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Water security in northern Morocco: natural difficulties, water requirements, technical measures, and the most important state strategies - the case of the Al Hoceima region

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Abstract

Water is very important in the Al Hoceima region of Northern Morocco and underpins the region's stability, population growth, and social, economic, and environmental development. Al Hoceima, along with the rest of North Morocco, has been receiving heavy rainfall over the last two decades. Al Hoceima, however, has been receiving much less rain than it has over the last two decades. Current climate change poses obstacles that affect almost every domain: Al Hoceima's natural wealth has been stressed, and in Al Hoceima, the water has literally reversed. Rainfall has been very extreme in Al Hoceima (the last 20+ year time span shows that annually it has been as low as 300-1000mm and for the rest of the Kingdom, Al Hoceima persists* to use a water management strategy, of its own, as it is the case for the rest of the Kingdom. For this reason, the issue of Al Hoceima is particularly relevant, given the lack of rainfall and water stress.

This particularly applies to Northern Morocco and the region of Al Hoceima, which recognises the decreasing availability of water. This is particularly the case during the time of the realisation of the impacts of climate change and even the localised impacts of climate change, which include, among others, industrial water use and the resultant and sustained high demand attributed to population increase, which also affects the water-deficient resources due to over-reliance on dam water, coupled with water-consuming farming practices. In this regard, the above factors necessitated the formulation of numerous questions, particularly regarding the water resources of the Northern region of Morocco, and Al-Hoceima in particular. We then pose a secondary question: how effectively do the water policies in place promote water governance and regulate water use?

Keywords: water resources - northern Morocco - Al Hoceima city - rainfall - climate change.

Introduction:

Morocco, along with other regional and global actors, has acknowledged the linkages between the triad of water security, climate change, and sustainable development. Like many other countries, Morocco's water resources are affected by climate change. However, Morocco is more affected by the adverse impacts of climate change than many other countries. Morocco is situated in a transitional climate zone, meaning the country is subject to both the dry and hot air mass and the northwestern wet air mass. All countries have some degree of water scarcity. However, across Morocco's varied regions, differing climatic conditions, and uneven distribution of water resources, the country faces water issues distinct from those in the rest of the world. Among the factors driving increased water demand are population growth, urbanisation, and water use in industry and agriculture. To achieve the country's sustainable development, there is a dire need to develop comprehensive management strategies and implement them.

The effects of climate change, combined with site factors, affect the Tangier-Tetouan-Al Hoceima region (one of Morocco's constituent territorial units). It receives more rain than the rest of Morocco, but that doesn't make it water vulnerable. Water insecurity is one of Morocco's many problems and one of the region's most pressing problems. The declining water resources and the water resource problems should worsen it even further.

Since Al Hoceima is one of the significant urban centres in the Tangier-Tetouan-Al Hoceima region, it is of great importance to the region's geographical and demographic makeup and is a key player. Al Hoceima also has to deal with the problems created by the nexus of consecutive years of drought, rapid demographic growth, and significant urban expansion. These factors worsen challenges at the water resources level in the Al Hoceima region, requiring greater effort from both the local and central governments to address them.

Given the northern province's water resource constraints, this study will examine the challenges and prospects of the Al-Hoceima region in Morocco.

Problems and hypotheses of the study

Most important to this study is the problem of how to integrate/merge the emergency strategies and plans with the water problems of northern Morocco, particularly in the region of Al Hoceima, in order to achieve an optimal sustainable balance with regard to the water resources, which will be of the greatest benefit to the people in the area, especially given the region and the climatological region's outstanding natural (and combined regional climatological/thermodynamic) features that warrant the formulation of a policy to address the prevailing climate variability and devise emergency strategies to improvise and innovate with water. Accordingly, within this context, the problem of this study can be broken down into the following questions:

- What natural features characterise the study area?
- What is causing the reduction of the area's water resources?
- What is preventing sustainable development in the area of water?
- What strategies could be used to attain sustainable equilibrium in the area of water resources?

Objectives of the study

- The objectives of this study are:
- To outline a study that diagnoses the water resources of the region and evaluates the activities of the agents in the field.
- To understand the different reasons that have caused the region's water resources to decrease;
- To arrive at conclusions that assist in the construction of a set of recommendations to enhance the water resources valuation.

Methodology and Research Tools

This document was built using a particular set of methods based on the three pillars of observation, interviewing, and questionnaire surveying.

Approaches to study

In this study, we employed description and analysis, diagnosing and assessing both the manifest and latent potentials. We used the documentary method in conjunction with several scholarly writings. We also used fieldwork, which included observation and then extended to interviews.

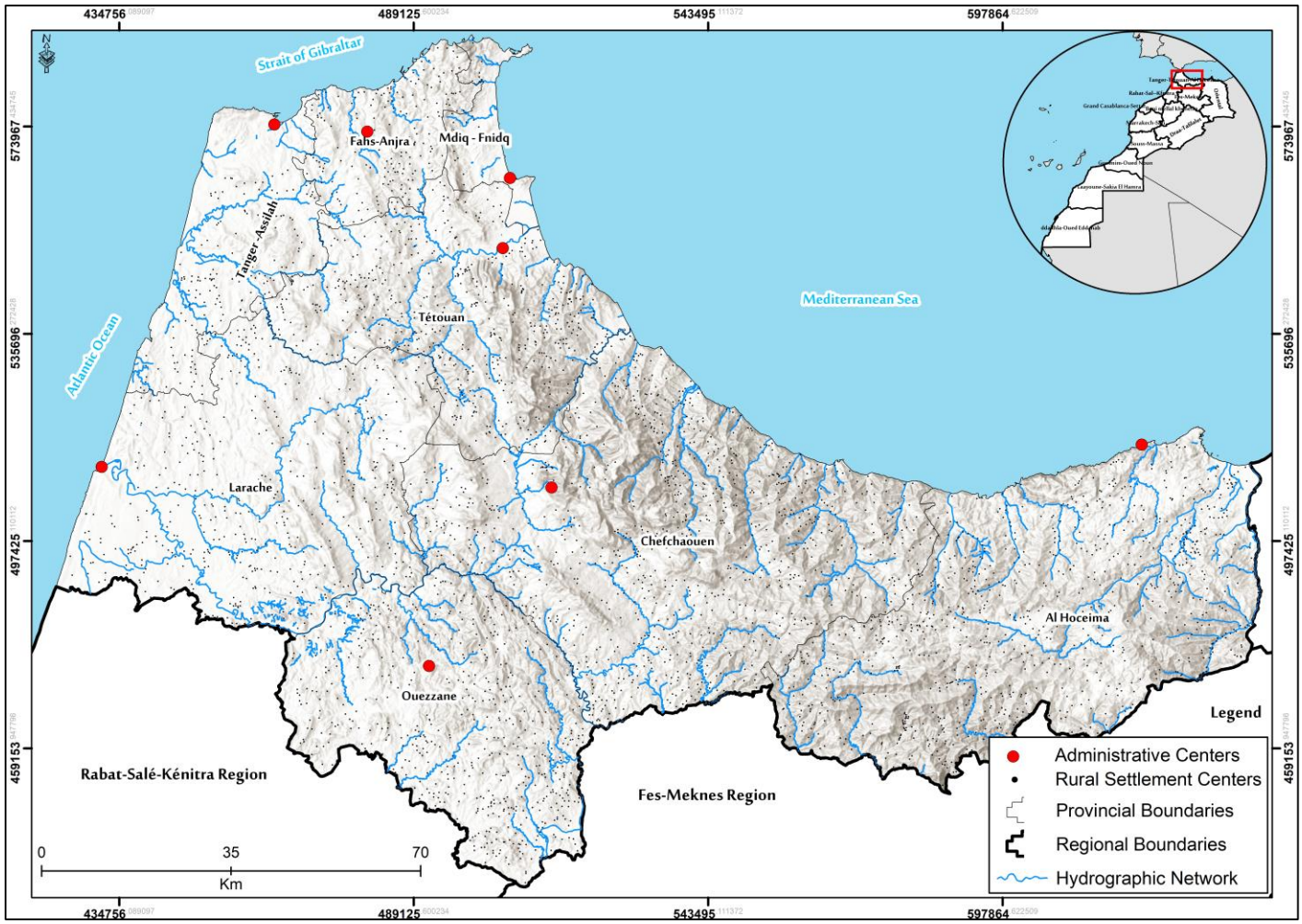
The Al-Hoceima region in northern Morocco faces both natural challenges and water stress.

