contributed 2.5% of total infrastructure investments, and 10% if China and India are excluded. (BAD, 2017).

This situation has led the MDBs and major international donors to seek to attract resources from the private sector. The idea is that, under certain conditions, public finances can encourage

private funding towards infrastructure projects through blended finance agreements, sometimes referred to as the "billions to billions" strategy. A more refined version of this argument can be found in the World Bank's guidelines "Maximizing Finance for Development," which proposes a step-by-step approach to prioritize and attract commercial financing not guaranteed by the government, by assessing their viability and addressing regulatory and institutional reform needs. (Banque mondiale, 2017). However, to date, out of a total of approximately 1 trillion dollars invested each year in developing countries, only 9 to 13% comes from the private sector. (Fay et al., 2019).

V) SUSTAINABLE SANITATION AND GAPS IN GLOBAL CLIMATE POLICY AND FINANCING

Target 6.2 of the Sustainable Development Goals (SDGs) aims to ensure universal access to "safely managed" sanitation facilities and to eliminate open defecation. Achieving this goal will require considerable efforts, as approximately 5.6 billion people will need to use safe services, and 1.3 billion will need to transition from open defecation to sanitation systems by 2030.

According to the Joint Monitoring Programme, "safely managed" services refer to improved sanitation facilities that are not shared with other households, and where excreta must be safely treated on-site or transported and treated off-site. Target 6.3 is closely related, as it concerns the proper treatment of wastewater, the majority of which is currently discharged untreated.

Climate change impacts existing sanitation systems and complicates progress towards these goals by increasing the variability of the water cycle, causing increasingly intense climatic events, and making water supply unpredictable. These impacts also exacerbate existing challenges, such as the sustainability of infrastructure. Heavy rains and floods can cause physical damage to sanitation infrastructure, as well as indirect effects related to transportation and energy supply, thereby disrupting the operation and maintenance of the systems. In coastal areas, rising sea levels are expected to exacerbate flooding. Pit latrines and septic systems become non-functional when flooded and can collapse during storms, forcing users to resort to open defecation. These events also harm the systems for collecting and transporting fecal sludge, particularly in dense urban areas and informal settlements.

The reduction in precipitation and limited water availability affect sewer systems, which rely on an adequate water supply to eliminate waste. A lack of water due to drought can increase the concentration of pollutants, thereby increasing the contamination of wastewater, especially when

it is discharged untreated into the environment. Moreover, high temperatures and extreme weather events can alter the spread of diarrheal diseases, compromising the progress made in public health over the past decades.

This situation requires a careful examination of adaptation options, which should not be limited to technical considerations. Improving access to sanitation and wastewater treatment is also crucial for mitigating climate change, as emissions in this sector have often been neglected. Although the impact of climate change on sanitation is recognized, there are gaps in addressing mitigation and adaptation, leading to poor integration of policies, programming, and financing in sanitation and climate.

Sanitation and wastewater treatment systems contribute to greenhouse gas (GHG) emissions, both directly through the decomposition of excrement and indirectly due to the energy required for treatment. Centralized treatment plants, which consume a lot of energy, account for about 3% of global electricity consumption. The degradation of organic matter in these plants contributes to approximately 1.57% of global GHG emissions, and 5% of greenhouse gas emissions other than carbon dioxide. Although GHG emissions from biological processes in treatment plants are significant in some countries, they often remain poorly understood due to a lack of data and the complexity of models. This information will be essential as countries seek to improve wastewater treatment coverage.

For example, in China, urbanization led to a 400% increase in domestic wastewater emissions between 2000 and 2014. In the metropolitan area of Santiago, Chile, GHG emissions related to wastewater could reach approximately 50% of national emissions by 2027. Furthermore, it is possible to reduce energy consumption during the transport of wastewater by using gravity systems and decentralized facilities that minimize pumping distances. The decisions made today regarding the development of wastewater treatment systems and the replacement of aging infrastructure will have lasting impacts on climate action.

V 1) Sanitation absent from the climate policy debate

The range of mitigation and adaptation opportunities related to sanitation systems and wastewater treatment shows that these possibilities are often overlooked in the context of climate policies and financing. To understand the place of sanitation in the climate policy debate, it is useful to examine its inclusion in the nationally determined contributions. (CDN).

Although the NDCs are not legally binding, they reflect national priorities and interests in terms of mitigation and adaptation. Water is one of the five main sectors identified as vulnerable to climate change by 100 countries. However, despite this recognition, few concrete actions regarding sanitation are proposed. The SDG-NDC Connections tool analyzes and quantifies the synergies between mitigation or adaptation activities included in the NDCs and the SDGs, focusing particularly on access to safe sanitation and wastewater treatment. According to our analysis of the data from this tool, only 2% of NDCs mention access to sanitation, while 3% refer to wastewater management.

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Upon closer examination of activities related to access to sanitation and wastewater management, it appears that the majority of initiatives are focused on adaptation, with little effort dedicated to mitigation. Sanitation and wastewater treatment activities are primarily reported by lower-middle-income countries, while inclusion is very limited in high-income countries. Geographical trends also emerge, with a higher concentration of sanitation-related activities in the Middle East and North Africa (MENA) region and Sub-Saharan Africa. This can be attributed to the significant experience in water reuse and treatment in the MENA region, as well as the water scarcity challenges faced by these regions.

It is also important to note that no sanitation-related mitigation activities are included by the United States, Indonesia, India, or China, even though these countries are responsible for nearly half of the global methane and nitrous oxide emissions from domestic wastewater. This limited inclusion of sanitation activities in the NDCs suggests that national policymakers may not recognize the role of sanitation in climate action or lack evidence regarding these links.

V 2) Is climate financing part of the problem or part of the solution?

The capital investment required to achieve Sustainable Development Goals 6.1 and 6.2 related

to drinking water and sanitation is almost three times higher than the current investment level. These financial issues highlight the sectors where current expenditures are insufficient to meet the Sustainable Development Goals by 2030. However, it is crucial to consider how these investments will be made in order to contribute to solving the climate problem. Climate financing allows for meeting these investment demands by focusing on sanitation measures, but so far, it has been heavily restricted.

The study conducted by the authors on the projects approved by the board of directors of the Green Climate Fund (GCF) until April 1, 2019, reveals a limited number of projects focused on or associated with sanitation and waste. So far, the GCF board has only approved 7 projects that included a specific aspect related to sanitation or wastewater. Moreover, the funding for these sanitation systems primarily came from development banks or national governments rather than the GCF itself.

Two projects did not receive significant funding for the sanitation component, while the other five benefited from 1.24 million dollars from the GCF out of a total budget of 5 billion dollars allocated for approved projects. This corresponds to <0.025% of the project budgets approved by the GCF.

The analysis of OECD information regarding climate-related official development assistance (ODA) reveals a similar trend. In 2017, commitments for climate change-focused water supply and sanitation projects reached a total of 938 million dollars.⁴⁴ That same year, projects aimed at reducing and adapting basic sanitation issues and large sanitation networks received 29 million dollars. This constitutes 3% of the climate funds allocated to the field of water supply and sanitation. Even though other codes like "Basic Water Supply and Sanitation" also include sanitation projects, studies have shown that there is a dilution of ODA funding for drinking water supply and sanitation. It is estimated that this database indicates significant overestimations, with significantly fewer projects than reported that could be useful in climate change mitigation and adaptation.

VI) INTEGRATED WATER RESOURCES MANAGEMENT APPROACHES TO IMPROVE WATER RESOURCES GOVERNANCE.

Water constitutes and also occupies an essential place both in the natural environment and in the lives of individuals [11,12]. Little water, consisting of 2.5% freshwater and the rest saline, is easily exploitable to meet the multiple needs of the population, thus testing the myth of

inexhaustibility [13]. Thus, the global water crisis, marked by increasing water demand, restricted access to drinking water, poor management of water resources, and uncertainties, can also be considered a governance crisis in watersheds [14]

Water resource users, managers, and the interests of each for a comprehensive consideration [12,15-17]. One of these methods is Integrated Water Resources Management (IWRM), which complies with the guidelines of Agenda 21 of the 1992 International Conference on Environment and Development, section 2. These suggestions led to the establishment of the Global Water Partnership (GWP) in 1996. Encourage a comprehensive management of water resources while strengthening their governance and control for sustainable and equitable development [15–17]. Integrated water resources management is defined as an approach that encourages the coordinated development and administration of water, soil, and related resources with the aim of equitably optimizing social and economic well-being, while preserving the sustainability of vital ecosystems [18]. To implement a comprehensive water resource management strategy, it is essential to establish a conducive context that includes appropriate policies, strategies, and laws, as well as an institutional framework and suitable management mechanisms [19]. Moreover, the four water principles from [19,20] must be implemented:

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Freshwater is a limited and inaccessible resource, crucial for the preservation of life, development, and the environment. It is imperative to adopt a participatory approach that involves users, planners, and policymakers at all levels. Women play a crucial role in the supply, management, and preservation of water. Moreover, it has economic value in all its competitive applications and deserves to be valued both as a social good.

Despite their connection, the concepts of integrated water resources management and water governance do not exclude each other [21-24].

The potential reasons for focusing on water management include the documented constraints and obstacles related to the application of the concept of integrated water resources management worldwide [20,21]. For some, it is controversial to focus on the signs of water supply shortages and the reduction of water resources while neglecting the deep-rooted origins of power inequalities, unjust patterns between different countries, and the lack of democratization [14]. The deficits can lead to the exclusion of informal and traditional water management systems and governance reforms in developing countries [25,26]. Thus, the issues related to water

management cannot be resolved solely through infrastructure, but also through the control of water resources. The integrated water resources management approach addresses governance and water management, which have conceptual differences while being interdependent. Water management refers to the central process that enables the implementation of measures aimed at achieving defined objectives [27]. It includes structural actions such as soil erosion control, flood control devices, and non-structural measures like behavior change, education, appreciation of water resources, allocation, monitoring and regulation of pollution, financial management, information, and planning for human and environmental reasons [23].

Many countries in East Africa, the Mediterranean, the Caribbean, Central and Eastern Europe, South Asia, among other regions, are adopting or ratifying the integrated water resources management strategy through the Global Water Partnership [28]. In this work, we focus on examples from Uganda in East Africa. Pilot projects for integrated water resources management have been established in selected watersheds to assess the potential of this method to optimize water resource management. Analysis (a) examines the presence of a significant difference in water resource management in the watersheds where integrated water management methods have been implemented. Moreover, analysis (b) determines whether effective water resource management has been implemented in these watersheds. We hope that the results will provide empirical evidence on the ability of comprehensive water resource management methods to alleviate the water control crisis, with the aim of amplifying these methods.

VI-1) The concept and context of water resource governance

It is estimated that the management of water resources impacts their governance by determining power, ownership, constraints, decision-making processes, and the steps to be followed.

Therefore, if governance is ineffective, it could also affect management. This manifests as a degradation in the quality and volume of available resources, restricted access to functional resources, significant costs associated with the services provided, and inefficiency in its implementation [29]. The functions of water resource management mainly include: (a) assistance in the development and implementation of institutions, laws, and policies regarding water resources; (b) clarifying the responsibilities of the government, civil society, and private sector water services, promoting dialogue and coordination between different entities, stakeholder involvement, and conflict resolution; and (c) determining water rights and regulations [30]. Thus, elements of management and governance support water use systems [29,30].

The concepts of governance can encompass different mechanisms of authority and decision-making, whether through markets, hierarchies, or networks. Governance can also encompass the actions of social, political, and administrative stakeholders perceived as intentional attempts to direct, lead, supervise, or manage the administration of public goods [32,33]. In a higher hierarchy, governance encompasses the use of economic, political, and administrative authority to manage national affairs at each level. It is perceived as a set of mechanisms, procedures, and institutions through which citizens and civic entities express their interests and assume their responsibilities. As indicated in [34], the definition of water resource management also varies. However, we have favored a perspective that includes a variety of political, social, economic, and administrative mechanisms aimed at the development and management of water resources, as well as the provision of water services within society [35]. It seems that the various perspectives on water resource management frequently illuminate contradictory strategies and policy choices. Some perspectives reproduce political processes, marked by the confrontation of rival political theories based on distinct government values and principles [31].

Recently, many individuals see water resource management as a pragmatic approach of "pluralism." Pluralism envisions various types of interactions arising (a) from the manifestation of traditional forms of authority embodied in the State (hierarchical structures), (b) from the private sector (dominated by market competition), and (c) from the associative domain. Or "civil society" (defined by the will, reciprocity, and solidarity of citizens) by the stakeholders in the water sector. Thus, these concepts include "public-private partnership" and "tripartite partnership" [23,31].

The concept of good governance, which refers to a framework that adheres to principles of water resource management, requires the consideration of various interests in decisions regarding water, while acknowledging the crucial role of power and politics [23]. Among the principles of water governance are transparency, accountability, responsiveness, equity and inclusion, stakeholder engagement, legal compliance, integrity, efficiency, and effectiveness in service delivery [37].

Various entities and stakeholders highlight various captivating governance principles, while emphasizing accountability, participation aimed at engaging all concerned parties in the decision-making process, and transparency which ensures that all relevant information is disseminated in a

timely manner [22,24,35,36,37,38].

Thus, effective governance of water resources is linked to good management, which leads to optimal management of these resources. The failure of a series of technical solutions to water problems is also linked to poor governance [29].

However, in research and monitoring of water resource management, it is complex to evaluate relative and descriptive concepts such as "good," "poor," "bad," as well as the "principles of good governance" formulated [35] to reach a generalizable consensus. In the governance debate, other aspects include the scope and degree of measures concerning water. That is why it is essential to develop a management system appropriate to the geographical and jurisdictional dimensions of the resource. [32, 37, 39, 40]. In water management, certain strategies have led to (a) a strategy of water resource integration that emphasizes the different functional, operational, organizational, and constitutional levels that are interconnected as a decision-making process [35]; (b) the notion of a multi-layered administration aimed at simplifying administrative and ecological scales at the supranational, national, regional, and local levels. This also involves a transfer of control and power from the state to international actors, then to regions, cities, and communities, and ultimately to external entities. Regarding civil society and non-state entities [32,41]. The previously mentioned innovations ensure the adjustment of governance responses based on territorial particularities, an elaboration tailored to the context and appropriate solutions [42,43].

Some of the conceptual changes regarding monocentric governance forms may have been influenced by the issue of the dimension and degree of intervention in the management of natural resources [32]. In monocentric governance, the state is primarily the central point of power, authority, and control over society, the economy, and resources. Unlike multipartite methods where state authority values reciprocal interdependencies. Therefore, monocentric administration requires the establishment of the agenda of social issues, the selection of goals and political resources, and the top-down implementation of policies. Unlike polycentric systems that operate in a network, at multiple scales, within the terrestrial system, with adaptive management devices, and with collaborative management devices [30,32]. In Table 1, we highlight the water resource management systems on which our research focuses more.

PART 2
WATER POLICY IN ALGERIA

Chapter 1

**Supporting the Ministry of Water Resources in its
Integrated Water Resources Management Policy**

I) BACKGROUND

1) Strategic framework

As part of the partnership between Algeria and the European Union, the Association Agreement (AA) came into force on September 1, 2005. It constitutes the legal framework governing relations between the parties in the economic, commercial, political, social and cultural fields. In this context, which began aims to:

- Facilitate the success of the partnership between Algeria and the European Union,
- Strengthen the process of implementing the AA.

The aim is to support the implementation of the AA in all its dimensions. Its areas of intervention include:

- Direct support to administrations in charge of AA implementation,
- Setting up an organizational structure for the Program,
- Ongoing information of the players directly or indirectly involved, and of the public, on the implications of implementing the AA.

The Association Agreement concluded on April 22, 2002 between the People's Democratic Republic of Algeria and the European Union (EU), stipulates in Title V, Article 52:

"The Parties shall promote cooperation in combating environmental degradation, controlling pollution and making rational use of natural resources, with a view to ensuring sustainable development, the quality of the environment and the protection of human health".

Paragraph 2 of the same article specifies that "cooperation shall focus in particular on :

- Issues related to desertification;
- Rational management of water resources;
- Salinization;
- The impact of agriculture on soil and water quality;

Similarly, the roadmap for implementing the Association Agreement adopted at the end of the first session of the Association Committee, held in Algiers on September 16 2008, states in its Annex 1:

"Environmental protection: deepen cooperation in key sectors, such as water and the marine environment, deepen cooperation in the field of environmental governance: strengthen cooperation in the implementation of multilateral environmental agreements, notably in the fields of climate change and the protection of the marine environment and the Mediterranean coastline: cooperation within the framework of regional initiatives of common interest. [46].

- **Background and rationale for twinning**

Over the decade (2001-2011), Algeria has made considerable investment efforts to build a large number of water resource mobilization, transfer, treatment and supply facilities, in order to meet the ever-increasing demand for various water uses. The scale of the investments made under the various programs has produced tangible results in terms of meeting water needs, both in terms of quantity and quality.

