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CLIMATE CHANGES IN ALGERIAN SAHARA FROM ANCIENT TIMES - AN APPROACH TO HUMAN INTERACTIONS WITH THEIR ENVIRONMENT

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Abstract. This study investigates the dynamic interplay between climate change and human-environment interactions in the Algerian Sahara from prehistory to the present. Challenging colonial historiography that presented North Africa's climate as statically arid, we reveal significant paleoclimatic shifts and address key research gaps concerning hydrological ambiguity in prehistoric river networks and groundwater systems. We explore the adaptation asymmetry between thriving prehistoric communities, evidenced by sophisticated water management and rich rock art during humid periods, and modern Algeria's struggles with intensified droughts despite advanced infrastructure. Furthermore, the study aims for narrative decolonization, using Saharan rock art and indigenous knowledge to counter Eurocentric claims of civilizational stagnation. We hypothesize that prehistoric Saharans developed sophisticated water management strategies during humid Holocene phases, contrasting sharply with modern vulnerabilities to drought, and propose that climate-driven shifts are the primary catalysts for sociocultural transitions. Employing Fernand Braudel's multi-temporal framework, our methodology integrates paleoclimatic reconstruction through sediment cores and rock art analysis, hydrological modeling using satellite imagery and GIS, historical archaeology to decolonize climatological perspectives, and policy analysis comparing modern climate adaptation measures with prehistoric resilience models. This approach offers a nuanced understanding of Algeria's environmental history and its implications for sustainable development.

Keywords: Climate changes; Sahara; Algeria; prehistory; Environment; Interaction

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КЛИМАТИЧЕСКИЕ ИЗМЕНЕНИЯ В АЛЖИРСКОЙ САХАРЕ С ДРЕВНЕЙШИХ ВРЕМЁН: ПОДХОД К ВЗАИМОДЕЙСТВИЮ ЧЕЛОВЕКА С ОКРУЖАЮЩЕЙ СРЕДОЙ

Джуад Мусса*
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Абстракт. Настоящее исследование посвящено динамическому взаимодействию между климатическими изменениями и человеческой деятельностью в Алжирской Сахаре- от доисторических времён до современности. Противопоставляя себя колониальной историографии, изображавшей климат Северной Африки как неизменно засушливый, работа выявляет значительные палеоклиматические сдвиги и обращает внимание на пробелы в изучении гидрологической неопределённости древних речных сетей и подземных водных систем. Исследование сопоставляет процветание доисторических сообществ, свидетельством чего являются развитые системы водоуправления и богатое наскальное искусство влажных периодов, с современными трудностями Алжира, испытывающего усиленные засухи, несмотря на развитую инфраструктуру. Кроме того, цель исследования-деколонизация нарратива: использование наскального искусства и традиционных знаний Сахары для опровержения евроцентрических представлений о «цивилизационном застое». Гипотеза исследования состоит в том, что доисторические сахарские общества выработали сложные стратегии управления водными ресурсами в гумидные фазы голоцена, тогда как современные сообщества проявляют уязвимость к засухам. Климатические сдвиги рассматриваются как основные катализаторы социокультурных трансформаций. Методология опирается на многоуровневый временной подход Фернана Броделя, включая палеоклиматическую реконструкцию по осадочным кернам и наскальным изображениям, гидрологическое моделирование с использованием спутниковых данных и ГИС, историко-археологический анализ для деколонизации климатологического дискурса, а также сравнение современных адаптационных стратегий с древними моделями устойчивости. Такой подход способствует глубокому пониманию экологической истории Алжира и её значению для устойчивого развития.

Ключевые слова: климатические изменения; Сахара; Алжир; доисторический период; окружающая среда; взаимодействие

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İQLİM DƏYİŞİKLİKLƏRİ VƏ ƏLCƏZAİR SƏHRASINDA İNSANLARIN ƏTRAF MÜHİTLƏ QARŞILIQLI ƏLAQƏLƏRİ: QƏDİM DÖVRLƏRDƏN MÜASİR ZAMANADƏK YANAŞMA