The breakdown of the region's administrative boundaries and its resources.

With respect to the geographical distribution and location of the Mediterranean basin, the region of Tangier-Tetouan-Al Hoceima is of great importance because it is a point of intersection of the Maghreb and the three Europe-Africa-Mediterranean regions. The total area of the region is 17,262 square kilometres. According to the 2014 general census, the region's population is 3,556,729, making it, statistically, the 3rd most populous region in the Kingdom of Morocco, with an average population density of 206 people per square kilometre. The Tangier-Tetouan-Al Hoceima region is divided into 8 administrative divisions/borders, referred to as the 8 territorial units: 2 arrondissements and 6 provincial divisions. At the sub-province/bas district level, the region is divided into 146 territorial units and 22 divisions/communes. The Tangier-Tetouan-Al Hoceima region is unique for its expansive, diverse natural resources, including a vast array of biogeoclimatic and ecological zones of great value. Of special note is that the presence of a considerable amount of natural resources, in the form of forests, within the region has not been diminished by overuse.

Given the area's geographic location, it is prone to numerous natural hazards, including earthquakes, climate change, floods, and wildfires. The region is also affected by soil erosion, which causes negative effects such as landslides and flooding. The last contributing factor is human activities that negatively impact nature.

Map No. (01): Administrative division of Tangier-Tetouan-Al Hoceima



Source: Personal Achievement for Researcher

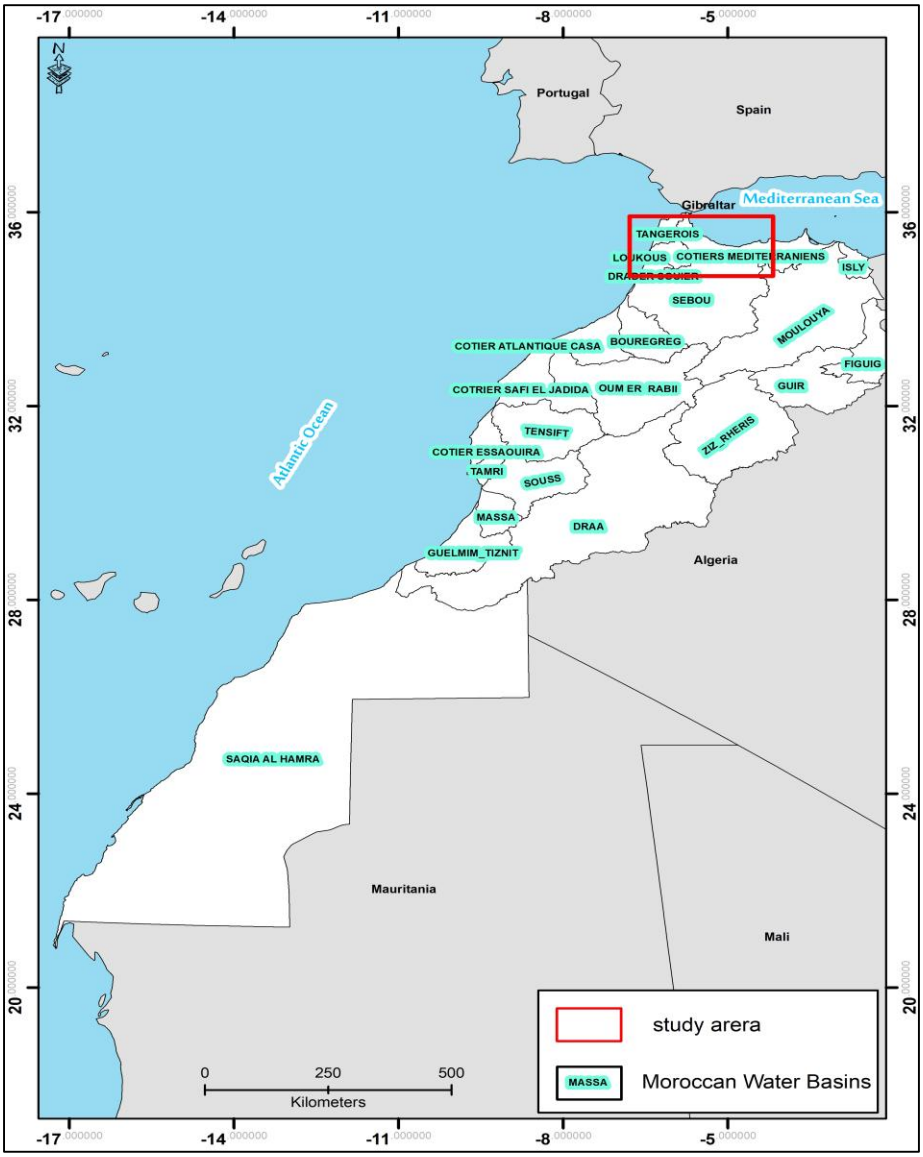
For centuries, access to water has legitimised human social structures, with Ancient Egypt illustrating how vital resources are to the formation of advanced societies, while denying them to others. Empires crumbled, and social order, safety, and security dissipated after losing control of water sources. More recently, in a historical context, water has served the same purpose for organised human society in Morocco, and has also been vital to the country's socio-economic development and to the protection and fostering of natural ecosystems. The historical importance of water in Morocco has also been conflictual, marked by long periods of violence. The most recent and violent periods of conflict saw the French and Spanish colonisers of Morocco prioritising water in their control of the Coast and the Central Atlas, the regions of Morocco with the most water resources.