As part of the 2010-2014 five-year plan, several projects have been scheduled, including the construction of:

- 18 large dams;
- 127 hill reservoirs;
- 65,780 ml of boreholes;
- Water mobilization: 11 dams;
- Drinking water supply (AEP): 13,000 km of AEP networks and 11 drinking water treatment plants;
- Sanitation: 6,000 km of sanitation networks, 73 WWTPs and lagoons, including 05 WWTPs, and protection of 90 towns against flooding;
- Agricultural hydraulics: 40,000 ha equipped and 96 hill reservoirs;
- Seawater desalination: 13 plants.

Algeria's new water policy is based on the following principles:

- Unicity of the resource (surface water, groundwater)
- Integrated, concerted, participatory management at watershed level
- Economic management
- Ecological management (respect for the environment)
- The principle of equity and security of supply,
- Sustainability and good governance.

Water resource policy is also inspired by regional development policy, which aims to create a dynamic rebalancing of the region, and in particular the sustainable development of the High Plateaux and the South. To achieve this objective, major water transfers are required, as well as the use of non-conventional resources, in particular seawater desalination, the reuse of purified wastewater and the implementation of a water-saving policy. [47].

The main strategic axes of the water resources sector are based on:

- Improving knowledge of resources,
- Mobilizing as many conventional and non-conventional resources as possible,
- Interconnection between dams, to compensate for the spatial irregularity of inflows and the poor distribution of resources,
- Continuation of the ongoing program of major regional water transfers,
- Securing drinking water supplies for populations in coastal areas through seawater desalination,
- Putting in place instruments for good governance and better water management (institutional, legal and organizational reforms, modernization of management tools, public-private partnerships, etc.),
- Ensuring better access to sanitation,
- Improving the efficiency of water supply and irrigation networks, through network rehabilitation,
- Combating pollution,
- Development of large-scale irrigation schemes, and small and medium-scale hydraulic engineering,
- Water transfer projects for agricultural purposes. [48].

Water is a major concern in Algeria, which is characterized by an arid and semi-arid climate; and its proper management is a duty for those in power, who have an obligation of means, and for every citizen, who must adopt the right behavior to ensure the sustainability of the resource. For a long time, water resource management was essentially a sectoral affair, not just because of the country's vulnerability to rainfall deficits and irregular spatial and temporal patterns. Awareness of water-related issues has gradually converged towards a consensus in favor of an innovative approach to water resource management. IWRM has thus emerged as one of the approaches for achieving good water governance. [47].

2) What IWRM means

IWRM is based on a global vision that takes into account the dynamics of water resources within natural spaces such as river basins or aquifers, and involves all water stakeholders in a new

management framework, enabling all uses to be reconciled as effectively as possible for the continued development of a region or country, while preserving the needs of future generations.

IWRM therefore means:

- A cross-sectoral approach integrating ecological, economic and social objectives to achieve multiple, cross-cutting benefits.
 - Cross-sectoral integration, integration of uses, integration of demands, integration with both the environment and populations.
 - Coordinated management of water, land and related resources.
 - Stakeholder participation to facilitate broad ownership and responsibility for resource preservation.
 - Active involvement of affected people and interest groups in conflict resolution.
 - Promotion of sustainability to mobilize more resources, and socially responsible resource management that benefits all components of society and combines new institutional methods.
- 1- Systemic approach that recognizes both individual components and the interactions between them, and that any disruption of one system leads to a modification of the others. [47].

II) PROGRAMS IN SUPPORT OF THE WATER RESOURCES SECTOR

Algeria has benefited from several cooperation programs in support of this policy.

1) EAU I programs

The water resources sector benefited from a €20 million program from 2006 to 2011. This program provided support for updating the National Water Plan (PNE), strengthening the institutional framework for resource management and implementing dynamic tools for managing aquifer systems, dams and reservoirs, in particular by setting up an information system and a geographic information system.

2) EAU II programs

Officially launched in January 2013, the €30 million Water II program is dedicated to budget support for the sanitation sub-sector.

The overall objective of this program is to support Algeria's sanitation policy, and in particular to protect against water-borne diseases (WBDs), by improving the quality of treated water.

3) ADE/SWE twinning

The water sector has benefited from a twinning project between Algérienne des Eaux (ADE) and Société Wallonne des Eaux (Belgium). The contract for this P3AI project was signed on December 30, 2010.

Worth 1,000,000 euros, the twinning ended in July 2012.

The general objective of the twinning is to contribute to improving public health in Algeria and the quality of the water distributed.

The specific objective is to strengthen the capacity of Algérienne des Eaux to improve the quality of the water distributed by its networks.

This twinning project, which lasted 18 months, achieved the 4 results set out in the twinning contract:

- Reinforcement of ADE's self-monitoring of water quality;
- Improved management of non-conformities, including emergencies;
- Implementation of a short-, medium- and long-term continuous improvement process for water quality;
- The implementation of a best-practice water quality communication system.

Concrete results achieved through twinning include:

- Commitment to ISO 17025 certification for the Algiers central laboratory;
- Training staff at the Algiers central laboratory and regional laboratories in the latest analytical techniques;
- Development and deployment of a computer program for sample management, based on web technologies and an SQL database;
- Setting up a pilot production and distribution unit in which water quality and crisis management procedures have been defined and implemented;
- Definition and implementation of reliable water quality indicators;
- Validation of a project plan for the implementation of an ISO 9001 approach;
- Validation and publication of a quality policy based on ISO 9001 standards;
- An audit of the company's water quality communication policy and organization. This audit contains concrete proposals for improvement;
- Improvement of the water quality non-conformity management guide;
- Development of a computer program to capitalize on experience, particularly in non-conformity management;
- Implementation of measures to reduce vulnerability to contamination in production and distribution;
- The planning of training courses in non-conformity management.

Among the measures and procedures designed to ensure the sustainability of the results achieved during the twinning, ADE must, in particular, pursue the implementation of an ISO 9001 total quality system. It must also continue the protocol initiated with the ALGERAC certification body until accreditation is obtained. [46].

4) Specific action N°1.4/24 "Identification of technical assistance needs and instruments to be mobilized accordingly".

Several institutions, some of them new, under the supervision of the Ministry of Water Resources are in need of reinforcement and support, particularly in the field of water governance and managerial capacity building.

With a view to one or more twinning arrangements, the MRE needs to identify priority areas for which requests for support need to be formulated in a way that is relevant and able to target a crucial need relating to cross-cutting and institutional functions.

Therefore, at its request, a one-off action to support its services in defining and identifying needs that should lead to short- or long-term technical assistance actions was carried out in October 2013.

In the context of strengthening the managerial and institutional capacities of the Ministry of Water Resources through its central and mandated structures, the results assigned to this mission were three in number:

- **Result 1:** a strategic priority area for technical assistance was identified.
- **Result 2:** a SWOT analysis of the various structures and organizations involved in strategic planning and capacity-building in water management is drawn up.
- **Result 3:** appropriate support instruments to meet identified needs are recommended, and priorities for organizational and managerial capacity building are defined.

This twinning project falls within the scope of Outcome 1, which has, in particular, highlighted the need for institutional strengthening in governance and integrated water management. [46].

III) INTEGRATED WATER RESOURCES MANAGEMENT POLICY (IWRM)

The Algerian government has enacted modern water legislation in the form of Law 05-12 of August 4, 2005.

IWRM is based on the principles of:

- Unity of the resource (surface water, groundwater),
- Integrated, concerted, participatory management at watershed level,
- Economic management,
- Ecological management (respect for the environment),

- Equity and security of supply,
- Sustainability and good governance.

The water resources policy is inspired by the regional development policy, which aims to create a dynamic rebalancing of the territory, in particular the sustainable development of the High Plateaux and the South. Achieving this objective requires the implementation of a policy of water conservation and resource management, enabling the distribution of water and the use of new "non-conventional" resources (purified or desalinated water).

The main strategic axes of the water resources sector are based on:

- Improving knowledge of resources,
- Mobilizing as many conventional and non-conventional resources as possible,
- Interconnection between dams, to offset the spatial irregularity of inflows and the poor distribution of resources,
- Pursue the ongoing program of major regional water transfers,
- Securing drinking water supplies for populations in coastal areas through seawater desalination,
- Implementing instruments for good governance and improved water management (institutional, legal and organizational reforms, modernization of management tools, public-private partnerships) [46].
- Ensuring better access to sanitation,
- Improving the efficiency of water supply and irrigation systems, by rehabilitating networks,
- Combating pollution,
- Development of large-scale irrigation schemes and small and medium-scale water supply,
- Water transfer projects for agricultural purposes.

To achieve this, the entire water sector: The Ministry, its supervised institutions (EPAs and EPICs) and their subsidiaries (the Ministry's armed forces) must be able to:

Work in synergy, in the service of Algeria and its supervisory authorities;

- Collaborate more closely by pooling their knowledge, human and material resources, in joint actions or in which each takes its place and no more;
- Train their technical and managerial staff on an ongoing basis to meet the technical challenges of geographical, health and social, national, regional and even global nature, and in particular by opening up management as a whole to modern managerial practices in Water Resources Management and Human Resources Management;

- Cooperate more closely with the national and international technical and scientific community in a dynamic exchange of knowledge.

It is in this context that the national agency for integrated water resources management "AGIRE" was created by executive decree N°11-262 of July 30, 2011. [46].

AGIRE is essentially responsible for carrying out all actions intended to contribute to integrated water management, including in particular:

- Carrying out surveys, studies and research related to IWRM;
- Developing and coordinating the integrated water information management system on a national scale;
- Contribute to the preparation, evaluation and updating of medium- and long-term sector development plans at national level;
- Contribute to the management of incentives for water conservation and the preservation of water resource quality;
- At river basin level, AGIRE's mission is to collect the fees instituted by current legislation and regulations.

AGIRE carries out the public service duties assigned to it by the State on the basis of a set of specifications. [46].

1) Purpose of the proposed twinning

a) Beneficiary institution

The Ministry of Water Resources, and more specifically the Direction of Integrated Water (DGIRE).

b) Purpose of the planned twinning

b1) General objective

The general objective of this twinning project is to contribute to a better consideration of the issues of resource preservation and water demand management in an integrated approach. Ultimately, it aims to contribute to a shift in public policies and strategies, currently still focused on increasing supply, towards more sustainable management integrating qualitative and quantitative control of demand. [46].

b2) Specific objective

The project aims to support the improvement of water resource governance in Algeria by strengthening the institutional, organizational and technical capacities for governance and integrated water resource management of the Ministry of Water Resources (MRE).

It should help improve the MRE's strategic approaches and intervention methods in key areas (conventional water resource management, water management at the agricultural plot level, water pollution control). [46].

b3) Expected results

R.1. Institutional, managerial and organizational capacities for monitoring and steering water policy are strengthened through:

- drawing up an action plan for water and soil conservation
- strengthening the DGIRE's capacity to improve sectoral governance
- The implementation of a cross-sectoral approach integrating ecological, economic and social objectives to achieve multiple, cross-cutting benefits.
- Definition of a directory and reference system for water professions
- The design of a strategy and communication plan for a national water-saving awareness campaign involving the various target groups (administrative structures, municipalities, NGOs, civil society). [46].

R.2. Operational management of water resources is improved through:

- Drawing up guidelines on the economic and technical instruments needed to prepare river basin management plans.
- Training in the use of economic instruments for water management
- Defining a funding strategy to support the current and future missions of beneficiary institutions (logistics, human resources, training, etc.), based on a budget planning exercise.

R.3. An information system to optimize internal and external coordination of beneficiary structures is defined:

- Identification and assessment of information technology needs for the implementation of economic instruments
- Identification of information sources and flows; integration of information systems of supervisory bodies
- Diagnosis of current exchange procedures and proposals for improvement
- Establishment of a database system to process and disseminate economic data. [46].

IV) RELATED PROJECTS AND INITIATIVES

a) The Sustainable Integrated Water Management (SWIM) program:

SWIM is a 22million euro project funded by the European Commission and implemented through two closely interrelated and integrated components, the breakdown of which is as follows:

- A budget of 6.7 million euros for the Support Mechanism (SWIM-SM) over 04 years (2010-2014)
- A budget of 15 million Euros for Demonstration/Pilot Projects.

SWIM's partner countries are: Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Occupied Palestinian Territories, Syria and Tunisia.

Within this framework, Algeria has benefited from the funding of a single regional WADIS-MAR project, entitled "Water use and agricultural techniques in arid zones: an integrated and sustainable model in the Maghreb region". This project is one of five demonstration projects, to which the European Union is contributing 2,741,235.07 Euros. Carried out in coordination with the University of Cagliari (Italy) and with the participation of ANRH, OSS and the Institute of arid region (Tunisia), the project focuses on artificial groundwater recharge, with the Biskra region in Algeria as a pilot zone.

The overall aim of WADIS-MAR is to improve the standard of living of the rural population in the arid and semi-arid zones of the Maghreb, where water scarcity is contributing to the desertification process. [46].

V) DESCRIPTION OF THE MISSION TO PREPARE THE DATA SHEET

1) General objectives of the assignment

The general objective of the assignment is to support the Ministry of Water Resources and the Association Agreement Implementation Support Program Management Unit (UGP-P3A) in the preparation of a twinning project.

2) Specific objective

The specific objective of the mission is to support the MRE in drafting a twinning reference form to achieve the objectives defined above (Cf. 1.6).

This form will be sent to all EU member states as part of a competitive call for proposals.

3) Contracting authority

The contracting authority is the Association Agreement Implementation Support Program Management Unit (UGP-P3AIII). [46].

4) Beneficiary of the assignment

The beneficiary of the assignment is the Ministry of Water Resources (MRE).

This fact sheet will be sent to all European Union member states as part of a competitive call for proposals. [46].

5) Services required - Methodology

Based on the project cycle management guidelines adopted by the European Commission, two outputs are expected: [49].

Result 1: Elaboration of the twinning intervention logic

As a first step, the mission will examine in greater depth the rationale for twinning in terms of the Association Agreement, the priorities set out in the accompanying roadmap and the Union's acquis.

Through an analysis of the MRE's situation, in particular its DGIRE, the exhaustive identification of stakeholders and the determination of their needs, the mission will propose the objectives set for the twinning as well as the minimum expected results and planned activities.

On this basis, the mission will propose the strategy chosen for the twinning and will draw up a first version of the logical framework including the results indicators and an estimate of the means to be implemented. [46].

Result 2: Definition of all aspects of the twinning project

The mission will study the feasibility of the selected activities, in particular with regard to the MRE's capacity to implement them jointly with the twin EU institution. It will define precisely the resources to be mobilized to carry out these activities, and establish the budget required for their implementation.

The mission will also define the organizational structure of the twinning and draw up a timetable for its implementation, both in terms of activities and resource mobilization.

These elements will enable it to produce the twinning project sheet as described in the twinning manual and its appendices [46].

Throughout its work, the mission will apply the principles of the logical framework approach as described in the project cycle management guidelines.

The mission will take place in 2 phases of 15 days each. The first phase will be devoted to the construction of the intervention logic, and the second to the definition of twinning in all its dimensions.

During the first week of the project, based on the meetings held, the team will draw up a project plan based on the model attached in Appendix 1, covering all phases of the project. This work plan will enable the mission to comment on the feasibility of the work requested, and to suggest any necessary adaptations. Validation of this work plan by the beneficiary party will confirm the orientations adopted. [47].

6) Deliverables

a) Work plan

Five days after its arrival, the mission will submit the intervention plan. This plan will be validated at a meeting to be held with the MRE and the PMU within four days of its submission.

b) For activities under Outcome 1

1. Depending on the situation: analysis of gaps in relation to the target situation (reconciliation with the Union acquis) or analysis of hierarchical constraints (cause-effect) presented in the form of a tree.
2. Logical framework to be proposed

c) Activities planned under Outcome 2

1. Twinning project sheet
2. Detailed budget
3. Twinning project organizational structure. [46].

Chapter 2

Water policy in Algeria

I) INTRODUCTION

Water policy in Algeria is a crucial issue of strategic importance, both environmentally and socio-economically. Because of its geography, Algeria faces challenges linked to the scarcity of water resources and their sustainable management. To meet these challenges, the country has developed a water policy aimed at ensuring access to drinking water, encouraging agricultural irrigation, preserving the aquatic ecosystem and supporting economic development.

As you know, the demand for water in Algeria continues to grow, due to a number of factors. Algeria's population has risen from 9 million in 1962 to 43 million in 2019, an almost fivefold increase. The rate of urbanization has risen from 30% to 73% over the same period, increasing the need for drinking water and sanitation.

Industrialization and economic diversification have also generated increased demand for water in the productive sectors. Finally, agriculture remains the main water consumer in Algeria, accounting for around 60% of total withdrawals. [46].

II) Water policy in Algeria

Algeria's water policy aims to ensure that current and future water needs are met, while preserving the quality and quantity of available resources. It is based on several principles, such as integrated planning, user participation, incentive pricing, decentralization and regional cooperation. It relies on several legal, institutional and financial instruments, such as the water code, basin agencies, water development and management master plans (SDAGE) and national investment programs.

Algeria's water policy has led to the implementation of numerous projects aimed at increasing water supply, improving distribution and rational use, improving treatment and sanitation, protecting resources against pollution and preventing the risks associated with flooding. These projects have significantly improved indicators relating to access to drinking water and sanitation, water safety and environmental protection.

This leads us to make the following analysis:

III) Analysis of water policy in Algeria

Water policy in Algeria can be analyzed along four main lines: increasing water supply, managing water demand, protecting water quality and preventing water-related risks. [46].