Cüad Musa*
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Abstrakt. Bu tədqiqat Əlcəzair Səhrasında iqlim dəyişiklikləri ilə insan-ətraf mühit qarşılıqlı əlaqələrinin dinamikasını, tarixöncəsi dövrlərdən bu günədək araşdırır. Ənənəvi kolonial tarixşünaslığın Şimali Afrikanın iqlimini sabit və quru kimi təqdim edən təsəvvürünə meydan oxuyaraq, bu tədqiqat əhəmiyyətli paleoiqlim dəyişikliklərini üzə çıxarır və tarixöncəsi dövrlərdəki çay şəbəkələri və yeraltı su sistemləri ilə bağlı hidroloji qeyri-müəyyənliklərə diqqət yetirir. Əsər, nəm dövrlərdə inkişaf etmiş su idarəçiliyi və zəngin qaya rəsmləri ilə sübut olunan qədim icmaların tərəqqisini, müasir Əlcəzairin texnoloji infrastruktura baxmayaraq quraqlıqla mübarizədəki çətinlikləri ilə müqayisə edir. Araşdırma, həmçinin kolonial narrativlərin dekolonizasiyasına yönəlir və Səhranın qaya incəsənəti ilə yerli bilik sistemlərindən istifadə etməklə Avrosentrik "sivilizasiya durğunluğu" fikrini təkzib edir. Biz fərz edirik ki, tarixöncəsi Səhra icmaları Holosenin rütubətli mərhələlərində mürəkkəb su idarəetmə strategiyaları inkişaf etdirmiş, lakin müasir dövrdəki iqlim dəyişikliklərinə qarşı həssaslıq bu irsə uyğun gəlmir. İqlim yönümlü dəyişikliklərin sosial-mədəni transformasiyaların əsas katalizatoru olduğu təklif edilir. Fernand Brodelin çoxzamanlı yanaşmasına əsaslanaraq, tədqiqat metodologiyası çökmə nüvələri və qaya rəsmlərinin analizi vasitəsilə paleoiqlim rekonstruksiyasını, peyk təsvirləri və GIS-dən istifadə etməklə hidroloji modelləşdirməni, tarix-arxeoloji məlumatların dekolonial təhlilini və müasir iqlim adaptasiyasının qədim dövr modelləri ilə müqayisəsini əhatə edir. Bu yanaşma Əlcəzairin ekoloji tarixinin və dayanıqlı inkişaf üçün elmi nəticələrinin daha dərin anlaşılmasına töhfə verir.

Açar sözlər: İqlim dəyişiklikləri; Səhra; Əlcəzair; tarixöncəsi dövr; ətraf mühit; qarşılıqlı əlaqə

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1.Introduction

The distribution of water resources in the Algerian Sahara is closely linked to two main elements: topography and climate. Climate, in particular, has had a profound impact on shaping the water map of the region, from prehistoric times to later historical periods. The Algerian Sahara is generally characterized by an arid climate, but it has witnessed significant climatic fluctuations throughout the ages, with periods of relative humidity interspersed with severe droughts. These climatic changes have led to radical transformations in the network of rivers, lakes, and groundwater, which in turn has affected human life and economic activities.

In humid periods, the Algerian Sahara enjoyed a more temperate climate, with rivers and lakes that contributed to the formation of an environment rich in water resources. In times of drought, these resources declined significantly, leading to the disappearance of many bodies of water and the transformation of the region into an arid desert. These climatic shifts not only affected the natural geography but also human activity, as people were forced to adapt to these changes by developing new survival strategies, such as relying on groundwater and building water storage systems.

In studying these phenomena, we can benefit from the perspective of the historian Fernand Braudel, who pointed to the multiplicity of historical times and their dismantling into different layers of influences and speeds. If time affects everything, from topography to climate, and from mental structures to economics and civilizations, its impact is not at a uniform pace. Therefore, understanding the impact of climate on the water map in the Algerian Sahara requires a multi-dimensional approach that takes into account the complex interactions between environmental and human factors across time.

Through this presentation, we also ask about the possible relationship between history and the natural realm? History with its political, economic, military, and civilizational burdens in general, and the realm represented in geography such as topography and climate. Can the environment of a particular region contribute to the development of civilization in that region? And can any civilizational development necessarily be considered a reflection of the environment in which it occurred? These are a set of legitimate questions that have been raised before, but with less intensity. Researching the topic is also like researching the problem of civilizational development throughout history, especially if we are dealing today- as axioms- with the emergence of developed civilizations in some regions and not others, and especially also as we know that the capabilities of the human mind can only be the same in all regions of the world. If there is a disparity in the degree of progress of this mind in one region and not another, the reasons for this must be sought in fields other than the physiological and genetic makeup of humans. The main problem of this

study: How did climate changes affect the Algerian Sahara? Sub-issues include: What is the relationship between climate and water wealth? , What are the most important climatic changes that occurred in the Algerian Sahara in prehistoric times? And how can it be proven?