Many countries experience water stress, including Morocco. In Morocco, approximately 18 billion m3 of surface water is available. Of Morocco's total water resources, only 20% is captured from groundwater. The water shortage in Morocco is acute. Morocco's water output of 650 m3 per person is 1,185 m3 lower than in 1960, when it was 2,500 m3, and is even predicted to reach 500 m3 by 2030. Water-wise Morocco is very water-stressed. Dam water is a useful resource, but from 2018 to 2022, it was unavailable due to persistent drought. In the 2021/22 season, 85% of the water storage was unavailable. In 2022, only 900 million m3 of water was available for irrigation, a sharp drop from 2009-2017, when the average was 3.4 billion m3. The groundwater deficit was also severe, resulting in a loss of 3 to 6 meters.

Tangier-Tetouan-Al Hoceima has the highest dam filling rate and the most precipitation in the country. However, it, like all other regions in the Kingdom, continues to suffer from extreme water stress, particularly during drought years, when thirst becomes a dire reality. Based on the most recent data and statistics, in the 2023-2024 hydrological year, all the Agency's regions recorded a 10% deficit in precipitation,

which negatively affected dam water imports and resulted in a 51% shortfall in annual imports.

Map No. (02): The studied field within the water basins in Morocco



Source: Personal Achievement for Researchers

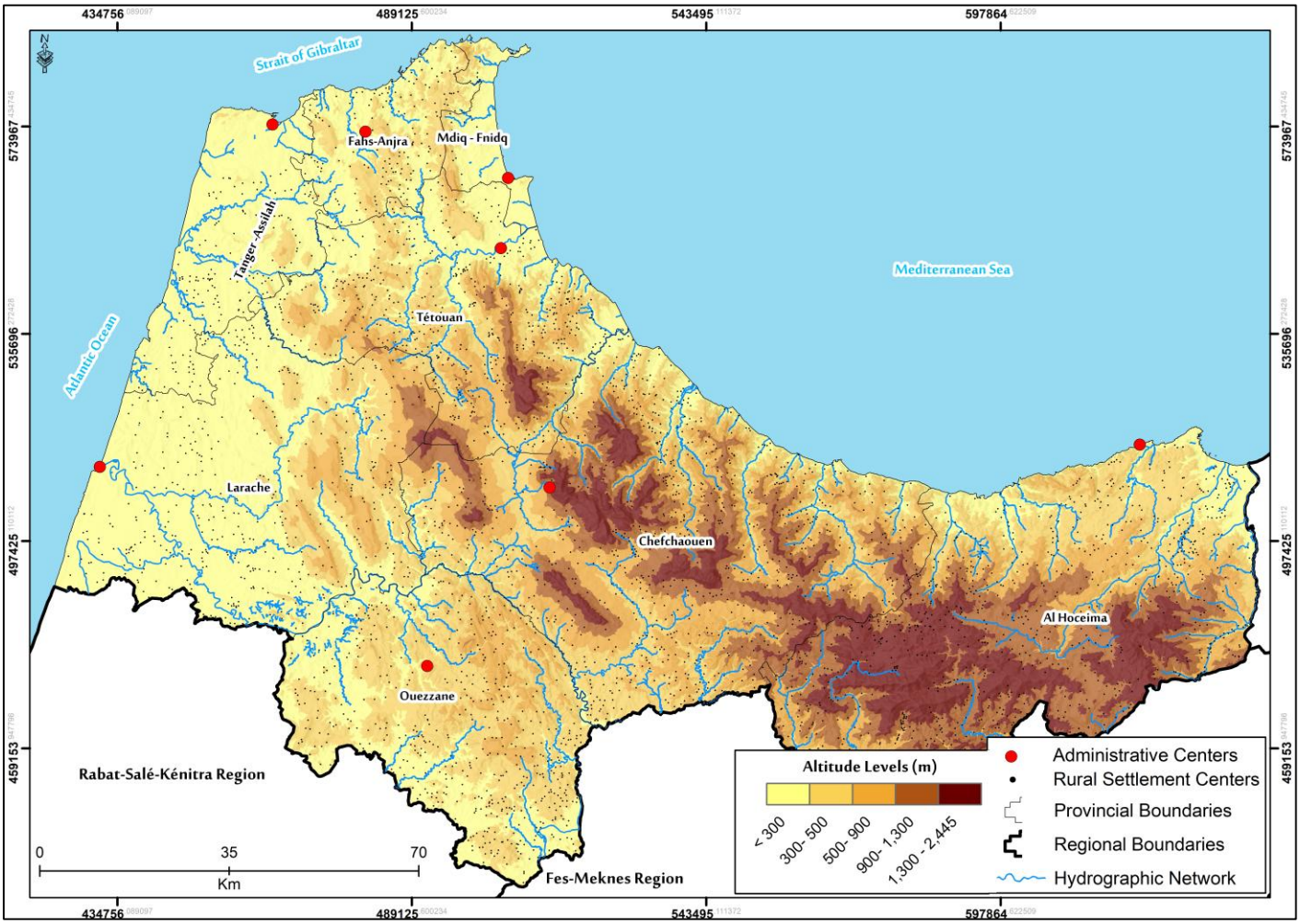
Deficiencies in the Conducted Influence of the Alcos Water Agency. The last hydrological year, 2022-2023, had 35% less rainfall than the average, which negatively affected imports at the dam injection level in this basin. The water deficit continues in the current hydrological year, which, as of March 1, 2024, has received 35% less rainfall than the same period last year.

The basin's dams had a filling percentage of 42.7% as of March 1, 2024, compared to 59.4% on the same day last year. In the Tangier-Tetouan-Al Hoceima region, important water projects have been planned in the long and medium terms. They are to construct nine massive dams, each with an overall capacity of about 2.5 billion cubic meters. The addition of these nine dams will improve water resources in the north, which has been suffering from drought, thereby raising water levels in several dams. Nonetheless, some other dams have recorded a filling rate of 100 per cent, in addition to the projects of the Gis and Kharoub Dams.

The northern regions of the Kingdom are part of the master plan for integrated water resource development for the Lucos and Tangier basins and the Mediterranean coastline. These large-scale water projects in the kingdom’s northern regions

will help provide potable water, irrigation, hydropower, and flood protection. The Mediterranean and Tangier basins integrated resource development masterplan. Based on the northern water basin development plans, it is anticipated that construction of the region's basin storage dams will be completed by 2050, and the entity will be able to increase its storage capacity to 4.5 billion cubic meters at a cost of 9.8 billion dirhams. These cost estimates are for the envisioned small and large regional northern basin dams. The Ayyasha Dam, located in the suburbs of Tangier, is one of the southern basin integrated resource development projects. Ayyasha Dam is designed for flood protection and to recharge the subsurface aquifers. Ayyasha's storage capacity is 118 million cubic meters and is designed for potable and irrigation water supplies.