III.1) Increasing water supply

Increasing water supply involves mobilizing more water resources, through the construction of hydraulic infrastructures such as dams, transfers, boreholes, desalination plants and wastewater treatment plants. Algeria currently has 84 dams in operation, with a storage capacity of 8.5 billion cubic meters. The country also boasts the world's largest water transfer network, stretching over 5,000 km and enabling water to be channelled from surplus to deficit regions. The country also uses seawater desalination, with 13 plants in operation and 10 under construction, with a total

capacity of 2.6 million cubic meters per day. Finally, the country has developed wastewater treatment, with 154 treatment plants and 29 under construction, with a total capacity of 2.4 million cubic meters per day. [47].

III.2) Water demand management

Water demand management aims to optimize water use, by rationalizing withdrawals, reducing losses, reusing treated water and promoting water conservation. Algeria has introduced a progressive water pricing system to encourage users to reduce their consumption. The country has also launched campaigns to raise awareness and educate people about water saving, particularly in the agricultural and industrial sectors. The country also encourages the reuse of treated water for agricultural irrigation and watering green spaces. Finally, the country supports the development of water-saving techniques, such as drip irrigation, recycling and rainwater harvesting. [47].

III.3) Protecting water quality

Protecting water quality means preserving water resources against pollution from domestic, industrial or agricultural sources. Algeria has adopted legislation defining water quality standards and punishing polluters. The country has also strengthened water quality control and monitoring, through the creation of a national monitoring network and a national analysis laboratory.

III.4) Water risk prevention

Water risk prevention involves reducing the country's vulnerability to climatic hazards, such as drought and flooding. Algeria has drawn up a national strategy for adaptation to climate change, aimed at strengthening the country's resilience to potential impacts on water resources. The country has also set up a national early warning and water crisis management system, which enables it to anticipate and respond to emergency situations. The country has also carried out work to protect populations and infrastructures against flooding, such as cleaning up wadis, building dykes and retention basins, and developing flood-prone areas. [50].

Algeria's water policy is based on several key principles:

- a) Integrated water resource management (IWRM):** Algeria recognizes the need for integrated water management, taking into account the social, economic and environmental aspects of water resource management. This implies coordination between different stakeholders, such as ministries, water management agencies, local authorities and civil associations.
- b) Improving access to drinking water:** Access to drinking water is a priority for the Algerian government. Efforts have been made to extend drinking water supply infrastructures to the most remote rural and urban areas, thereby improving the population's quality of life.
- c) Development of agricultural irrigation:** Agriculture is an important economic sector in Algeria, and irrigation plays an essential role in food security and economic growth. Water policy aims to encourage the adoption of efficient irrigation practices for the sustainable use of water in agriculture.

- d) Protection of aquatic ecosystems: Algeria's freshwater resources are home to precious biodiversity. Water policy aims to preserve aquatic ecosystems and promote the conservation of associated flora and fauna. [46].

Water policy in Algeria can be divided into three main phases: the post-independence phase (1962-1986), the transition phase (1987-2001) and the current phase (2002-present).

- **The post-independence phase** was characterized by a centralized, state-run, sector-based approach to water management, based on the development of hydraulic infrastructures (dams, transfers, boreholes) to meet the growing needs of the agricultural and industrial sectors. This policy increased the availability of water, but also gave rise to problems of efficiency, equity and sustainability, such as wastage, pollution, over-indebtedness and ecosystem degradation.

- **The transition phase** corresponds to a period of economic, social and political crisis, marked by partial economic liberalization, administrative decentralization and the rise of terrorism. Water management was faced with budgetary constraints, deteriorating infrastructure, dissatisfied users and increasing conflict. This phase also saw the first reforms aimed at introducing a more integrated, participative and rational approach to water management, notably through the creation of the River Basin Agencies (ABH) in 1989 and the adoption of the Water Code in 1995.

- **The current phase** is characterized by a clear political will to modernize and improve water management, based on the principles of sustainable development, national solidarity and regional cooperation. This phase is reflected in the implementation of a National Action Plan for the Environment and Sustainable Development (PNAE-DD) in 2002, a National Water Saving Program (PNEE) in 2005, a National Water Strategy (SNE) in 2010 and a National Master Plan for the Development and Management of Water Resources (SNDAGRE) in 2015. These instruments aim to strengthen water planning, regulation, pricing, participation, awareness and innovation. They also provide for the use of non-conventional water sources, such as desalination, recycling and wastewater reuse.

Algeria's water policy has evolved significantly over the last few decades, moving from a mobilization approach to a resource management approach. However, this policy still faces numerous challenges, such as improving the performance of public water services, reducing regional and social disparities, preserving water quality and quantity, and preventing and managing risks linked to climatic hazards, and the promotion of a water culture shared by all stakeholders and users. [46].

2. Conclusion

In conclusion, Algeria's water policy faces complex challenges, but also offers opportunities to improve the management of this vital resource. By adopting an integrated, sustainable and inclusive approach, Algeria can hope to ensure an adequate water supply for current and future generations, while preserving its natural environment. This requires the ongoing commitment of the

government, civil society and the population as a whole. Algeria's water policy represents a major challenge for the country, given the scarcity of water resources and the growing pressure exerted on them. However, it also offers opportunities for sustainable development by implementing effective policies and mobilizing all stakeholders. By adopting an integrated, responsible and mutually supportive approach, Algeria can hope to overcome current and future water-related challenges, and thus ensure water security for generations to come. Enlightened management of this vital resource is essential to preserve the environment, support socio-economic development and guarantee a better quality of life for all Algerian citizens.

PART 3

**WATER POLICY IN THE WILAYA OF TLEMCEN
AND FINANCING**

Chapter 1

Water policy in the Wilaya of Tlemcen

A) WATER POLICY ADOPTED IN THE WILAYA OF TLEMCCEN

1) Geographical and economic data

The agglomerated population of the Tlemcen willaya was estimated at: 913,000 and will reach 1,420,000 in 2030. It should be noted that the willaya of Tlemcen will be home to one of the SNAT's high-growth new towns: El Aricha.

The city of Tlemcen had a population of 127,000 in 2010. By 2030, this figure is expected to rise to 161,000.

The wilaya extends from the coastline in the north to the steppe region in the south. It is divided into four physical areas:

The north, covering 70% of the area, is made up of the Traras and Sebâa Chioukh mountains. The Monts de Tlemcen, a natural barrier between the high steppe plains and the Tell, 300 km² in extent and remarkable for its plant cover and rainfall.

The Maghnia plain, the low valleys of Tafna and Isser and the Ouled Riah plateau offer high agricultural potential and are home to a dense urban fabric.

The high steppe plains of the south. The El-Aricha High Plains are not open to the Chott-Ech-Chergui basin to the south. At an altitude of over 1,100 m, they form a tabular zone before ending north of the Chott-Al-Gharbi basin.

The wilaya of Tlemcen benefits from a well-developed transport infrastructure (freeway, railroad, port and airport), and its location on the Moroccan border will make it a privileged crossroads in the future as inter-Maghreb trade grows.

The willaya's UAA of 353,000 ha is occupied by cereal crops, arboriculture and, to a lesser extent, irrigated market gardening. Particularly in the plains, the willaya has a very large area of potentially irrigable land. This means that, in the long term, the wilaya's economy will be dominated by highly diversified, export-oriented agricultural production (market gardening and arboriculture).

The fisheries resources of the willaya's coastal region are highly diversified and offer considerable scope for growth in the fishing economy.

The existence of major industrial complexes in the fields of telecommunications, electronics, textiles, zinc electrolysis, agri-food and building materials all represent opportunities for economic growth.

In terms of tourism, in addition to the seaside resorts currently under development, the cities of Tlemcen and Nedroma (historical and cultural cities) are currently benefiting from significant investments that will make them new tourism hubs in the Maghreb. [48].

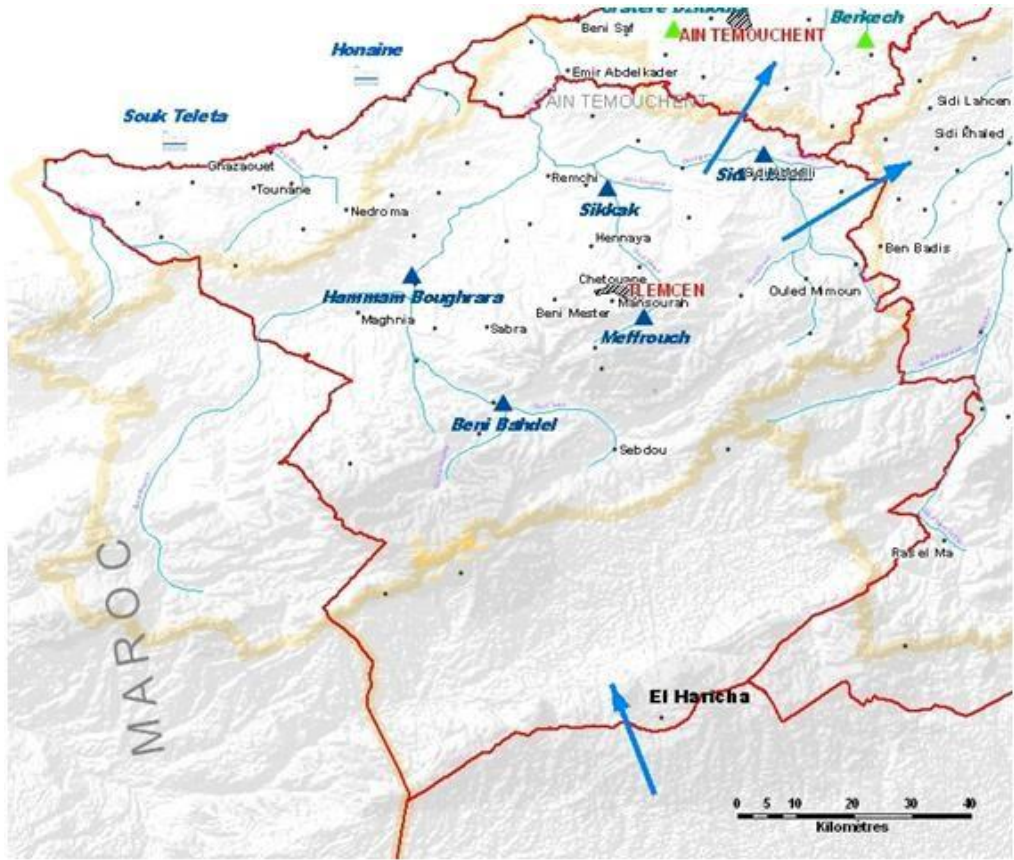


Figure 0: Map of the Wilaya of Tlemcen [47].

2) Hydraulics: major characteristics

a) Current situation

Demand for drinking water is on the order of 74 Hm³, while demand for irrigation is close to 83 Hm³ for the PMH. Two GPIs are planned: Tafna-Isser (2015) and Maghnia (2020).

The wilaya has 5 dams (152 Hm³) and 2 small SDEMs (1.8 Hm³/year) in addition to groundwater mobilized for AEP. [47].

b) Horizon 2030

The balance sheet for the wilaya of Tlemcen will be largely positive: resources will represent 471 Hm³ while demand will be of the order of 277 Hm³.

Two high-capacity SDEMs (mainly Honaine and Souk Tleta) will produce 147 Hm³, while demand for water will be 105 Hm³.

The wilaya has more than 5 dams capable of mobilizing 152 Hm³. The demand for irrigation water concerns 2 GPI (Maglia and Tafna-Isser) and represents almost 50 Hm³, while the PMH represents a demand of almost 116.5 Hm³.

Groundwater accounts for 77 Hm³, 11 of which comes from CCs and 67 from resources available at commune level (communal catchment fields).

The SNAT plans to create a new town at El Aricha, on the southern edge of the wilaya. This town is expected to have a population of 165,000 in 2030, representing an annual demand for water of around 13 Hm³. [47].

3) Water supply adequacy

Eventually, the wilaya will have two main water supply networks: the North, supplied by the SDEMs, and the South, with 2 Chott el Gharbi CCs located in the wilaya of Naama. Of the 53 communes in the wilaya, 16 are not connected to one of these networks. Total demand in 2030 is estimated at 105 million.

a) North network

The old Beni Bahdel - Oran pipeline is the main water supply corridor, running from west to east. The design of the SDEM connections aims to make use of this pipe while providing new services on the area's north-south axes. This pipeline, which will continue to be strategic in terms of inter-regional transfers, is scheduled to be rehabilitated on several sections.

This network includes the resources of 4 SDEM (mainly Souk Tleta and Honaine, 148 Hm³) and 4 dams (Beni Bahdel, Sidi Abdelly, Sikak and Hammam Bougrara, 152 Hm³).

The demand for drinking water concerns 43 communes, or 83 Hm³.

The SDEMs can not only cover the demand of all these communes, but also ensure transfers to neighboring wilayas. Dams can therefore be reserved for irrigation.

The implementation of a number of new conveyances has made it possible to supply 43 communes, representing a demand of 83 Hm³ from the SDEMs. Remaining resources are noted at SDEM (65 Hm³) and BARRAGE (88 Hm³), while the CC de Zaouia (potential of 11 Hm³, originally supplying the ACL de Maghlia) is no longer mobilized.

Examination of the AEP of the wilaya of Sidi Bel Abbes will show that 33 Hm³ of this remainder could be allocated to the Sidi Bel Abbes network. [47].

b) Southern network

The Sud network originally uses 2 CC from the Chott El Gharbi (Naama wilaya) and can serve the south of the Tlemcen wilaya as well as the west of the Sidi Bel Abbes wilaya.

In periods of average rainfall, the balance of the Tlemcen Sud network is positive, with resources from the catchment fields representing 30 Hm³ for a demand of 24.6 Hm³ (including the western part of Sidi Bel Abbes). On the other hand, in drier periods (SS), the balance is negative, with CC resources supplying only 18 Hm³. It should be noted that the new town of El Aricha alone represents a demand of 13 Hm³.

An additional resource needs to be integrated into this network. The installation of a hydraulic connection (D800 pipe) between the Beni Bahdel dam and the fork located south of Sebdou will enable the necessary complement to be sent to El Aricha. The southern network then includes the 2 CCs of Chott El Gharbi and, as an alternative during dry periods, the Beni Bahdel dam, which will of course have to be equipped with a treatment plant (the water is currently treated downstream of the dam at Bouhlou, 15 km north of the dam, and it would be too costly to send it back upstream, treated, to the south).

However, a variant to be considered is to use the surplus desalinated water to send it back to the South to supplement the supply from the chott, in which case the transit pipe from Beni Bahdel would be maintained, but with desalinated water tapped into the Honaine system. A detailed comparative study of the two variants, and in particular the rate of expansion of the new town of El Haricha and therefore the exact value of the increase in demand, will enable us to make a decision.

10 communes in the south of Tlemcen (21.6 Hm³) and 8 communes in the south-west of Sidi Bel Abbes (5 Hm³) will be supplied by this Southern network. [46].

4) Irrigation adequacy

a) GPI

The Tafna-Isser IPG will be supplied by the Hamam Boughrara dam (31 Hm³), while the Maghnia IPG will be supplied by the Beni Bahdel dam (19 Hm³).

b) PMH

PMH demand represents almost 116.5 Hm³ spread over 53 communes. The resource will come from hill reservoirs or small dams (Zioua, El Abed, Bahloula).

Of these, 8 communes have their needs met by surface water. These are communes whose PMH surface area has been reduced (compared with 2010) due to the commissioning of the 2 GPIs.

25 communes have sufficient ESC and CCC resources to meet the needs of their PMH. These communes also have a surplus of groundwater resources of almost 25 Hm³. A further 11 communes have between 75% and 100% of their demand met via ESC and CCC, and in periods of average rainfall, their needs can be fully covered.

The 28 communes with less than 100% PMH supply have a slight water deficit, which can be made up by relying on REUT.

The CC of the Zaouia commune could be used for irrigation in this zone (11 hm³/year in dry periods). In the end, 100% of PMH demand will be met in both average and dry periods. [48].

5) Summary for the wilaya of Tlemcen to 2030

53 communes are supplied by SDEM in the north, two dams and two CC (catchment fields) in the south.

Remaining resources are available from SDEM (70 Hm³) and 2 BARRAGE (Sidi Abdelly, H. Bougrara and Sikkak; 83 Hm³).

It should be noted that the transport capacity required for the SDEM surplus corresponds to one D 1700 mm pipeline or two D 1200 pipelines.

Only the existing Beni Bahdel-Oran pipeline, with a capacity of around 30 Hm³/year, can evacuate water to the east; in the projected configuration, it will be used for 6.5 Hm³. This pipeline is used to reach Sidi Bel Abbes and Oran.

As a reminder, we mention the issue of sanitation with a view to protecting the resource, but this sub-sector falls outside the remit of the PNE. [47].

Chapter 2

Water policy adopted by the urban grouping of Tlemcen

The Tlemcen group comprises 3 daïra: Tlemcen, Mansourah and Chetouane.

I- STATE OF THE ENVIRONMENT AND POLLUTION RISKS

1- Water protection (underground and surface)

This precious resource, which is used for life in general and for drinking water and crops in particular, is threatened by the combined action of man and nature.