2.Climate Issue

The relationship between water resources and climate change is reflected in the role that climate change plays as an independent variable affecting water resources, which serve as a dependent variable. This is evident through the direct impact of climate change on rainfall, temperature, evaporation, and transpiration rates.

This climate change effect varies from one geographical region to another worldwide. For instance, an increase in rainfall is expected in Western Europe and Southeast Asia, while a decrease in rainfall is anticipated in other parts of the world, including the Middle East and North Africa, which already lack sufficient water resources [Anbar, n.d., p.24].

The subject of precipitation is closely linked to a fundamental issue concerning climate, as it both affects and is affected by it directly. A recurring question in many historical studies focused on climate history (climatology) has been: "Has the climate of North Africa changed from ancient times to the present?" One of the early scholars interested in this matter was Stéphane Gsell who provided a substantial bibliographic list to support his viewpoint [Gsell, 1915, pp.44-90].

Although this question may seem superficial, it encompasses numerous historical perspectives and theories that are not devoid of directed ideologies; thus, discussing them is essential in such studies.

Should we not revisit prehistoric periods? And pose the same question raised by Stéphane Gsell within the framework of Braudel's approach, but this time not within its Mediterranean context but rather its desert extension?

Therefore, we will attempt to address the issue from a broader perspective in terms of time and space. Geographically, this will encompass areas adjacent to the Mediterranean Sea and the Sahara Desert. The Maghreb region includes both spaces; "the history of the region without the Sahara is considered incomplete" [Boudraga, 2007, p.59].

The same applies to time; we emphasize that ancient North African history includes both prehistoric and historical phases since most historical events find their explanations in prehistoric occurrences. It is impossible to draw arbitrary lines separating space or historical time for North Africa [Boudraga, 2007, p.59].

Thus, returning to prehistoric times and the Sahara Desert is an urgent necessity for understanding the long-term impact on historical events while

also liberating our ancient history from the burdens imposed by colonial school narratives.

Isn't it worth changing our starting point, both temporally and geographically, to align with our identity? To answer some fundamental questions regarding rewriting our national history: Where do we begin the historical construction process? What is our relationship with this scientific legacy of colonial education? How can we predict levels of production and overcome this temporary stagnation and perpetual consumption state we are experiencing? How can we establish a historical discourse that addresses our scientific and national concerns? What priorities should we focus on in our research, and what key milestones are essential for grasping historical awareness? This aims to complete the historical picture and develop a vision that responds to issues stemming from our history and geography [Aibech, 2009, p.11].

If the beginning of historical writing is primarily linked to the emergence of writing itself, it is true that ancient Maghreb lacks documented records about its history due to the region's delayed development of a recording method. However, it has left us with a significant heritage of mural art sometimes accompanied by symbols; these drawings are scarce along coastal areas but abundant in interior regions like the Saharan Atlas highlands. They are plentiful in the south on the Fazzan highlands of Tassili and Ahaggar. These drawings were the primary means used by local inhabitants for communication and expression over thousands of years.

Starting from the third millennium BCE, this artistic output did not cease; thousands of paintings were created that serve as raw material for studies. Although they may not be written historical documents, they are indeed archaeological artifacts. In examining the development and sequence of themes in these drawings, we find ourselves facing cycles that testify to their owners' civilizational progress. These works provide us with images of cultural distinction known in ancient Morocco throughout its natural extension into the central desert while offering a contrasting perspective against contemporary writers' frequent depictions of stagnation and civilizational failure in Morocco remaining trapped in prehistoric darkness until Phoenician arrival. These writers drew their information from classical sources that distorted reality [Al-Aggoun, 2016, p.92].

Thus, we will attempt to identify significant climatic changes in ancient Maghreb during prehistoric times and in some northern regions to attempt mapping out the hydrological landscape of this area.