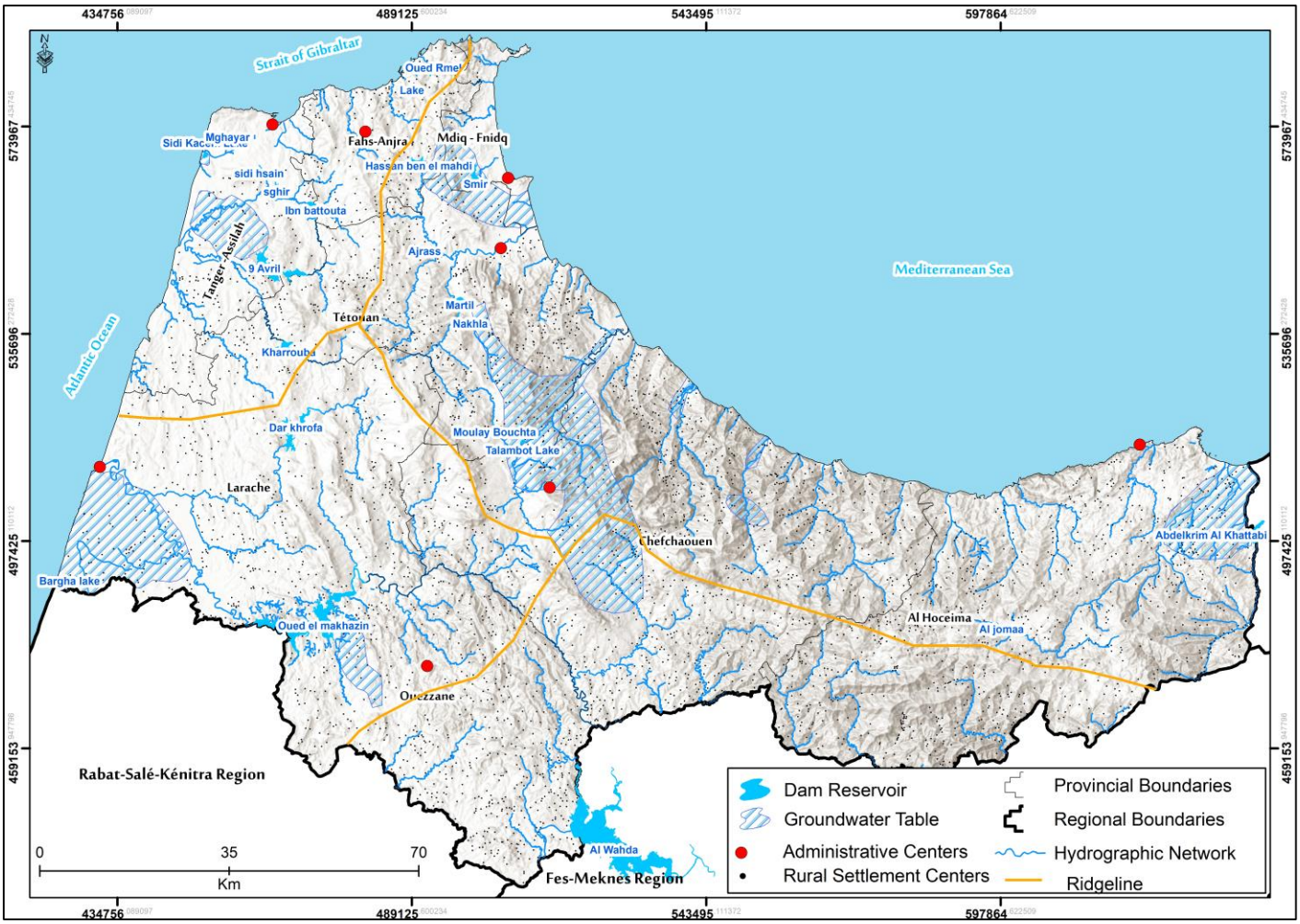
Map No. (03): Topographical characteristics of the field of study



Source: Personal Achievement for Researchers

The maps show the roughness of this area, and the predominant region here consists of the rough mountains lying between the primary elevations of the Rif Mountains and plateaus. The many deep valleys further the roughness and complexity of this region, making its terrain difficult to utilise for resource extraction. The utilisation of the region's water resources is particularly difficult.

Map No. (04): Hydrology of Tetouan Al-Hoceima Region



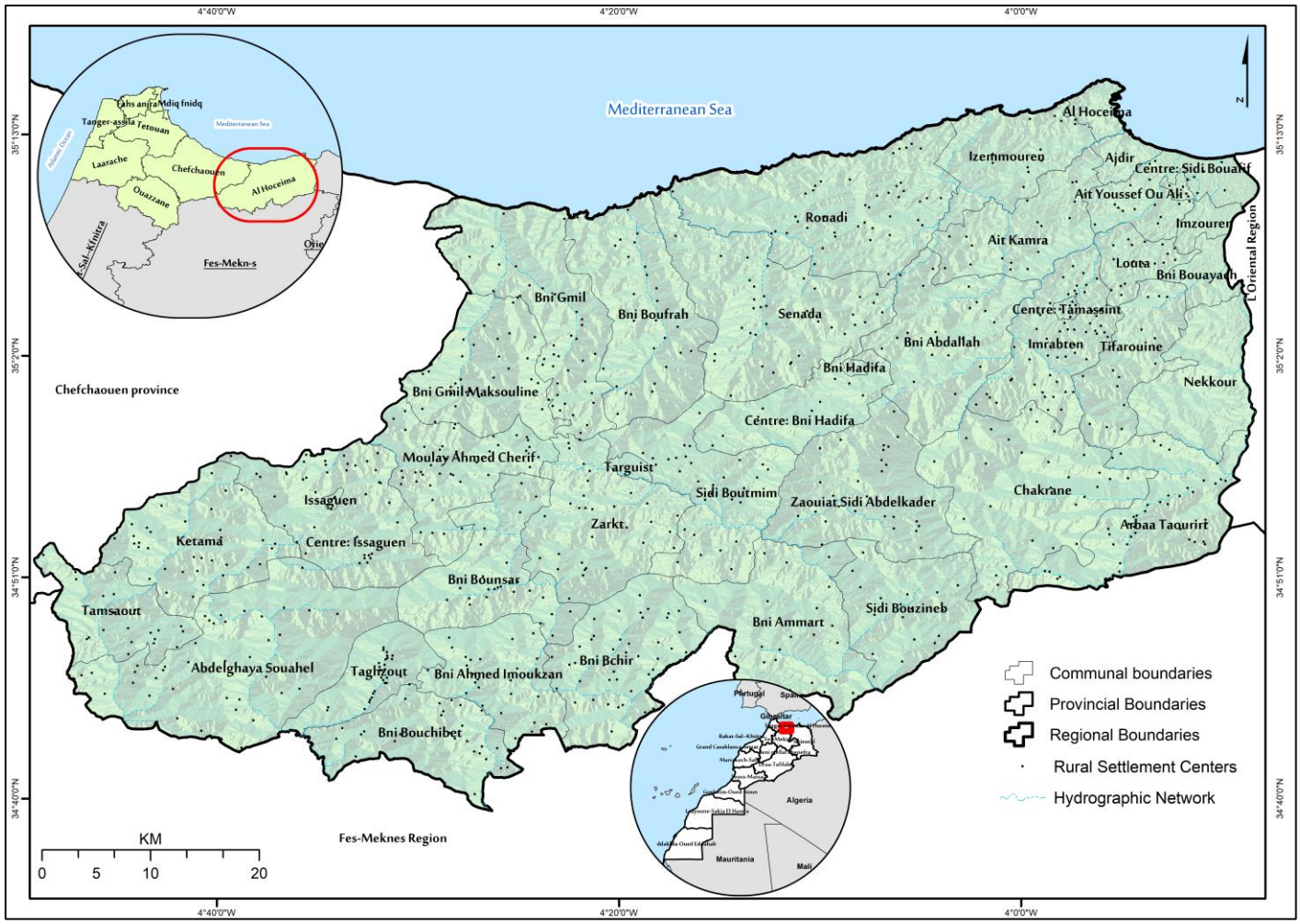
Source: Personal Achievement for Researchers