The waters concerned are:

The karstic aquifer of the dolomites of the Tlemcen mountains, and the springs flowing from the foothills of the mountains and from the plains and plateaus of the north and the valleys of the east of the inter-municipal area.

The Mefrouch dam, located on the plateaus of the Tlemcen mountains, overlooking the town. [47].

2- Risks of pollution from agricultural sources

Chemical pollution is caused by the standardized use of chemical fertilizers, pesticides and herbicides. While potash is better absorbed by the soil, nitrogen and nitrates are more mobile and are discharged by washing into rivers and introduced into aquifers by infiltration. [48].

3- Risks of pollution from wastewater discharges

The concentration of pollution in the four communes, which has absorbed the surrounding small and medium-sized agglomerations and created new large areas of urban sprawl, means that some wastewater is discharged into the natural environment untreated (directly into the wadis or into septic tanks).

This wastewater is either:

Infiltrated directly into the soil and then into the water table.

Used for watering crops in certain inter-communal areas, thus posing a real danger to human and even animal health. [46].

4- Risks of pollution from household refuse and solid waste.

The Safsaf and Jbel El Haddid landfills are very close to the urban environment, and the risks of pollution are very high:

- Air pollution from smoke fumes
- Pollution from combustion gases with volatile heavy metals
- Pollution from wind-blown paper and plastic.

- Concentration of air pollutants in Tlemcen, Chetouane, Mansourah and surrounding towns.
- Numerous unauthorized dumps everywhere:

In wadis, valleys and inaccessible corners close to urban areas.

Sometimes, in addition to ordinary household waste, they also contain

Specialized waste: hydrocarbon products, particularly motor oil.

- Poultry waste (feathers, feet, offal and rotting whole chickens).
- Hospital waste. [46].

5- Pollution risks from cemeteries

Cemeteries also represent a risk to be taken into consideration, due to

The decomposition of corpses and the transfer of pollutants to groundwater. water tables. [51].

6- Risks of pollution from industrial activities.

Industrial units located in the Chetouane industrial zone and the Aboutechefine mini-industrial zone, as well as those isolated within the urban fabric and in scattered areas, must take precautions to avoid discharging industrial waste directly into nature or into public landfills. They must dispose of their waste in specialized areas. [50].

7- Environmental damage in urban areas

The main environmental problems in urban areas are as follows:

- Insufficient and sometimes non-existent green spaces in residential neighborhoods and even in the city center.

- Degradation of the living environment

- Degradation of cultural heritage (ex Medina)

- Uncontrolled housing in several intercommunal zones and appropriation

Anarchic appropriation of space

- Construction on historic sites (ex Mansourah)

Absence or lack of follow-up and implementation of general and operational urban planning studies.

- Construction on easement zones, unbuildable areas and high-risk zones.

- Intense rural exodus and consequent decline of neighboring communities.

- Mixed forms, styles and volumes; urban composition without structure or harmony.

- Major risks not taken into account in hasty decisions
- Problems of access to extension areas and overloading of the town center. [50].

II) SOCIO-ECONOMIC CHARACTERISTICS

1- The population

The analysis is focused on demographic, social and economic aspects. In particular, the population (its structure, evolution, spatial distribution and economic activity) and household living conditions (housing and housing amenities) are analyzed.

The statistical data used for the analysis comes mainly from the results of the various population and housing censuses (RGPH). [52].

It is important to note that a population and housing census is the sole source of exhaustive statistical information at commune level. As a result, it may appear that the data from the latest 2008 census is "out of date".

1-1- Overall population.

In 2008[50], the Tlemcen PDAU had a population of 255,559.

In terms of population volume, its proportion in the wilaya remains preponderant.

More than a quarter (26.9%) of the wilaya's inhabitants are concentrated in this area. [53].

This proportion has risen steadily over the last twenty years: from 23.4% in 1987, it was 26.9% in 2008, rising to 26.2% in 1998. This inter-communal demographic weighting is mainly due to the predominant position occupied by the commune of Tlemcen in the wilaya, both demographically and economically. This commune alone accounts for more than half (54.9%) of the inter-communal population and 14.8% of the wilaya's total. Consequently, all the measurement indicators presented here for the intercommunal PDAU are influenced by the weight of this commune. [53].

2) Sewage network

All four communes have a combined sewerage system, and the rate of connection to the network is estimated at 96%. However, given the scattered nature of the settlements, the problem of uncontrolled discharges is a major constraint. The Aïn EL Hout wastewater treatment plant only treats effluent from the city of Tlemcen.

Even though all the towns are connected to sewerage networks, the majority of discharges are open-air and untreated.

To this end, the wilaya's water resources department has launched a study to update the Tlemcen and Ennuya urban inter-municipal sanitation master plan, the main aim of which is to unify all wastewater discharges into the SIKKAK dam catchment area and treat them in the planned HENNAYA wastewater treatment plant, the construction of this plant is now becoming a major

priority in order to preserve the environment and the use of this purified water for the irrigation of the peri-urban market gardening area. [54].

The planned HENNAYA wastewater treatment plant will only affect the WEST part of the city of TLEMCEN (commune of MANSOURH) and the EAST part (COMMUNE DE CHETOUANE). However, the commune of BENI MESTER and these secondary agglomerations are still untreated, necessitating the construction of a new wastewater treatment plant. [47].

III) DEMOGRAPHIC PROSPECTS

1- Proposed demographic prospects

a) Water supply master plan

	Adduction	Sampling point	Delivery point	Capacity (m3/j)
Desalination plant of Honaine	-Adduction of Sikkak	-SP 3	-Reservoir of Mansourah	55 000
Desalination Honaine or Souk Tleta Plant	-Beni Mester chain	-BC 1	-Reservoir of Mansourah	14 700
		-BC 1	-Reservoir of Boudjemil	4 300
	-Adduction of Beni Bahdel	-SP of Oujlida	- Reservoir of Oujlida	4 300
	-Adduction of Beni Bahdel	-SP -BC 2	-Pumping station of -Ain Bendou -R�servoir of Ouzidane	4 300
Total (m3/j)				82 600

Intercommunal drinking water supply is provided by surface and underground resources, namely the Mefrouche and Beni Bahdel dams. Currently, the intercommunal is benefiting from the country's new policy of mobilizing non-conventional water resources (seawater desalination).

Two seawater desalination plants currently supply drinking water to the four communes: SDEM Honaine and SDEM Souk Tleta (2 x 200,000 m³/d), of which 82,600 m³/d can be mobilized for the Tlemcen GUT (according to the ADE), distributed as follows:

Table 1: Distribution of resources at delivery points [47]. Source: ADE

Table 2: Delivery points

Delivery point	distribution floor	Volume allocated	
		(m ³ /j)	(%)
Reservoir of Mansourah	Intermediate	69 700	85%
Reservoir of Boudjemil	Intermediate	4 300	5%
Reservoir of Oujlida	Inferior	4 300	5%
- Ain Bendou pumping station - Reservoir Ouzidane	Inferior	4300	5%
Total		82 600	100%

[47]. Source : ADE

Table 3: Breakdown of requirements by floor

distribution floor	Number of subscribers	Needs	
		(m ³ /day)	(%)
Superior	18 230	16 800	30%
Intermediate	20 052	19 040	34%
Inferior	21 783	20 160	36%

Total	56 000	100%
--------------	---------------	-------------

[47]. Source : ADE

We note that Mansourah is the main delivery point. GUT's drinking water supply currently depends largely (85%) on the Mansourah reservoir.

The upper level, representing 30% of requirements, is supplied by backflow from the new Lalla Setti reservoir (30,000 m3).

Only 10% of the lower stage is supplied by desalination, whereas its needs represent 36% of GUT's total requirements.

As a result, the Mansourah reservoir supplies 18,230 subscribers, i.e. 30%, and its single delivery point is inadequate. Upstream infrastructures are inadequate and unstructured. Despite the surplus of water resources in the four communes of TLEMCEN, there will be no normal supply until the upstream problems are resolved. The drinking water supply network for the TLEMCEN urban area is divided into 23 sectors, each supplied by an independent reservoir.

This drinking water supply network is made up of :

Table 4: Percentage of water supply network

Nature	Linear(m)	Pourcentage (%)
Ductile Cast Iron	295 560	60
Ductile Cast Grey	19 703	4
Coated Steel	45 566	9
Galvanized Steel	103 784	21
HDPE	21 305	4
PVC	5 415	1
Total	491 333	100

[47]. Source : ADE

Table 4 shows the composition of the drinking water supply network, hence the non-conformity of materials: 95% steel, 5% PVC.

The drinking water supply network for the TLEMCEN urban area has 1,536 valves, of which 584 are visible and 175 are in good condition.

The four communes of TLEMCEN have a total storage capacity of 56,750 m3.

The solution to drinking water supply problems in the Tlemcen urban area must necessarily include two actions:

Restructuring the water supply system upstream of the distribution network,

Restructuring the distribution network. [47].

2) Sanitation master plan

The four communes have a combined sewerage system, with an estimated 96% connection rate to the network. However, given the scattered nature of the settlements, the problem of uncontrolled discharges is a major constraint. The Aïn EL Hout wastewater treatment plant only treats effluent from the city of Tlemcen.

Even though all the towns are connected to sewerage networks, the majority of discharges are open-air, without any treatment.

For this reason, the wilaya's water resources department has launched a study to update the sanitation master plan for the TLEMCEN intercommunal urban area and the town of HENNAYA, the main aim of which is to unify all wastewater discharges into the SIKKAK dam catchment area, and then treat them in the planned future HENNAYA wastewater treatment plant.

The construction of this plant is now becoming a major priority in order to preserve the environment and use the purified water to irrigate the peri-urban market garden area.

The planned HENNAYA wastewater treatment plant will only affect the WEST part of the city of TLEMCEN (commune of MANSOURH) and the EAST part (COMMUNE DE CHETOUANE). However, the commune of BENI MESTER and these secondary settlements discharge their untreated wastewater into the wadis and Chabat, necessitating the construction of a new wastewater treatment plant. [48].

Chapter 3

Chapter financing in the Wilaya of Tlemcen

A) Chapter financing in the wilaya of Tlemcen

Before beginning our interpretation and discussion. We will present the codifications of the 5 finance chapters in our study, which account for more than 99% of the allocated budget:

Chapter codes and meanings

322: represents funding for water mobilization

323: represents financing for pipelines

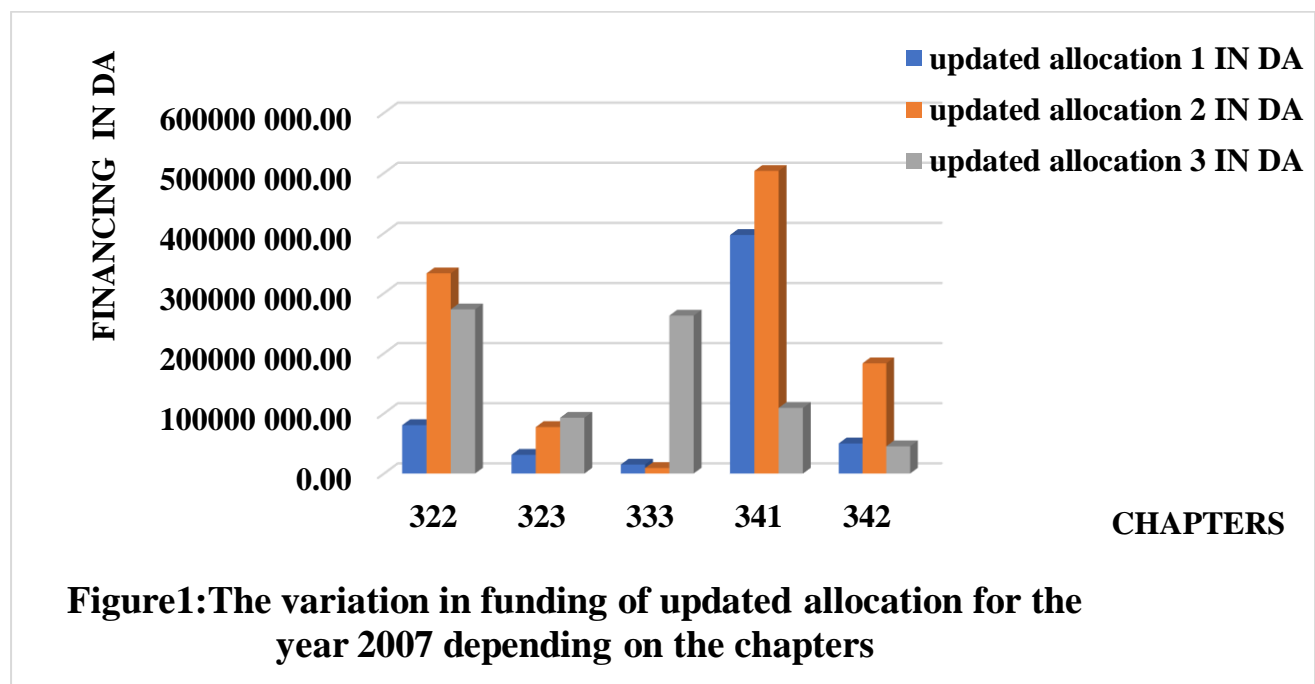
333: represents funding for irrigation + hill reservoirs

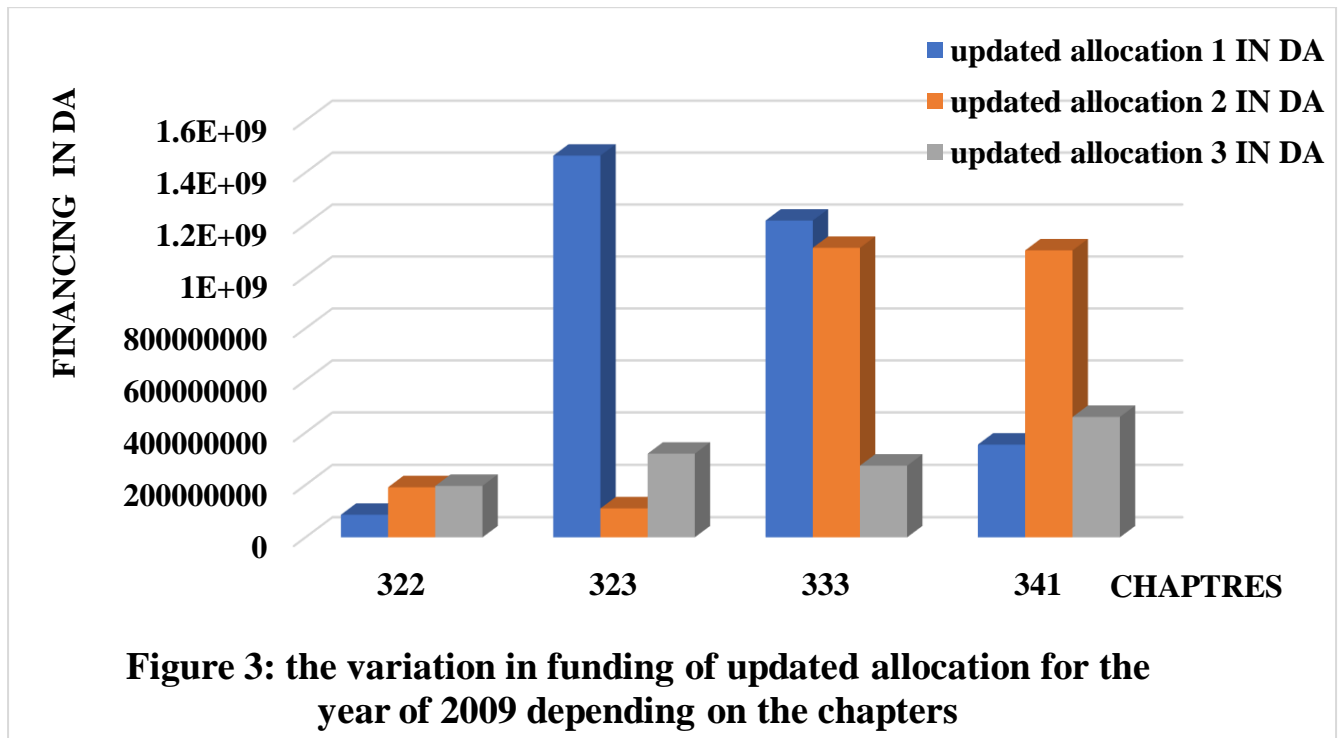
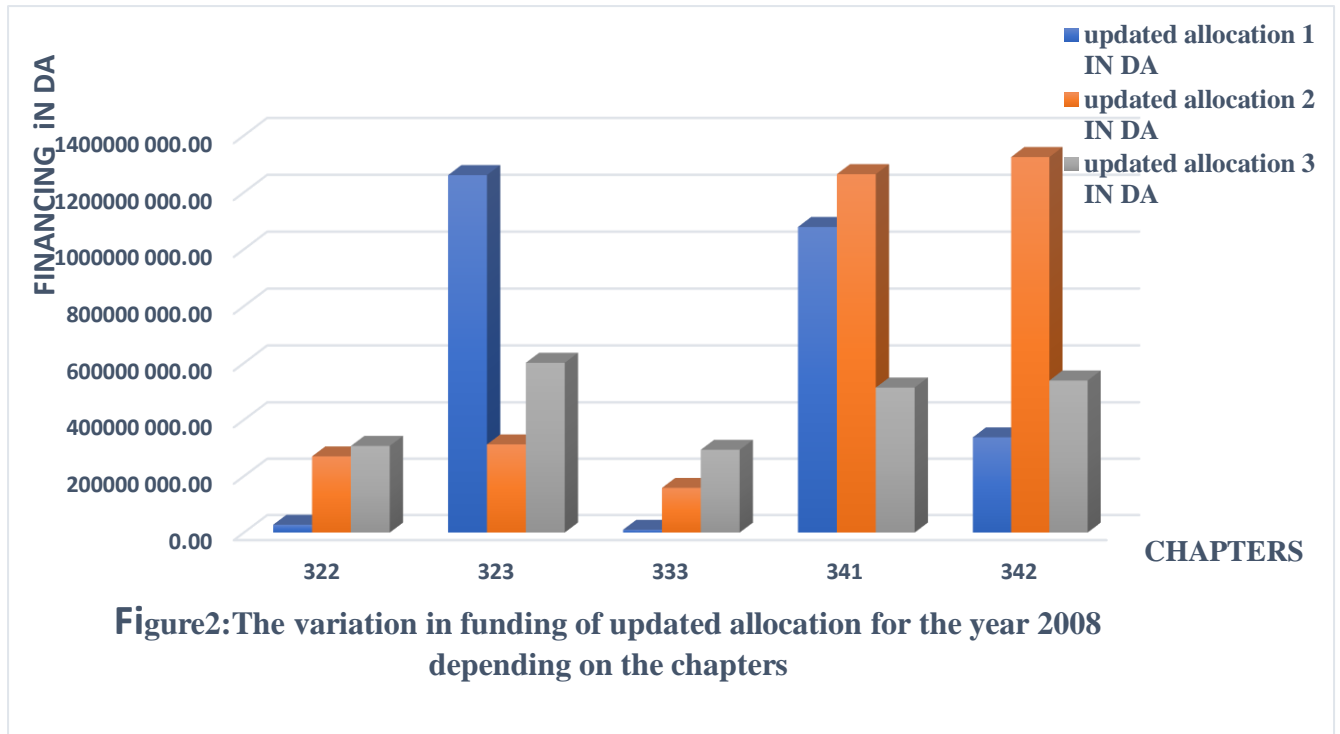
341: represents funding for water supply