3.Climatic Changes in Prehistoric Sahara (Quaternary Geological Period)

The climate of the Sahara has always been variable and unstable since ancient times, from the Pleistocene era (2.59 million years ago - 8000 BCE)

until generally during the Stone Age; this is evidenced by numerous skeletal remains of various animals found alongside stone tools.

The topic of defining Quaternary geological time has sparked intense debate among scientists who have held several scientific conferences addressing issues related to defining a minimum timeframe for this period. It has become evident that establishing an exact temporal boundary between the third and fourth periods is challenging since researchers' minimum definitions for Quaternary time vary based on their own perspectives as well as geographical areas under study and according to criteria used for its determination (climatic, paleontological, geophysical). Ultimately, they agreed at the 1973 "Cris Shore Conference" that Quaternary geological time encompasses two unequal periods: one called Pleistocene and another called Holocene; with their temporal separation coinciding with the end of the last ice age before entering a more favorable climate phase [S.Gsell, 1911, p.16].

The beginning of Quaternary time was characterized by significant climatic changes due to disturbances and astronomical developments such as solar activity and Earth's rotation; while rainy and humid periods prevailed in North Africa during this time frame, glacial periods dominated Europe- likely due to rising sea levels- resulting in Algeria's coastal regions experiencing their highest levels during Quaternary time [Bin al-shikh, 2013, p.59].

One of the issues we face in studying the Quaternary period in North Africa is the relationship between glacial periods in Europe and rainy periods in the Sahara. In other words, how was the Sahara during the glacial ages? And what period did the Sahara take on its current shape?

The rainy periods in the Sahara during the Pleistocene were caused by the climatic conditions of cold periods in Europe. Their occurrence is causally linked to the presence of glacial periods; without a glacial period in the north, there would be no rainy period in the Sahara [S.Gsell, 1911, p.17].

The cycles of rainfall in the Sahara are represented by:

- The rainfall cycle in the Upper Miocene.
- The rainfall cycle in the Lower Pleistocene.
- The rainfall cycle in the Upper Pleistocene [Rushdi, 2008, p. 25].
- The rainfall cycle during the Neolithic period, which includes distinctive Neolithic industries [Sahnouni, 1999, p.72].

4.Evidence of Climatic Changes in the Sahara

There is ample evidence of climatic changes that have affected the Sahara. River terraces serve as clear indicators of these changes. By studying a large number of rivers, researchers have identified many river terraces. In North Africa, a significant portion of the climatic record has been recognized through studying river terraces in the Nile Valley and in the "Saoura" valley in Béchar and Lake Chad. It is known that these river terraces formed as a result of

erosion and sedimentation caused by water and wind, which translates into variations in water and silt quantities in riverbeds due to climatic changes. Additionally, fluctuations in levels of desert lakes like Lake Chad have been linked to climatic changes that created lake terraces. On another note, remnants of plants and animals provide clear evidence of climatic changes that occurred in the region, as there are plants and animals associated with both humid and arid environments [Ben Bouzida, 2016, p.1034].

An important piece of evidence regarding climatic changes in the Sahara is limestone rocks that extend from Libya's borders through the Hamada al-Hamra at the heart of Algeria's desert to Wadi- Valley- Saoura. In the western corner of the desert region lies the Draa Plateau composed of rocks dating back to the Upper Cretaceous period [Halimi, 1968, p.10].

The presence of gravel and pebbles indicates sedimentation under humid climatic conditions and suggests past watercourses and rainy environments. Layers of gravel are often found in some desert areas corresponding temporally with wet phases. Geographic location plays a significant role in climate; for instance, Central Sahara is situated far from hurricanes [Faid y. A., 1974, pp.1-42].

It is also distant from high-pressure zones near the tropics and not aligned with major winds moving from east to west, which prevents it from receiving influences from the Atlantic Ocean or Mediterranean Sea. Furthermore, southern winds carrying rain do not reach it while extensive plains stretching from east to west contribute to strong winds that encounter no mountain ranges to obstruct or contain their effects as seen with the Saharan Atlas. This results in significant dryness and heat; moreover, there are no lakes or flowing rivers to moderate temperatures, making life possible only in oases [Muzzolini A., 1995, p.11].

Diversity prevails as vast areas of lakes juxtapose potential plant-covered valleys and mountains that were likely snow-covered along with shrub-covered plains and fast-flowing rivers within a rich fish-filled environment.