The map combines the study area water basin with its northernmost waterways, valleys, and geoquadrants, along with the northern section of the study area basin map. Also shown is the study area water basin. The study area's water basins are not evenly distributed. Most of the water basins in the study region are in the Chefchaouen, Tetouan, Al-Arash, and Al-Hoceima areas, while the surrounding areas are deficient in water basins. However, evaluating water basins across the study area is challenging due to the dominating mountainous region.

Most human and residential settlements are in areas with high and dense water resources. This is not a new phenomenon, and while human permanence is connected to the resource of water, the very essence of life cannot exist without water. Throughout history, water has been, in the view of social science, the main cause of countless conflicts and wars.

Without this fundamental, natural resource, famine occurs, and crops and livestock perish. Conversely, an excess of water floods the land, submerging all life, whether human, animal, or vegetation, with destructive water.

Map No. (05): Geographical location and territorial division of the Al-Hoceima region



Source: Personal Achievement for Researchers

Natural Environment of the Al Hoceima region

The Al Hoceima area includes a part of the Rif Mountain range with steep slopes (10 to 40 degrees) and deep abyssal valleys. Mount Tidghin, rising to 2,465 meters (8,084 ft), is the tallest mountain of the range. Due to the height of these mountains, Al Hoceima was designated a National Park covering 48,000 hectares. The Moroccan Mediterranean coast is also the centre of the National Park Al Hoceima. The Mediterranean Sea is to the North, the Secondary Road connecting Al Hoceima to the White Cockpit via Amzurn is to the South, and the Caliris Coastal Highway is to the West and Al Hoceima to the East, with the Centre of the National Park. The National Park is a designated area of protection due to its biodiversity, including over 200 plant species and a distinct diversity of animal species.

Climatic Characteristics of Al-Hoceima

Because of its location along the Mediterranean Sea, the Al Hoceima region has a Mediterranean climate with a wintery, rainy season followed by a hot, dry summer. The wet season lasts from October to April, and the dry season from May to September. Al Hoceima's average annual precipitation averages somewhere between 300 mm and 1000 mm. The highlands receive 1000 mm while the coastal areas receive 300 mm. The average annual temperature ranges from 10 degrees C to 30 degrees C. Al Hoceima's climate is influenced by the Mediterranean Sea, the Atlantic, and the Continent to the east. Al Hoceima also has varying humidity, with wet, cold winters and hot, dry summers.

Research at both national and international levels, focused on drought and climate change, is both applied and fundamental. The region's climate is changing, with climate variability, as weather systems can change rapidly in the short and long term. This was the basis for the World Meteorological Organisation (WMO) in 1959 to define climate as: “Climate is the aggregate of the variable weather conditions, and is characterised by the change, and evolution, of the various weather conditions over an extended period of time (30 years or more) within a given area of the earth’s surface…”

The diversity of water resources in the Al Hoceima region:

The Al-Hoceima region includes the Guess and Nakur basins, as well as four other main basins: Mastasa, Bani Boufrah, Sindah, and Buskour. Basins along the Nakur and Guess Mediterranean coasts provide the region's surface water. The Al-Hoceima region has a distinctive deficiency of surface water. The reduction in resources in Al-Hoceima and other parts of Morocco is a consequence of climate change and socio-economic shifts within the Moroccan population and the Al-Hoceima community. Given these changes, people are likely to adopt modernised irrigation practices, including new excavation methods, water pumping, and the use of modern tools, alongside local traditional methods. Major central valleys of the region are Mnouad Fadal, Oued Boufrah, Oued Badie, Oued Boskour, Oued Thurmset, and Oued Sannada. Groundwater in the region flows slowly, while the northern slope, adjacent to the coast and characterised by a water mattress, has higher flow.

The water mattress may be considered the most important in Agbal Roundab because of the amount of water it provides to a large area, reaching up to the middle of Al Rawadi. In this case, the underground resources are also being utilised through wells. Their depths range from 7 to 42 meters. Depending on the season, the thickness of the aquifer varies from 0.5 to 3 meters. Many studies on future water resource flows in Morocco (including Al-Hoceima) have considered the major climate changes expected in the 21st century. These studies have focused on a limited number of the country’s major water basins.

Water stress and its impacts:

The Al Hoceima region faces many interrelated issues, including land degradation, drought, and water stress. Also, the region's water resources are negatively affected by the underdevelopment of the country's judicial system and the lack of key resources. The past six years have been marked by drought across the entire kingdom, including the Al Hoceima and Tangier-Tetouan regions. Among the drought-affected areas, Al Hoceima has received the least rainfall. Studies show that the region will continue to receive little rainfall, especially due to climate change. Al Hoceima is located in the Alkos water basin, and during the past hydrological year (2023-2024), the region recorded a 3.2% deficit in rainfall, and the water captured in the region’s dams was 52% below the average. Several cities in the region suffered from a lack of potable water during the drought, and the poor agricultural output exacerbated the drought’s impact on Morocco's economy.