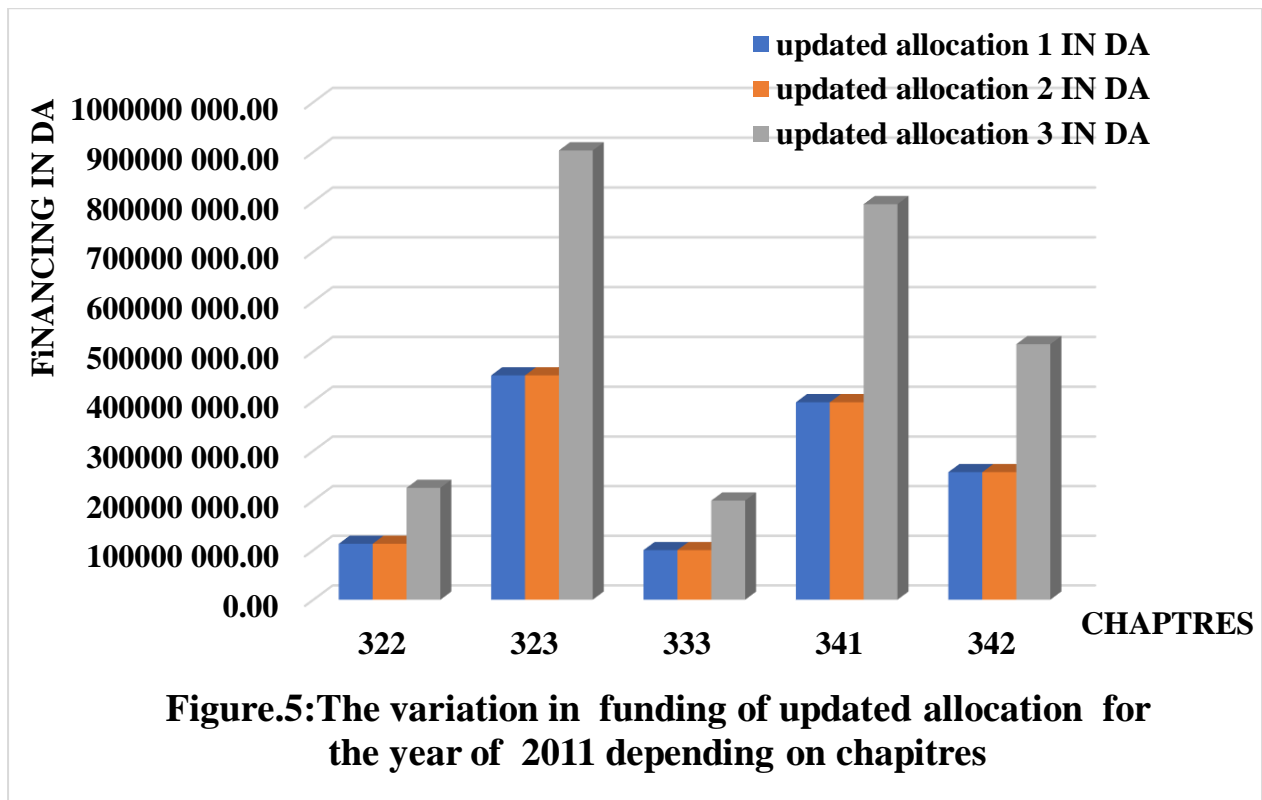
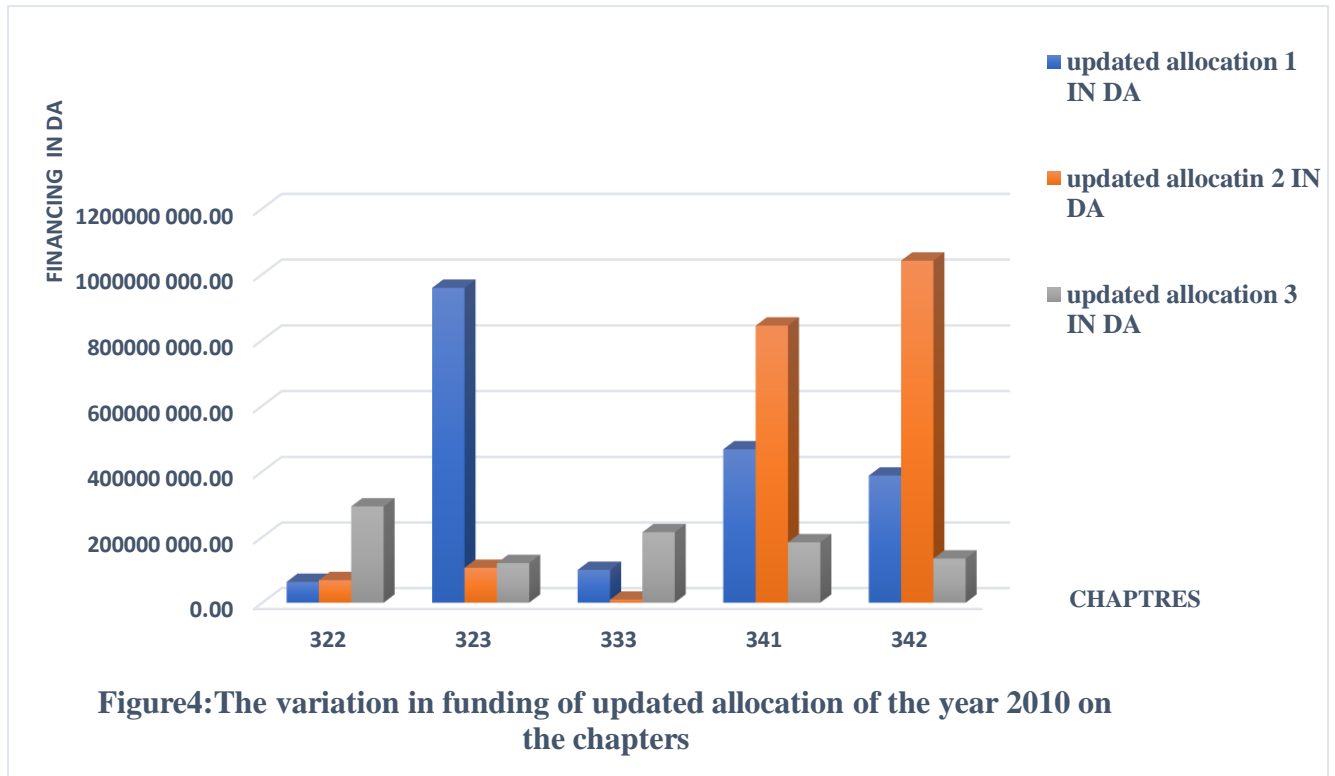
342: represents financing for sanitation

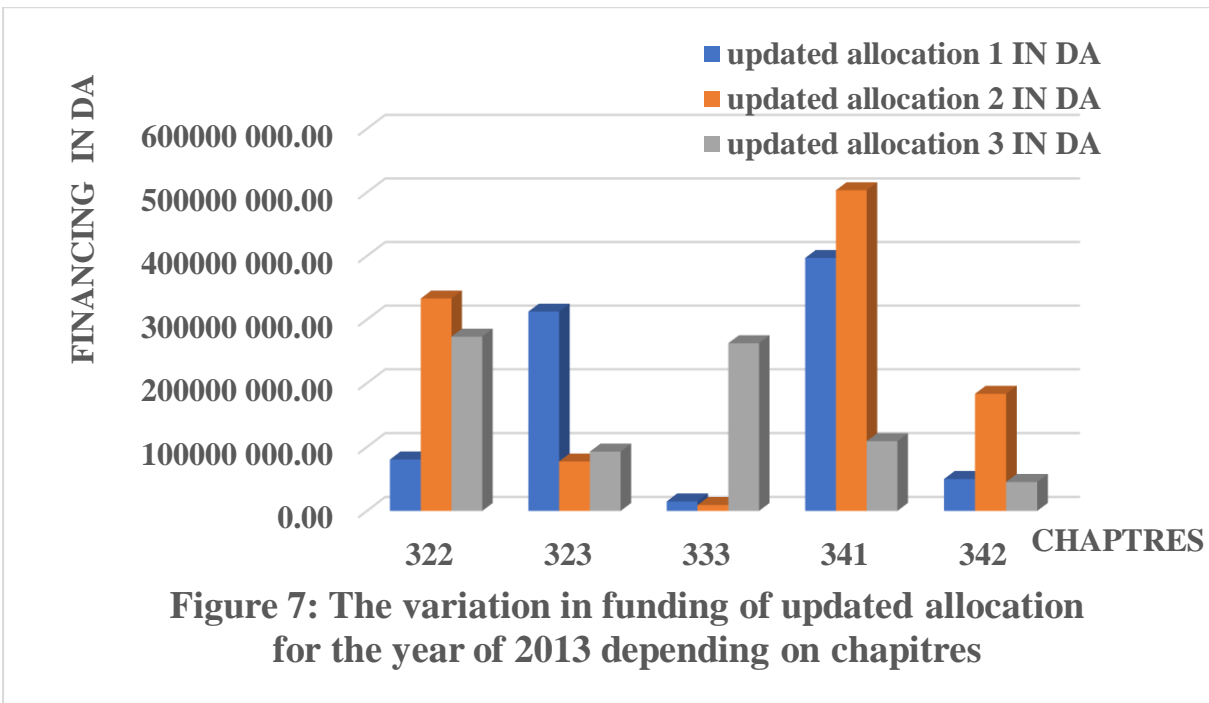
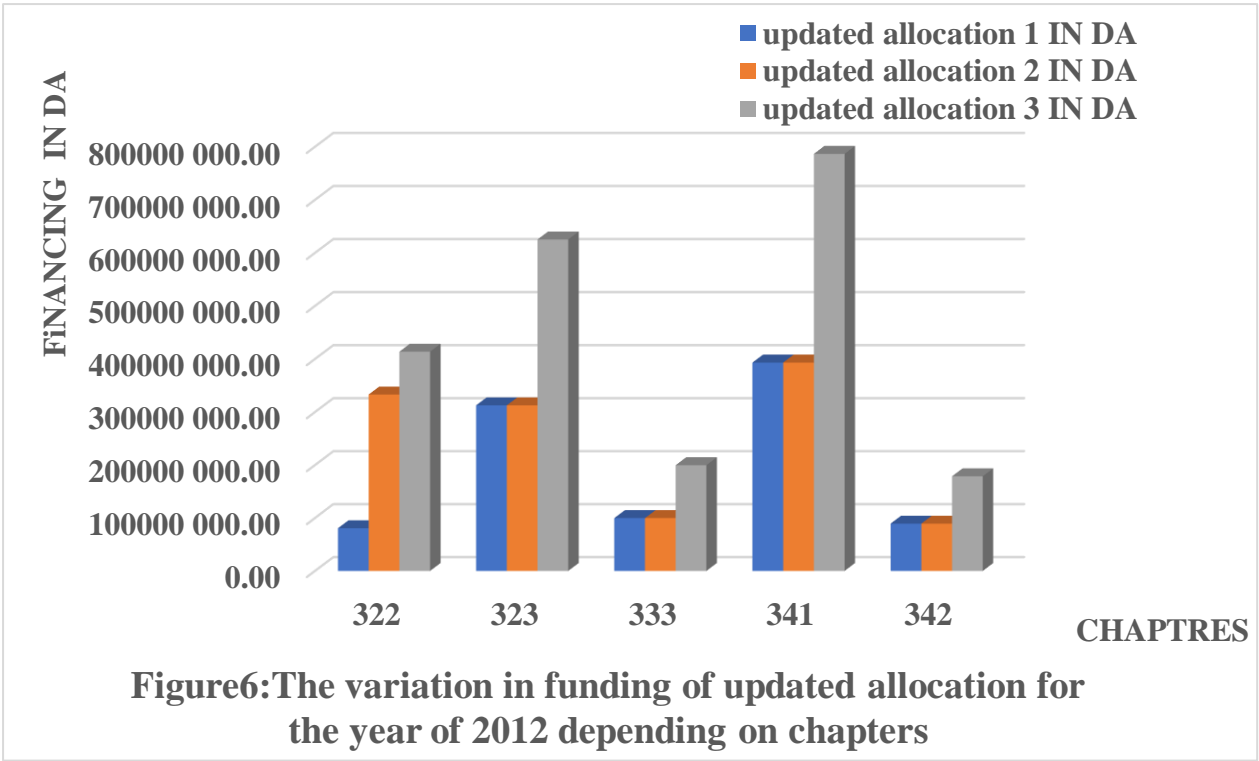
We have carried out an economic and political study on the financing of the chapters allocated to the water resources sector in the wilaya of Tlemcen.

First, we present the 17 histograms showing the variation in funding for the updated allocations between 2007 and 2023, followed by their interpretation.