The Al Hoceima region faces water-related challenges due to numerous human-related factors, including increased population, economic growth, and industrial development and their effects on ecosystems, coupled with climate change impacts, increased temperatures, and more erratic rainfall. Morocco faces the water crisis described as \"acute and unique\" characterised by unprecedented country's dam water levels and the annual groundwater over-exploitation of 3.68 billion cubic meters, exceeding the sustainable threshold of 3.44 billion cubic meters by 240 million cubic meters.

Subsurface aquifers in northern Morocco also face declining water levels, which in some locations could lead to the complete loss of river flow; many are already lost. Traditional surface water systems will also face deterioration in spatial and operational efficiency. As for the status of the region’s groundwater, it is extremely poor compared to the previous years. This is even more alarming, as this water is now threatened. Extreme and continued groundwater extraction is evident in many water sources, with flow loss, basic river regulation failing, large areas of formerly irrigated land being lost, multiple water beds now dry, and remaining water beds threatened with drying to the point where they can no longer support life. The region is also experiencing high water stress, with per capita water availability below 500 m3 per person per year.

In the Al Hoceima region, it is understood that water stress is not the only issue regarding water resources. Other issues encompass:

- Climate change. These have led to a 10%-20% reduction in rainfall, coupled with increased temperatures and higher evaporation.
- Intense agricultural pressure. The agricultural sector consumes 80% of resources and relies heavily on water-intensive crops such as citrus and avocado.
- Neglecting the circular economy. Merely 7% of the treated wastewater is reused.

State interventions and proposed measures to solve the water problem in the field of study:

During the construction of the above-described water projects, the Government, the Ministry of Equipment and Water, and partners in the water sector have previously initiated efforts to address the water crisis through additional measures to meet people's drinking water needs. Consequently, there are efforts to plan and manage the distribution of this surplus to the community. Here, it is necessary to differentiate the sustainable measure of water and the inherited human stability in a particular zone of scarcity, coupled with the planned measures, which are a combination of new programs and strategies aimed at mitigating the impacts of a range of natural and human-made factors, including climatic variations that affect water resources, in one way or another. Accordingly, to this end, water stakeholders have developed a range of legislation and strategies to formulate integrated water governance, ensuring that water resources are accessible to future generations. Specifically, initiatives undertaken by the Ministry of Equipment and Water in this regard, during the last year, in the execution of several projects in the Locos Basin, include:

- Facilitating the delivery of potable water to rural areas without access, using water tank trucks.
- Support the use of groundwater from the Lao Valley to ensure a sustained supply of drinking water for the city of Lao Valley.
- Attach two exploitable holes to Mizurun at an 80-litres-per-second capacity.

In the same context, Mr Nizar Baraka confirmed the government is implementing structured plans for the Alkos Basin, including:

- Construction of the Wadi Al Makhazin Dam Water Diversion Project towards Dar Akhrafa Dam.
- Commencing the study on the completion of the 70 million m3 capacity seawater desalination plant to support the potable water supply to the city of Tangier.
- Installation of floating pumps at the embankment of the basin.
- Activating the Guess Dam, which is 97% complete.
- Plans for the Ayyasha Dam in the Larache Region, with an estimated storage capacity of 118 million m3.
- Plans for three small dams within the agency's operational area.
- Continue the inexcusable increase in the unsustainable use of groundwater by completing a series of exploratory holes and converting the previously positive ones to exploitable ones to satisfy the water demand in the rural area.
- The Ministry negotiated 'water bedding' contracts with Sharaf Al-Aqab, Mediterranean Coastal, and Ghis Al-Nakkour, the stakeholders involved in the participatory and sustainable management of sand layer-embedded aquifers.
- The Ministry also continued implementing projects to reuse treated wastewater for irrigation of green spaces and golf courses, further relieving pressure on conventional water resources.
- Water scarcity and drought management in the Kingdom
- Water Use in Agriculture
- Water-efficient,
- Climate-smart alternative agriculture
- The Ministry continues with advertising, including banners, vodcasts, and radio and TV spots, as part of the water economy rationalisation and the water savings special awareness program.

The 'Alma Dialna' platform has also been developed and presented to the general public and stakeholders (professionals, experts, and civil society) to showcase the most up-to-date developments in the field of water, the current state of water reservoirs, innovations and perspectives in the field, the need to conserve and the call to save water and the raise the awareness of the problems related to water resources. We must also note that the real teachings of Islam emphasise the value of water (water is the backbone of life and its pillar, so life continues on earth). The Almighty asked questions that some of the disbelievers could not reflect on. As for the heavens and the earth, some of them were sewn together, and we split them asunder, and we made every living thing from water. In the Quran, the Almighty made another point. It is he who created man from water, then made him a lineage by

descent and made him a husband, and your Lord is indeed competent. Allah is truthful when he says, We sent water from the heavens in measured quantities, and we caused it to gather in the earth. In another example, Allah says in the Quran, "Say, what if your water should disappear and become untraceable? Who then could bring you water that is pure?" The story of our master Moses a.s. illustrates the importance of water in human life. So, we said, beat the rock with your stick, and from it twelve springs came forth. All the people who were there knew the springs that were there to drink from. The life of the Prophet Muhammad and the Quran contain many hadiths that talk about water.

The numerous lives that water supports are one of the great blessings from Allah.

Almighty on His creatures, because of the fact that water is essential to life, and is a primary source of sustenance for humans, animals, and plants. According to Islamic principles, water is a God-given resource essential to life. It is a valuable resource that should be kept from those who would abuse it and protected from those who would waste it and pollute it. Water is life; it is a common good and should be made available to everyone.

Thus, a country’s water resources are one of the most crucial resources that should be prioritised. The country's highest authorities focus on them. For example, His Majesty King Mohammed VI has dedicated a significant portion of his speeches to this topic and has met with the government to evaluate the progress and execution of the proposed tasks.1 Climate and water conditions have negatively impacted the agricultural season, and 143 billion dirhams have been allocated to mitigate the consequences of drought. This program includes:

- Water basins interconnection project.
- Build new dams to increase the storage capacity by an additional 6.6 billion cubic meters of fresh water.
- Utilise 1801 million cubic meters of treated water for agricultural purposes.
- Advance the unconventional water bottling initiatives by incorporating seawater desalination facilities.

Regarding the city of Al-Hoceima's water system, the agency has reported progress on the Guess dam, with construction anticipated to be finalised this year, increasing water storage capacity to 93 million cubic meters. This will significantly increase water availability in the Al-Hoceima province, especially for irrigation and potable water. Moreover, construction has also commenced on the floating pumps (at the Mohammed bin Abdul Karim Al-Khattabi and Guess dams), which will be directed to the submersible water layers. Two (Mizu) run-of-the-river pumps will be integrated into the Al-Hoceima system, and the Al-Hoceima Seawater Desalination Plant will be extended to boost its production capacity from 6.3 to 8 million cubic meters per annum.

With regard to the rural regions that lack a drinking water distribution network, the Alcos Water Basin Agency has recognised the need to implement its own policy, which pertains to cycles of inquiry and prospecting for additional water resources via the construction of exploratory water holes and the assessment, study, and alleviation of such deficiencies. To ensure that the inhabitants of the remote village receive water, the Agency assumed that circular areas adjacent to water sources are supplied with drinking water from natural springs or water holes, as observed in the calcareous peak roundabouts. Trace water resources.

Pertaining to the isolated roundabouts, which are located outside the generalized water beds, and are known to be extraordinarily water deficient, the Agency has been implementing “searching for additional groundwater resources through an annual program to complete exploratory water holes, in partnership with the Research and Water Planning Directorate, the National Water and Electricity Office - Water Sector, the local government, and the elected representatives.” For the year 2024, the Agency has planned to undertake a project worth 5.6 million dirhams to finalise 22 exploratory water holes in areas with minimal rainfall within the Agency’s area of influence and scattered deficient rainfall zones.

The program of 64 exploration and 32 exploitation water holes in the Tangier-Tetouan-Al Hoceima region awarded 12 million dirhams in 2022, along with their set of roundabouts and preliminary design of the \"partnership\" with the National Office of Water and Electricity - Water Division - and the Council of the Tangier-Tetouan-Al Hoceima. Out of the 180 l/s budgeted, 180 l/s is to be invested. Currently, the Locos Water Basin Agency is documenting waterwheels that are likely to be included in the exploration and exploitation of water holes in the rural areas of the Tangier-Tetouan-Al Hoceima sub-district. This is part of a 10-million-dirham budget, resulting from the same partnership with the same actors.

The Locos Water Basin Agency has begun documenting waterwheels aimed at water diversification within a 10-

million-dirham budget for the partnership program exploring and exploiting waterholes in the rural areas of the Tangier-Tetouan-AL Hoceima sub-district. In the past three years, Locos Aquarium Agency has built over 190 exploratory waterholes for 190 roundabouts, spending approximately 14 million dirhams and achieving a positive flow rate of 60 per cent, equivalent to approximately 200 litres per second. The water system of Tangier also marked the start of the diversion of Wadi Al-Makhazin Dam waters to Dar Akharafa Dam to supply the Tangier Grand Pole with potable water, as well as the commencement of preparatory studies for the construction of a seawater desalination plant in the city of Tangier.

Beginning of the floating pumps construction project at Dar Kharfa and Kharoub dams. This project seeks to exploit the water just below the water intakes. The Agency also focused on the ongoing construction of projects to reuse treated wastewater for the irrigation of green spaces and golf courses. This will relieve conventional water resources and reduce water allocation for the Dar Kharfa water basin to 22-60 million cubic meters for the 2023-2024 agricultural season.

Conclusion:

Water resources in northern Morocco have witnessed a significant development in recent years. This development has been negative due to the successive years of drought in the region and Morocco in general, which led to a deficit in water imports in the area, and the accumulation of its effects on water reserves, in addition to the impact of a set of development programs on water resources that contributed to water stress in the region. Topography and the structural field are also reasons for the weakness of water resources, due to the lack of extroversion in the field of study, which was recognised by the responsible institutions dealing with water and water resources at both national and local levels. Therefore, the authorities in this field took a set of measures. Can these urgent measures achieve water security in the region, including the Tangier region, and specifically in the field of study?

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Footers

- Idriss Alqerfa, 2020, "The Impact of Climate Change on Water Resources in the West Plain, the Case of the Boumaïse Earthen Community," an article within a collective book "Geographical Research in Morocco and the Question of Development", First Edition, p. 126.

- Zainab Mabsout, 2018: Man, and Water in the Moroccan-Atlantic Desert, First Edition. Afaq Foundation, p. 24.

- Water has played an important role in political stability, and the emergence of social and political unrest, and ancient civilisations have emerged in areas of water abundance in Mesopotamia and the Nile.

- Idriss Hafeez, Water Resources in Morocco, Management Capabilities and Challenges, Second Edition 2021, p. 13.

- In this regard, today we see the intensification of conflict in the twenty-first century in many regions of the world over rivers and water sources, for example : the conflict over the Nile River between Egypt and Sudan on the one hand and Ethiopia on the other hand and the Libyan project of the Great Industrial River, the acquisition by Israel of the Sea of Galilee and the waters of the Jordan River, which caused damage to the countries of Syria, Jordan, Lebanon and Palestine, the problem of the water river between Iran and Afghanistan, the problem of the Tigris River and the Euphrates River between Turkey and Iraq, in addition to the drought of many rivers in Europe, especially Germany, Spain, France and Italy. In addition to these data, the world is witnessing pressure on water resources today due to demographic growth and climate change resulting from global warming, which caused a hole in the ozone layer.

- In this context, Morocco has also known, inaddition to the high population density, the decline of its water resources due to drought and _irrational use, which led to a decline in the level of a large number of water basins and a significant decrease in the injection of dams, which led the Royal Institution of Morocco to declare a state of emergency in this regard and apply the water governance project, which deals with all the emergency measures required by the government to achieve water security, and to address the shortage that occurs between the dirt areas of Morocco, which has a large area overlooking two sea fronts and has rich natural qualifications, including water resources, whose distribution varies according to the regions of the country. This work is reflected in the launch of the first major national water transport project, specifically the water linkage project between the River Spo and the Abu Ruqraq River, which concluded in August 2023.

- Mustafa Al-Bayd, Omar Abtawi, Idris Dawi, Water Resources and Climate Change in Dry and Semi-Dry Environment, The Case of the City of Laayoune, an article in the collective book Water and the City: Towards Thinking about a Sustainable Measure, publications of the Cultural Forum of the City of Safro 2024.

- Ancient History of North Africa, by Stéphane Akeel Stéphane GSELL, translated by Mohamed Tazi Saud, Part V The civil kingdoms and their social, political, and economic system, Publications of the Academy of the Kingdom of Morocco, History of Morocco Series, Rabat 2007, p. 30.

- Water has gone astray throughout history in Morocco, forming a natural element that can create the earthy areas and the human and population gatherings that live and settle in them, because water is an essential dry element for the population and a major driver for choosing a lifestyle and the economic and social activities associated with it. It is the nerve of life in all its forms, as it - water - covers70% of the Earth's surface (seas, lakes, rivers, and water sources). It is found in the ground and in the air. Civilisations flourished wherever water sources were abundant and collapsed when they were reduced or disappeared.

- It must be recalled that the expansionist ambitions of the colonizer in the coasts of the Sahara date back to the beginning of the fifteenth century, as the colonial countries (France, Spain, Britain and Portugal) exploited the weakness and disintegration of Morocco at the end of the fifteenth century, and began to compete for the fish resources that abound in the Moroccan coasts, and the ambitions of these countries have expanded. The desert coasts have

- become a fertile area for their fleets. Spain is among the countries that focused its colonial policy on building military forts and fortresses in these areas. This area has been occupied in stages.