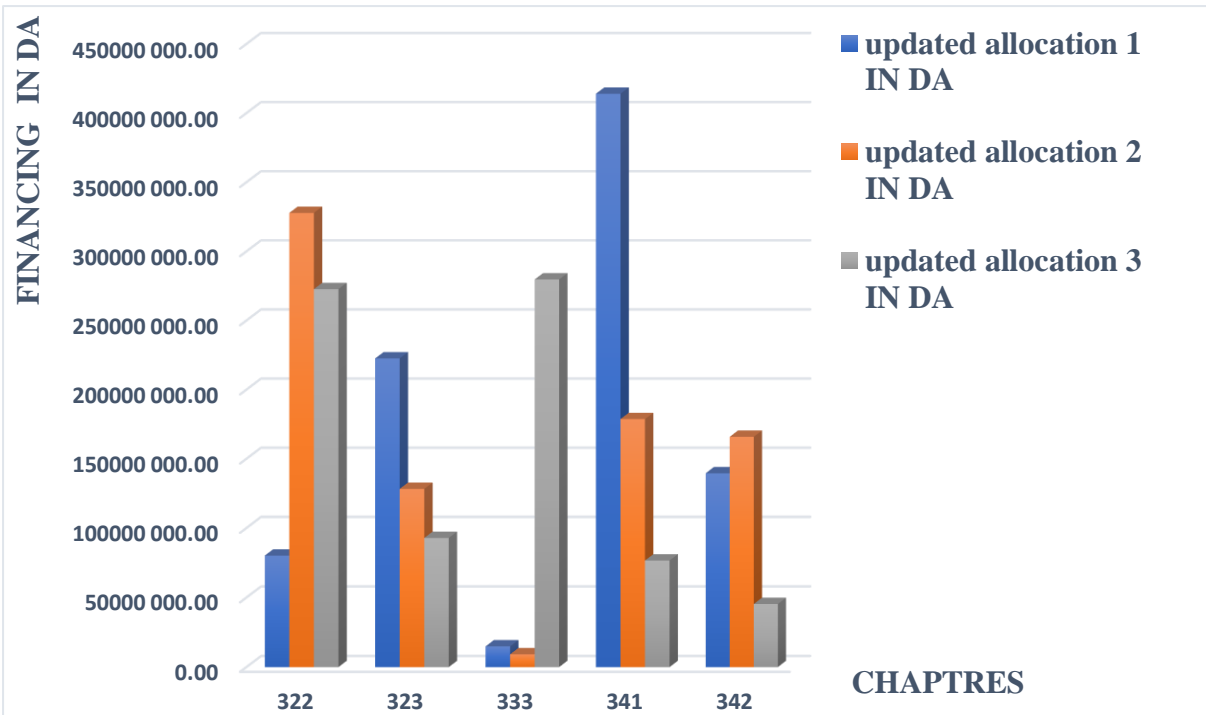


Figure8: The variation in funding of updated allocation for the year of 2014 depending on chapitres

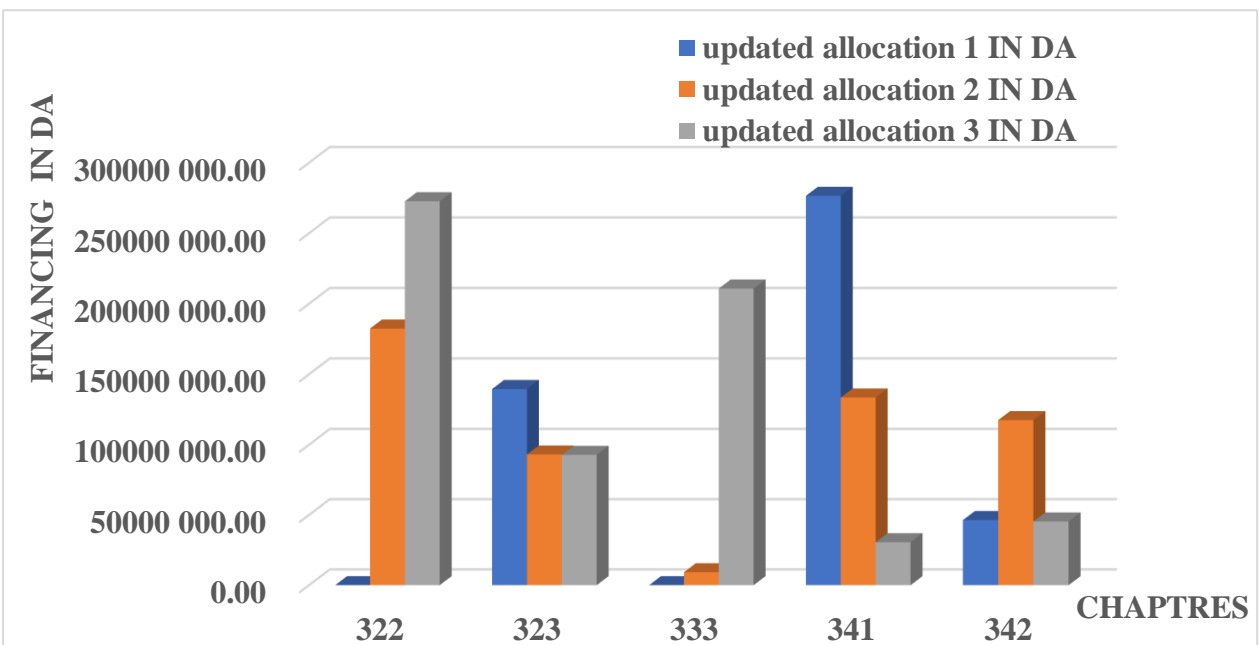


Figure 9: The variation in funding of updated allocation for the year of 2015 depending on chapitres

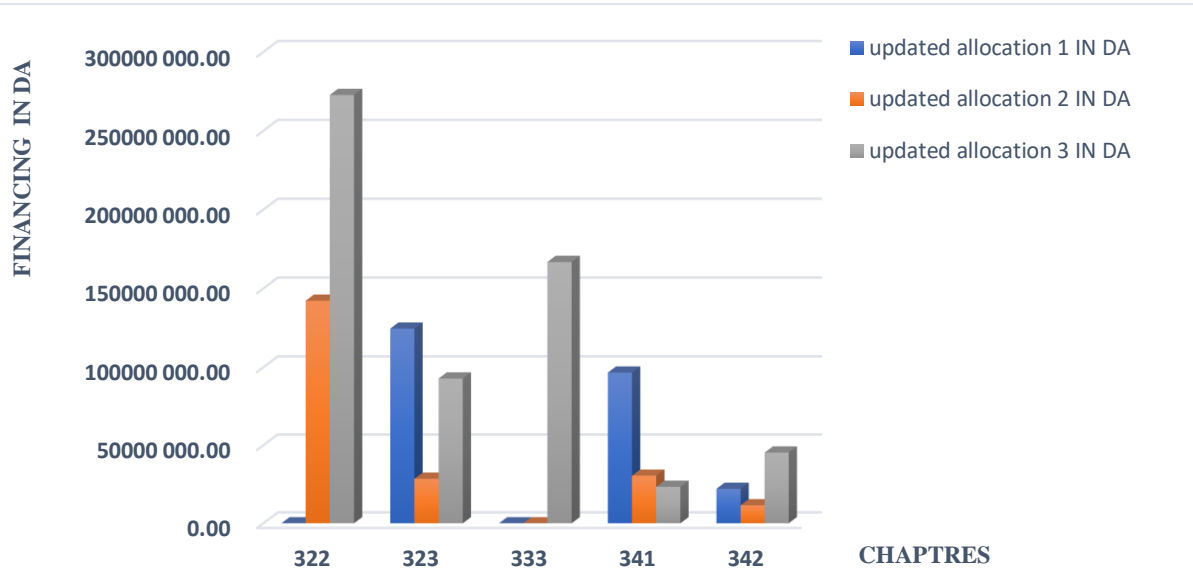


Figure10: The variation in funding of updated allocation for the year of 2016 depending on chapters

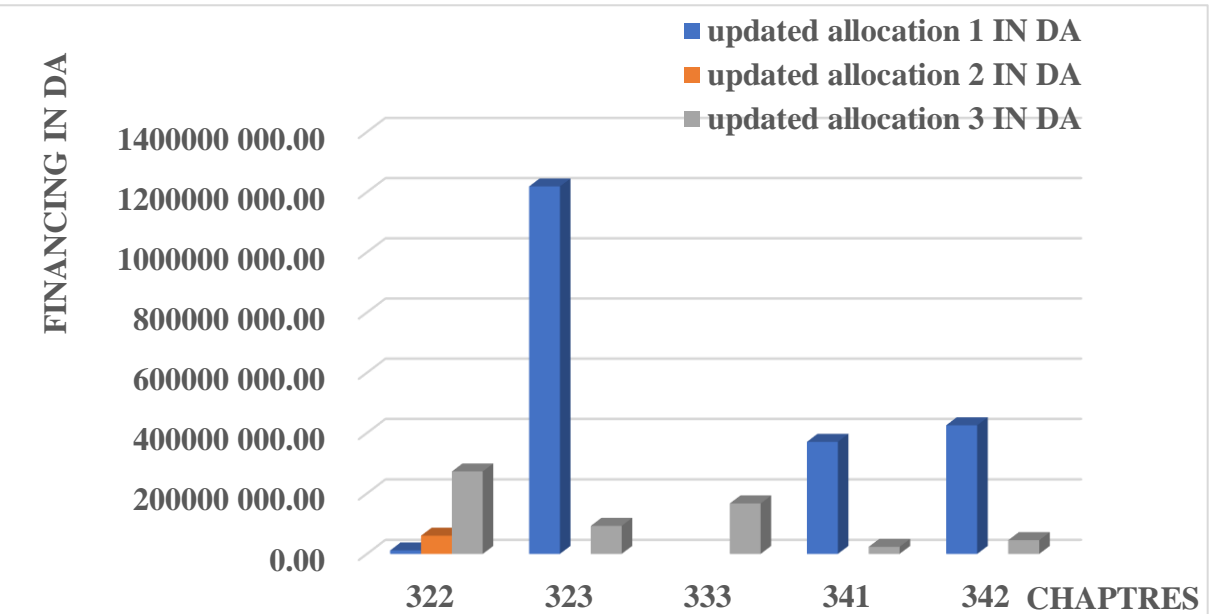


Figure 11: The variation in funding of updated allocation for the year of 2017 depending on the chapters

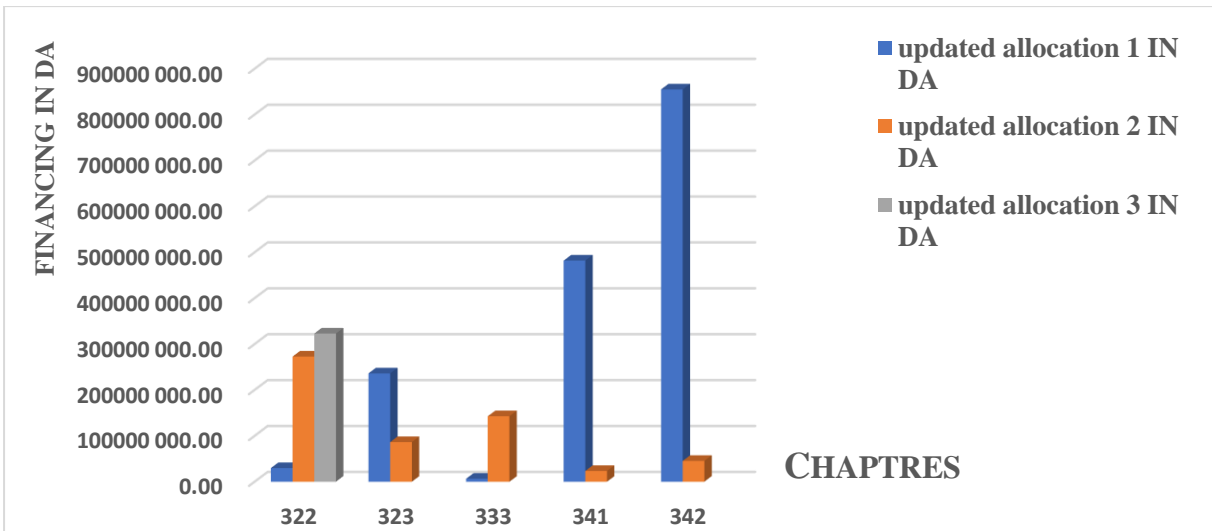


Figure12:the variation in funding of updated allocation for the year of 2018 depending on chapters

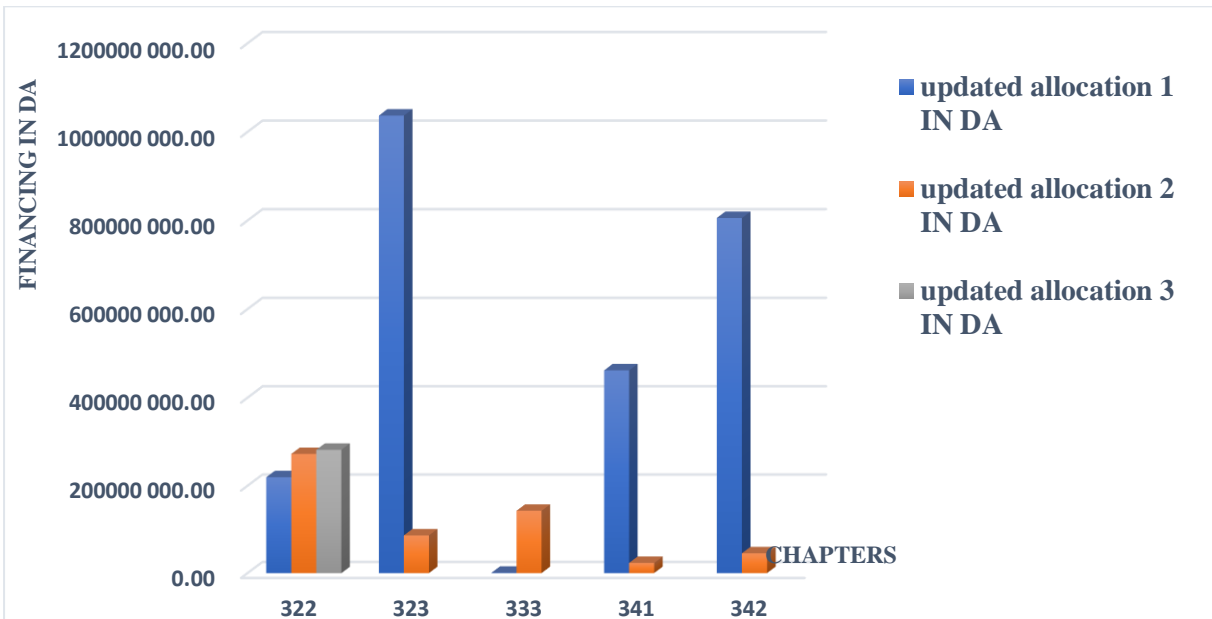


Figure13: the variation in funding of updated allocation for the year of 2019 depending on chapters

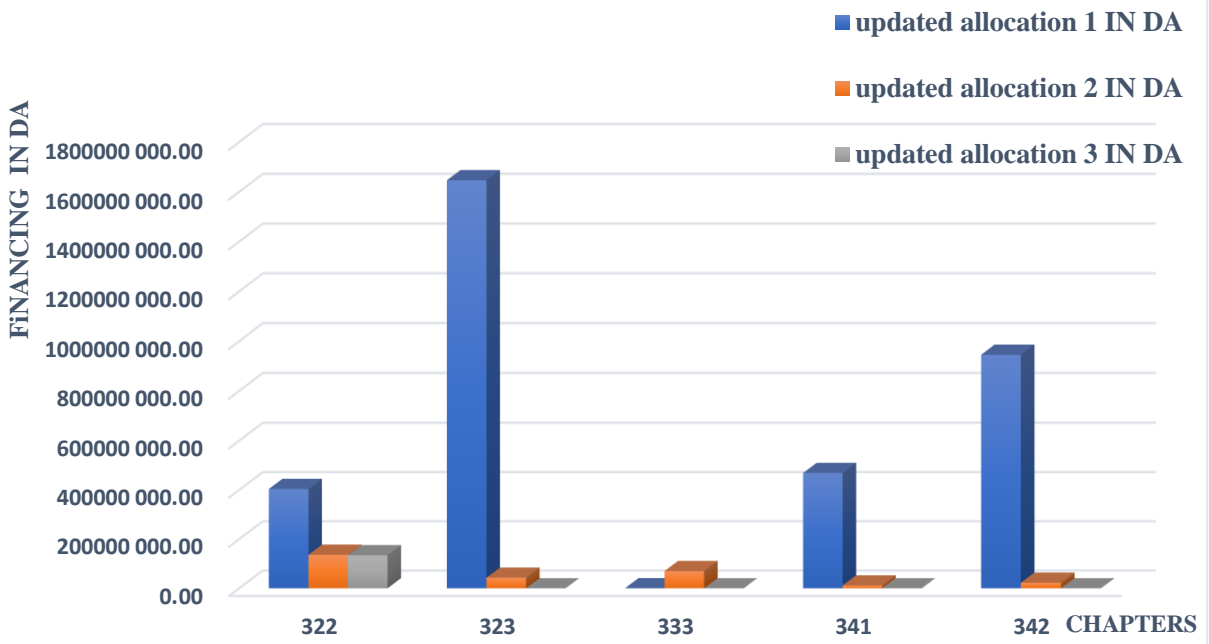


Figure14: The variation in funding of updated allocation for the year 2020 depending on chapters

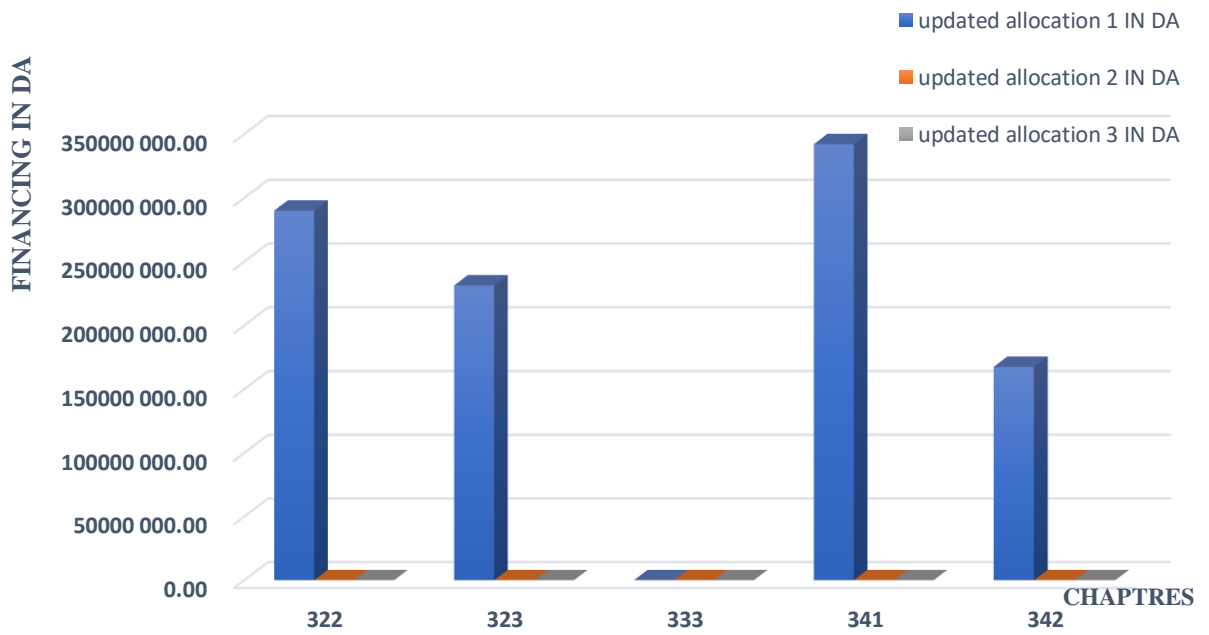


Figure15: The variation in funding of updated allocation for the year 2021 depending on chapters