- The scarcity of water and the difficulty of obtaining it, and the high price of it, led to the intensification of strife that threatened the goals of the colonizer, who continued to suffer from the anger of the desert resistance and was dominated by fear and terror, so the latter began to develop a plan to ensure the calm of the elements of the resistanceand satisfy the population at the same time, so he began to organize search and exploration campaigns for water in many areas.

- The plan to start searching for water can be considered a political trick, with its colonial approach, to calm the situation and ensure stability, so it can carry out a topographical survey and learn all the ways to fully control these areas. Indeed, the latter has achieved its goals by focusing on water search and drilling as a key element of its colonial policy.

- Zainab Mabsout, Man and Water in the Moroccan-Atlantic Desert, Afaq Foundation, First Edition, 2018, p. 109.

- Data and figures from the Alcos Water Basin Agency in 2024.

- The speech of the Minister of Infrastructure and Water, Mr Nizar Baraka, during his visit to the Alcos Water Basin Agency on Tuesday, March 5, 2025 - The information delivered by the Minister of Equipment and Water, Nizar Baraka, during a meeting chaired by the Board of Directors of the Alcos Water Basin Agency, in Tangier, in the year 2024.

- Man lives in a world of water, but most of that water is unusable. About 97% of this water is found in seas and oceans, and it is salty, difficult to exploit, and expensive to treat. 3% of the good water is also completely unavailable, including underground water and water in polar regions such as ice. The remaining amount of fresh water that can be used does not exceed 0.26%, which is the amount available to the inhabitants of this planet.

- In this regard, today we see the intensification of conflict in the twenty-first century in many regions of the world over rivers and water sources, for example : the conflict over the Nile River between Egypt and Sudan on the one hand and Ethiopia on the other hand and the Libyan project of the Great Industrial River, the acquisition by Israel of the Sea of Galilee and the waters of the Jordan River, which caused damage to the countries of Syria, Jordan, Lebanon and Palestine, the problem of the water river between Iran and Afghanistan, the problem of the Tigris River and the Euphrates River between Turkey and Iraq, in addition to the drought of many riverside Europe, especially Germany, Spain, France and Italy. In addition to these data, the world is witnessing pressure on water resources today due to demographic growth and climate change resulting from global warming, which has caused a hole in the ozone layer.

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- Mustafa Al-Bayd, Amar Abatouy, Idris Dawi, Water Resources and Climate Change in Dry and Semi-Dry Environment, The Case of the City of Laayoune, an article in the collective book Water and the City: Towards Thinking about a Sustainable Measure, publications of the Cultural Forum of the City of Safro 2024.

- Statistics and data of the High Commission for Planning

- Al Hoceima Region Monograph, Report of the High Commission for Planning, Regional Directorate of

- Tangier-Tetouan Al Hoceima, Regional Directorate of Al Hoceima 2020 Report, p. 12.

- Abdelaziz Bahou, Climate drought in Morocco: its characteristics and relations with the mechanisms of the air cycle and its impact on the cultivation of main grains.

- PhD thesis in geography, specialising in natural geography. 2002-2001 p.1 .2

- Boshuaib Salik, Climate and Surface Dynamics and their Relationship to Sustainable Development, Melilla Region, as a Model: An Approach to Remote Sensing Technologies and Geographic Information Systems (sig).

- PhD Thesis in Climate Geography 2013-2014, p.62

- At the international level, the attention of researchers and competent international organisations – in response to the increasing severity of drought disasters and the exacerbation of their consequences – has tended to focus on drought manifestations and the causes and mechanisms of contemporary climatic fluctuations.

- This international interest was crystallised at the World Climate Conference held in Geneva in 1978 (OMM)in cooperation with the International Council of Unions and organised by the World Meteorological Organisation (CIUS).

- At the national level, Morocco – as confirmed by geological, geomorphological and historical information – is among the region’s most vulnerable to drought and climate change. Its location in the transitional subtropical latitudes makes it constantly subject to the influence of archetypal high-pressure cells and dry tropical air masses.

- Although climate research in the country began early, since the period of protection – where many studies and research were carried out to determine the general characteristics of the country's climate – climate research stagnated during the period of independence; its production during this period was very meager, and did not exceed a few articles, published by some Moroccan or French geographers in the magazine " Geography of Morocco ".

- This situation continued until the 1980s and 1990s, where the intensification of drought – especially since the dry period of 80,1985, which had violent environmental, economic and social consequences – led to renewed attention to the need to deepen climate research, both basic and applied, on the characteristics of the country's climate and its repercussions.

- Report of the Locos Water Basin Agency, during the meeting of its Administrative Council in the city of Al-Hoceima in March 2025.

- Idriss Chehou and Mohamed Tialsan, 2016, Rural Economics as Alternatives to Sustainability in the Tafilalet Oases, cited in: Organisation and Preparation of the Rural Sphere in Morocco, Research and Interventions, Publications of the Faculty of Arts and Humanities Rabat.

- Ahmed Bouhamid, PhD thesis specialising in geography, The Problem of Water Management in Dry Areas, 'Shishawa Nomoda Region', Whole Season 2017/2018, p. 305.

- Climate change has affected the availability of water throughout the year in many regions, according to the Intergovernmental Panel on Climate Change (IPCC) report published in2014, where more than half of the world's population suffers from severe water scarcity for at least one month per year, and nearly 1.6billion people suffer from water scarcity, which means that these populations do not have the infrastructure necessary to access water. In fact, over the past century, global water use has increased sixfold and continues to grow rapidly.

- This has been addressed in the Intergovernmental Panel on Climate Change (IPCC), as well as in the UN World Water Valuation Report 2020, Water and Climate Change, «The State of Water Resources in the Context of Climate Change. 21, French Version.

- UN World Water Valuation Report 2020, Water and Climate Change, «The State of Water Resources in the Context of Climate Change.”

- Water stress occurs when demand for fresh water exceeds supply, affecting societies, economies, and ecosystems.

- This happens when there is a shortage of water compared to human, agricultural and industrial needs.

- Article 1by the expert in water resources, Mohammed Al-Bazeh, published on the Lakme website on September 27, 2022.

- Works of the meeting of the Board of Directors of the Alcos Basin Agency in 2024. Aly Dadon, veiled Ashmork.

- The article "Water Governance in Morocco" is part of the collective book entitled Regionalism, Governance and Territorial Development in Morocco: The Problem of Perception and the Challenges of Download, published by the Faculty of Languages, Arts and Humanities, Ait Melloul University Pole, in 2019. p. 126.

- Surah Al-Anbiya, verse 30.
- Surah Al-Furqan verse 54.
- Surah Al-Mouaminie, verse18.
- SurahAl-Malek verse 30.
- Surah Al-Baqara verse 60.
- Locos Water Basin data 2025