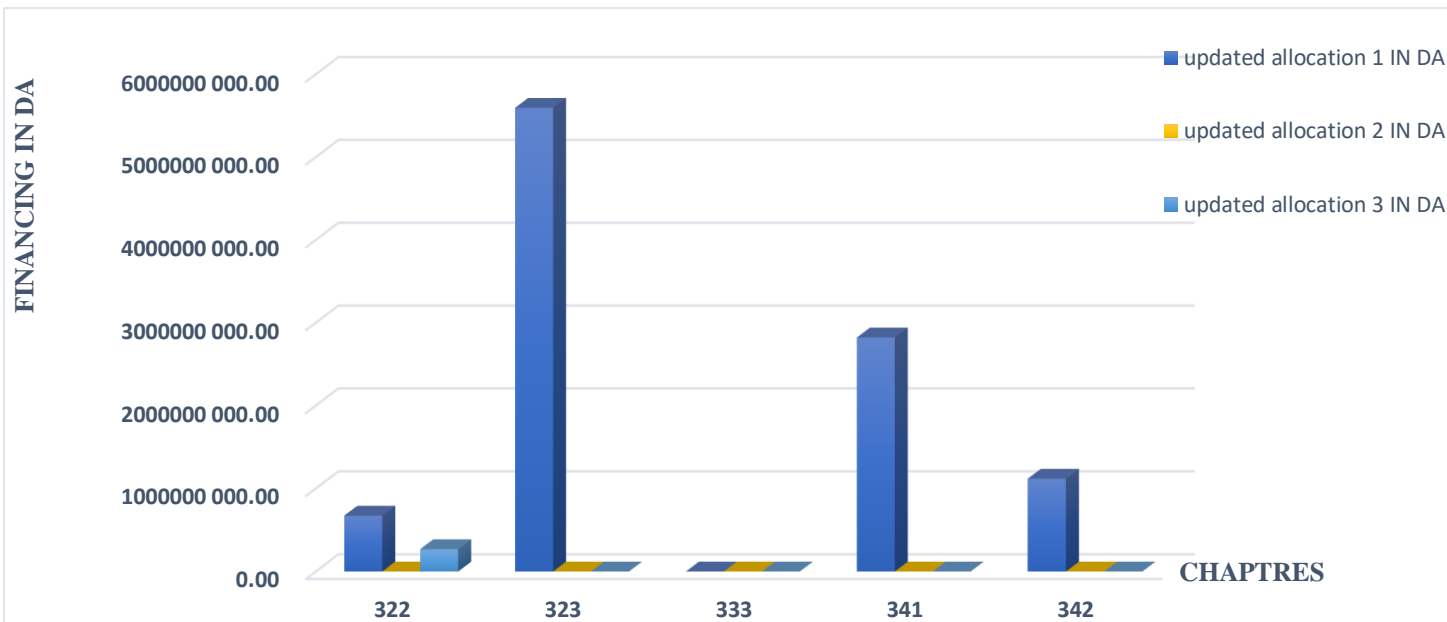


Figure16: The variation in funding of updated allocation for the year of 2022 depending on chapters

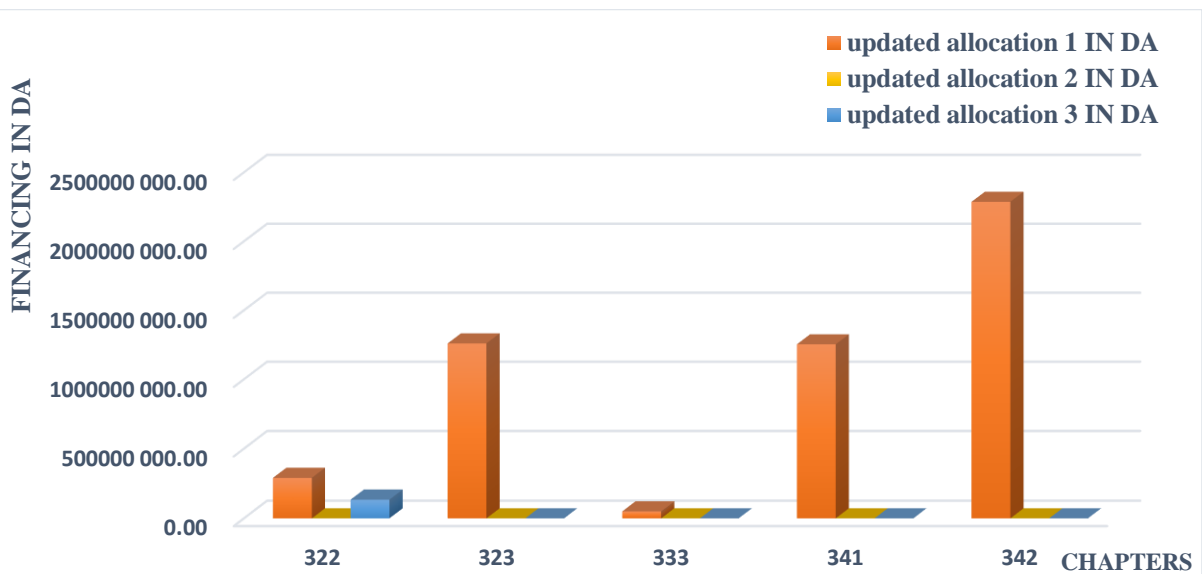


Figure17: The variation in funding of updated allocation for the year of 2023 depending on chapters

I) Histogram interpretation

1) Interpretation by year:

To better present our interpretation. We will make a percentage comparison of budgets allocated by year from 2007 to 2023. To do this, we will present Table 5, which shows the percentage of funding for the 5 chapters by year.

Table 5 : Percentage of funding for the 5 chapters between 2007 and 2023

Years	2007	2008	2009	2010	2011	2012	2013	2014
%	5.37	9.08	7.36	5.46	11.35	10.19	5.68	10.65

2015	2016	2017	2018	2019	2020	2021	2022	2023
7.20	5.17	2.88	2.11	3.67	4.33	4.69	2.35	2.40

This table shows that the best year was 2011 with 11.35% and the worst year was 2018 with 2.11%.

We can also see that the best years were "2008; 2011; 2012; 2014".

And the bad years were between 2017 and 2023.

If we take the first 9 years of our study, i.e. between 2007 and 2015 inclusive, we notice that the allocated budget presents 72.4%; this means that from 2016 onwards the budget has consequently dropped and represents only 27.6%; for this we can give 2 explanations:

- Either there was a lack of funding
- Or the projects carried out were nearing completion.

2) Interpretation by chapter for the same year:

Table 6 : Percentage of chapter funding for each year from 2007 to 2023

Years/Chapters	% chaptre 322	% chapter 323	% chapter 333	% chaptre 341	% chapitre 342	% total
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2007	27.42	<u>7.6</u>	11.4	42.2	11.4	100
2008	7	26.7	<u>5.23</u>	34.9	26.18	100.1
2009	6.15	27.07	38.77	28	<u>0</u>	99.99
2010	7.88	24.48	<u>6.22</u>	29.88	31.54	100
2011	8.15	34.6	<u>6.96</u>	30.82	19.1	99.83
2012	18.33	28.81	8.57	36.43	<u>7.86</u>	100
2013	25.68	16.73	10.50	38.14	<u>8.95</u>	100
2014	28.15	18.33	<u>12.15</u>	27.3	14.07	100
2015	28.30	19.81	13.52	26.41	<u>11.95</u>	99.99
2016	39.42	23.56	16.35	13.94	<u>6.73</u>	100
2017	11.81	49.61	<u>6.3</u>	14.96	17.32	100
2018	29.9	15.46	8.24	<u>1.03</u>	45.36	99.99
2019	21.60	33.33	<u>4.94</u>	14.20	25.92	99.99
2020	16.23	43.98	<u>1.57</u>	12.56	25.66	100
2021	28.02	22.22	<u>0.48</u>	32.85	16.42	99.99
2022	7.65	53.86	<u>0</u>	27.89	10.59	99.99
2023	7.54	23.6	<u>1.88</u>	24.53	42.45	100

Table 7 : Percentage of chapter funding for 2 parts of (8.5 years)

Chapters	% 322	%323	% 333	% 341	% 342	Total
01/01/2007 à 30/06/2015	11.29	16.65	8.37	22.49	10.2	69
01/07/2015 à 31/12/2023	7.11	9.69	1.95	5.95	6.30	31
Total	18.40	26.34	10.32	28.44	16.50	100
Division	1.59	1.72	4.29	3.78	1.62	2.226

3) Analysis of funding for the 5 chapters :

Table 6 clearly shows that chapter 341 is the best-endowed chapter, coming in first place with a percentage of 28.44%, just ahead of chapter 323 with a score of 26.34%. We can say that the 2 chapters 341 and 323 are equal from a financial point of view, since they alone cover more than half the budget, i.e. 54.78% of the total.

Chapter 322, with 18.40%, and chapter 342, with 16.50%, are also equal. On the other hand, funding for chapter 333 is the lowest of the 5 chapters.

However, to better characterize our analysis, we have divided our interpretation into 2 equal parts:

- The first part runs from 01/01/2007 to 30/06/2015;
- And the second part runs from 01/07/2015 to 31/12/2023.

We note that the 1st part is more than 2 times larger than the 2nd part, due to the major water crisis that hit the country between 2002 and 2003. For this, the Algerian government invested heavily between 2007 and 2014. Then it decreased as it began to satisfy citizens.

- Chapter 322 and 1.59 is larger in part 1 than in part 2.
- Chapter 323 and 1.72 larger in part 1 than in part 2
- chapter 342 and 1.62 larger in part 1 than in part 2

The ratio for these 3 chapters is almost identical, i.e. they have proceeded in almost the same way for all three chapters.

- The ratios between part 1 and part 2 for chapters 333 and 341 are 4.29 and 3.78 respectively, which clearly shows that the first part between 2007 and June 2015 was much studied by DRE decision-makers.

Next, we'll present Coube figures of the variation in the updated funding allocation for the 5 chapters over the period 2007 to 2023.

Then a general curve representing the variation in allocations for the five chapters as a function of the years (2007 to 2023) for all chapters.

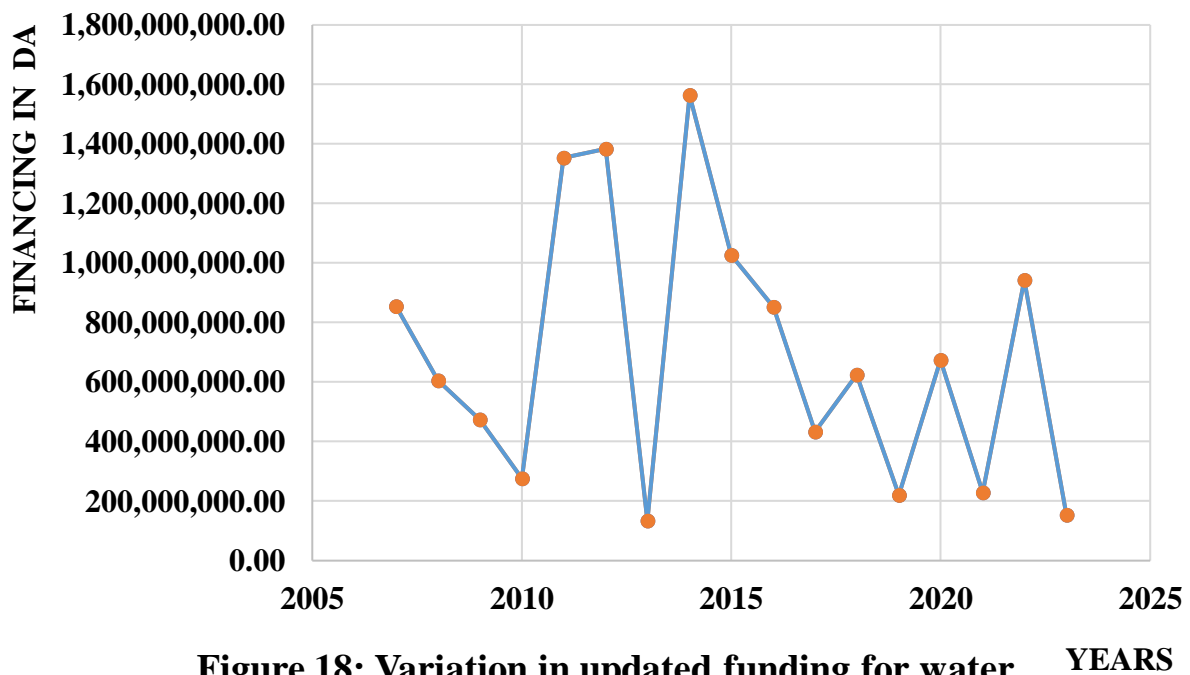


Figure 18: Variation in updated funding for water mobilization for chapter 322

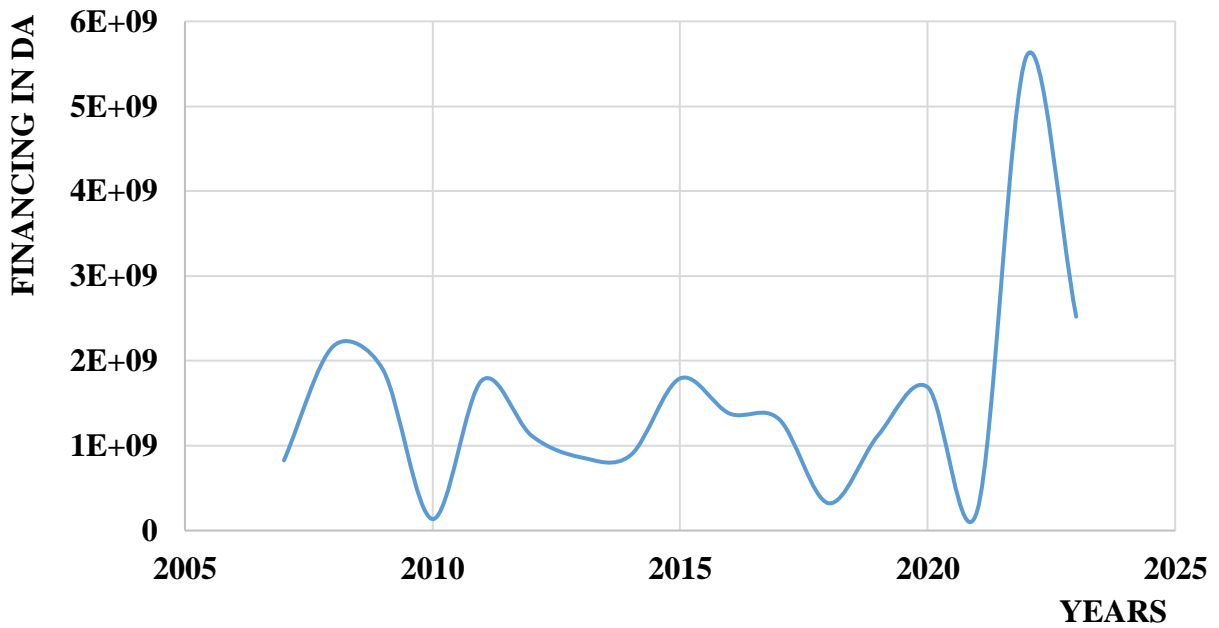


Figure 19: Variation in the updated funding allocation for pipelines from 2007 to 2023 for chapter 323

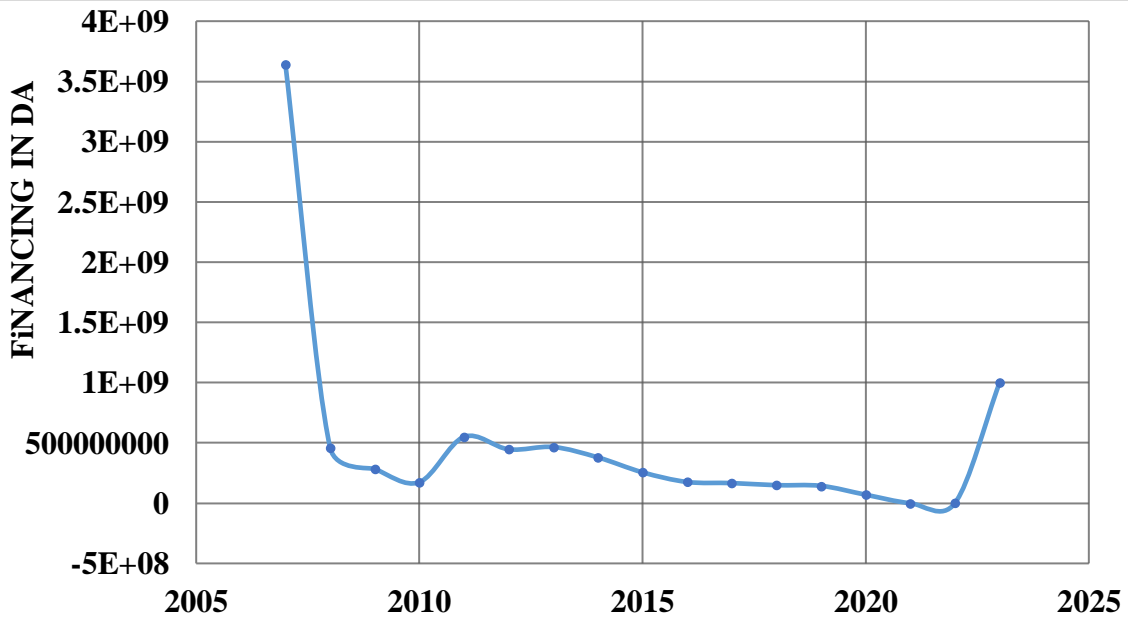


Figure 20: Variation in updated funding for irrigation and hill reservoirs over the period 2007-2023 for chapter 333

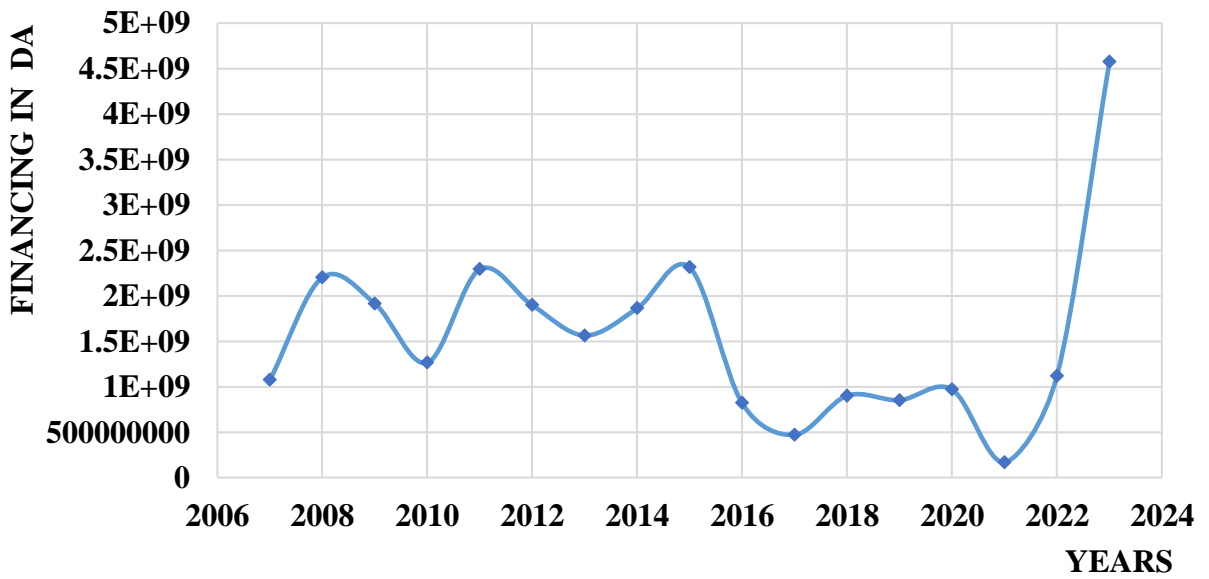


Figure 21: Variation in updated funding from 2007 to 2023 for chapter 342

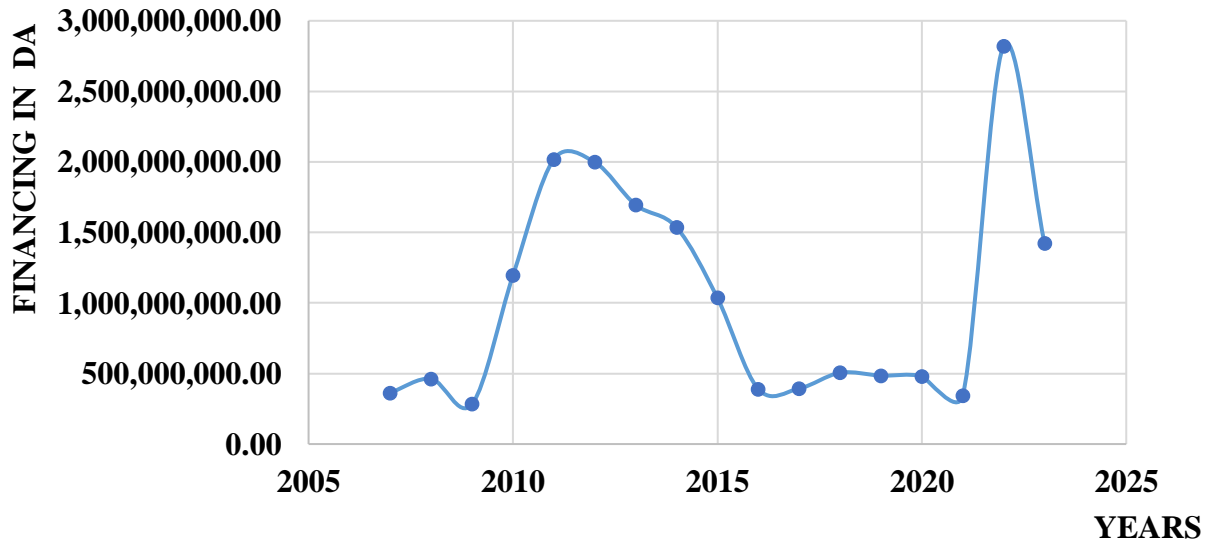
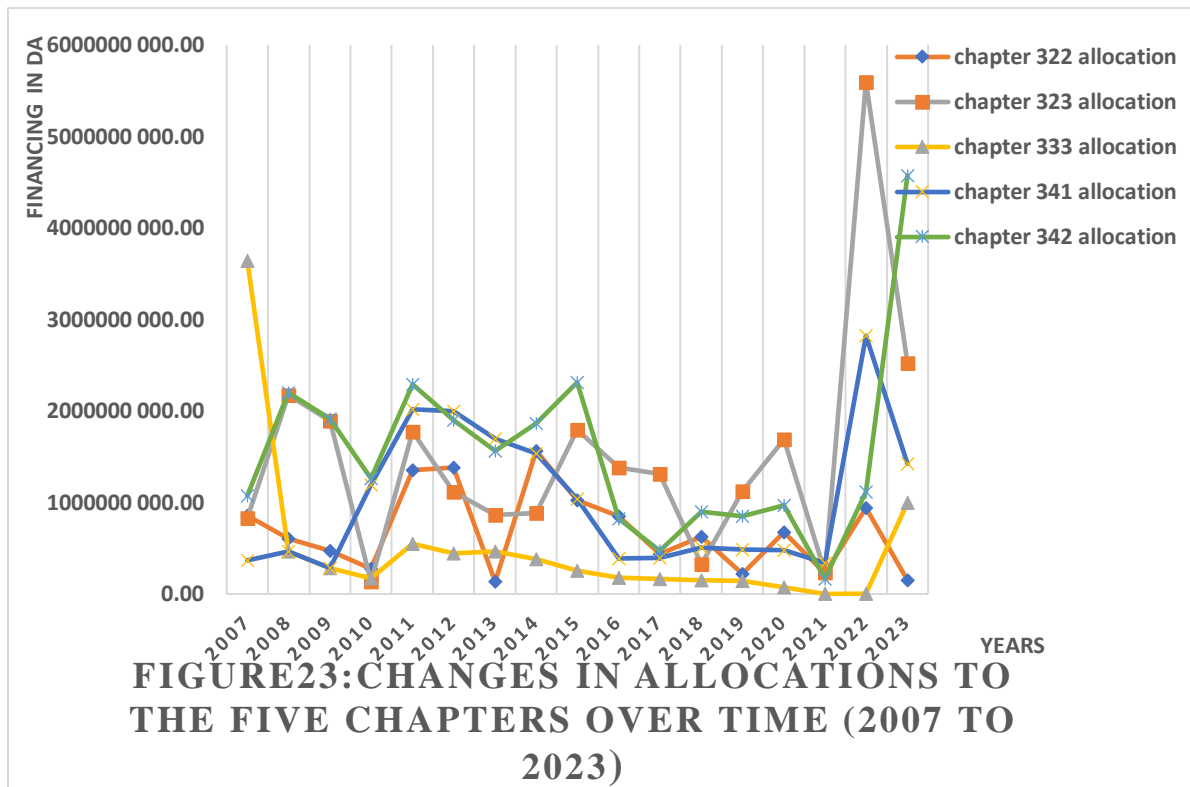


Figure 22: Variation in updated funding for water supply between 2007 and 2023 for chapter 341



II) Interpreting the curves

We can see from these 6 figures that funding for part 1 was greater than for part 2.

These figures show that the curve for the best-funded chapter 341 has 5 peaks for the years (2007, 2008, 2012, 2013 and 2021). This clearly shows why this chapter was the best endowed, as it presents 4 maximums in the first part and 1 maximum in the second part.

The second curve in the chapter, 323, also shows 5 maximums for the years (2011, 2017, 2019, 2020 and 2022). That is, 1 maximum in the first part and 4 maximums in the second part.

The other curves for chapters 322, 342 and 333 show 3 peaks in (2014, 2015, 2016) for chapter 322, 3 peaks in (2010, 2018, 2023) and 1 peak in 2009 for the least endowed chapter 333.

I would also like to inform you that the choice of chapter funding is based on several factors.

How were these budgets designated?

Chapter funding based on executive requests

A meeting chaired by Mr Wali of the wilaya to discuss any needs in the sector (drinking water supply, sanitation, agricultural hydraulics), in the presence of executive directors, heads of daïra of the wilaya and presidents of assemblé populaires of communes, after discussions, a summary was drawn up by order of priority of the needs of each daïra which will be subsequently decided by financial technical sheets that must be sent in turn to the minister of the sector (Minister of Water Resources MRE).

The Ministry then defines the budget allocated to each wilaya.

III) Impact of the water policy on the wilaya of Tlemcen and Algeria

This policy has brought several benefits to Algeria and the Tlemcen wilaya over the past 25 years:

A) For Algeria

a) Water supply

- For seawater desalination. The Minister of Energy and Mines, Mohamed Arkab, has indicated that the production of seawater desalination plants across the country is estimated at over 2 million cubic meters of water per day, a volume that could rise to 3.5 million cubic meters by the end of the current year 2024. Seawater desalination plants, which currently number 14 and will rise to 19 after another five plants come on stream shortly.

- For surface water, several dams with treatment plants have been built.

- Several boreholes have been drilled for groundwater.

b) A great deal of work has gone into sanitation and wastewater treatment plants.

c) Irrigation has also been provided.

B) For the wilaya of Tlemcen :

This policy has brought several benefits to the wilaya of Tlemcen over the past 25 years:

a) Water supply

- For surface water, the water policy in the wilaya of Tlemcen has created 3 dams: Sekkak, Boughrara and Sidi el obdeli, with their treatment plants.

- For groundwater, several boreholes have been drilled.

- They have built 2 small desalination plants and 2 large ones.

We have 53 Daïras in the wilaya of Tlemcen. Each Daïra is supplied by its own method, so we have:

- 8 Daïras supplied with mixed water (desalinated; underground; surface);

- 13 Daïras supplied with mixed water (desalinated; underground);

- 1 single Daïra supplied with mixed water (desalinated; surface);

- 6 Daïras supply mixed water (underground; surface) ;

- 16 Daïras supply groundwater ;

- 9 Daïras supply desalinated water only.

b) Sewerage, purification and irrigation

A large sewage network has been built, linked to the 2 large WWTPs at AIN EL HOUTZ and Maghnia.

STEP (AIN EL HOUT)

- In the wilaya of Tlemcen, 5% of borehole water is used for industry and 95% for irrigation.
- The perimeter irrigated from the STEP is 912 hectares (theoretically irrigated) and 847 Hectares (actually irrigated).
- The WWTP's capacity is of the order of 150,000 inhabitant equivalent.
- The purified wastewater capacity of the AIN EL HOUT WWTP is around 30,000 m³/d.
- The Henaya irrigation scheme is managed by ONID (Office National d'Irrigation et Drainage).
- The Henaya irrigation scheme is the first to be put into operation in Algeria (commissioning in 2011).

WWTP (Maghnia)

Plant capacity is 150,000 populations equivalent. (There is no irrigation perimeter).

Area of irrigated perimeter (4250 Ha), irrigated from the Beni Bahdel dam.

Given the dam's current volume of around 4 million m³, the perimeter does not benefit from the annual irrigation quota (intended solely for AEP).

The irrigation perimeter is supplied from the Hammam Boughrara dam. This perimeter has a surface area of 1714 Hectare (to be put into operation in 2022).

GENERAL CONCLUSION AND PERSPECTIVES

General conclusion:

In Algeria, the water sector is now one of the priorities of the government, which created its own Ministry in 1999, the "Ministère des Ressources en Eau (MRE)". This ministry is responsible for implementing and enforcing national water policy. Since the early 2000s, substantial public funding has been allocated to the water sector to help overcome the chaotic water shortage situation that affected the country between 1995 and 2002.

Algeria has enriched its national water policy by adapting it to all the changes brought about by climate change and growing social and economic needs. Algeria's water resources are limited, vulnerable and unevenly distributed. These pressures on water resources are accompanied by a sharp increase in demand for water, leading to overexploitation of underground water resources. In semi-arid and arid regions, groundwater exploitation is often the only immediate solution for water supply.

Algeria has made enormous efforts to mobilize water resources, both in terms of financial investment and in terms of reform and integrated management. These efforts are aimed at achieving an effective water policy, with the slogan "The social must be an objective, the economy a means and the environment a condition".

Algeria considers water to be the key to its sustainable development, while climate change, demographic pressure and exponential growth in urbanization are certain to exacerbate the country's water stress situation.

Faced with this situation, and in order to meet the challenges posed by water problems in Algeria, we need to put in place a new approach to water, based on an interactive system linking the area of need to the area of solution, by integrating the various functional and institutional relationships. In our view, the water crisis is not just a crisis of scarcity, but above all a crisis of management.

For this reason, Algerian policy has invested heavily in improving water resources during this period

- In water supply, several dams, boreholes and desalination plants were built.
- In sanitation, several WWTPs were built to improve the volume of water used to irrigate agriculture.
- Despite all these efforts and improvements, water resources are still limited, but better than before 2002.

Expected prospects:

- Algeria aims to produce 3.5 million cubic meters per day of seawater desalination.
- The Minister of Energy and Mines, Mohamed Arkab, has indicated that the production of seawater desalination plants across the country is estimated at over 2 million cubic meters of water per day, a volume that could rise to 3.5 million cubic meters by the end of the current year 2024. In other words, seawater desalination plants, of which there are currently 14, will rise to 19 after five more come on stream "soon".

The managing director of the Algerian energy company, affiliated to the sonatarach group, revealed that active efforts are being made to complete 6 new seawater desalination plants powered by solar

energy, as part of a new strategy that relies on renewable energy sources (solar energy) to operate desalination plants from the beginning of 2025. [55]

- The company, AEC, plans to start building the 6 stations, with a production capacity of 1.8 million cubic meters per day, next year, in 2025, to start operating between 2027 and 2028" second complementary program.

- The national water strategy 2021-2030, has forecast that production capacity will rise to 5.4 million cubic meters per day in 2028, after the completion of two programs, namely (6 solar power plants + 5 seawater desalination plants, which will put an end to the water crisis caused by the scarcity of rainfall in Algeria due to climate change. As for the value of investments in the water desalination sector, the Minister indicated that they will amount to around 4.5 billion dollars and will be financed by the state and implemented by Algerian public companies. [55]

As the price of desalinated water is subsidized by the state, it will remain so until 2035.

- Concerning the cost of desalinated water consumption through the stations. The Minister indicated that desalinated water would be sold at the same prices currently subsidized by the State.

- Concerning the possibility of Algeria resorting to nuclear power plants to provide important sources of energy. The President and CEO of AEC stated that future strategic perspectives are based on the operation of desalination plants in the future, integrating electricity generated by solar power to reduce desalination costs. [55]

- The Minister made no secret of the fact that the production of drinking water through desalination plants will provide additional quantities of water that will be directed towards agriculture, explaining that Algeria depends on dams and wells for 82% of its drinking water supply, and 18% on desalinated water. However, the operation of the plants under the two complementary programs will enable Algeria to meet around 60% of the population's drinking water requirements through seawater desalination, which will also help to supply significant quantities for agriculture. [55]

- Allocation of specialized funding for the construction of wastewater treatment plants that serve to reuse purified water for agricultural purposes especially after a considerable drop in rainfall. [55].

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