The diversity experienced by the Sahara was not only geographical but also chronological; throughout the entire Holocene period, climate continued to evolve from maximum humidity around 8500 BCE to short dry spells followed by significant ecological consequences around 7500, 6000, 4000, or 2800 BCE before current dryness set in- a condition mistakenly perceived as permanent [Malley (J.), 1989, pp.34-57].

According to previous data mentioned above, a humid climate predominated in Algeria's Sahara which allowed forest wealth to cover all southern mountainous regions [H.J., 1974]. This forest wealth continued to cover the Hoggar and Tassili mountains until around the third millennium BCE when drought began to spread across desert regions [Malley (J.), 1989, p.83].

It would be incorrect to assert definitively that around 8500 BCE- during maximum humidity- precipitation levels reached between 350 mm to 1000 mm in southern deserts; however, this amount fell below 100 mm by around 4000 BCE [Aoulmi E., 2011, p.3]. Looking at all of Sahara reveals that both Hoggar and Tassili [Leredde (C), 1957, p.47] occupy a distinctive position compared to other desert areas; they fall within a dry tropical zone where Cancer Tropic passes through them which allows them to receive weak tropical and equatorial influences while their elevation above sea level contributes to moderating their climate- averaging about 2000 m high- resulting in lower temperature rates compared with other regions. The Tassili area is generally classified among regions with moderate climates according to researcher Gribi's views [GRIBI & YOUNSI, 1992, p.72].

Although Hoggar is further southward it resides at the ultimate limit where monsoonal rains can reach; it's known that these rains affect coastal areas more significantly while at times substantial winter rains fall upon this region originating from coastal areas [Capot-Rey, 1940, pp.224-225].

It's worth noting that today coastal regions suffer from increasing drought due to global climate change receiving only about 100 mm annually [Swezey, 2009, p.90].

In general terms it can be said there are factors influencing Central Sahara's climate but major climatic changes such as transitions from aridity to humidity take considerable time occurring gradually linked with cosmic changes like alterations in Earth's orbit or subterranean movements causing earthquakes contributing significantly towards climatic shifts; furthermore variations resulting from cosmic factors impact climate over long durations [Ben Bouzid, 2016, p.1036].

Classical sources have discussed how fertile Sahara was; recently geologists and geographers have discovered numerous remnants of lakes and valleys where deposits accumulated during rainy periods occurred notably including WadiIgrigar which begins at Hoggar mountains heading north towards Taqurt depression through Wadi Rig reaching Shatt Melghigh south of Biskra along with diverse deposits found on Tassili plateaus north of Hoggar mountains [Al-Nadouri R., 1981, p.51].

It appears that this wet phase during Stone Age provided Neolithic inhabitants vast savanna spaces filled with lakes and rivers; thus we can assert that Sahara was profoundly affected by climatic changes throughout history [Julien, 1976, p.04].

The Algerian Sahara experienced Holocene rainy phases: firstly Sub-pluvial N°1 representing Europe's last cold wave; secondly Sub-pluvial N°2 coinciding with late Middle Stone Age and Neolithic era in Europe [Chaline J., 1985, p.255].

According to a study conducted on alpine snowy heights along Rithmus swamp bordering Austria's edges observed that at end of Form Ice Age around 8000 years ago noted advances & retreats reaching sometimes up-to800m within this area leading them towards establishing chronological sequences for significant climatic events during this period as follows:
-8000-7000 BCE: disappearance of continental ice sheets across Scandinavia & Britain.
-4500-4000 BCE: advance of high alpine ice sheets.
-4000-3000 BCE: optimal climate characterized by temperature increases between 2°to3°C above current levels represented optimal climates across North Africa & Great Sahara approximately between5000to2400BCE [Chaline J., 1985, p.256].

5.Water sources that prehistoric humans relied upon, enabling them to settle in this region (the Sahara):

The rainy phases led to a high-humidity climate during the seventh millennium BCE, resulting in the spread of dense forests that covered the peaks of mountainous areas such as Hoggar and Tassili, particularly in the Tiet region. The rainfall caused humans to settle around water basins, where they grazed their livestock along the shores of lakes for several reasons:

- Increased evaporation due to intense heat.
- Infiltration of water into the ground, forming mounds of sand known as "arouqs."
- The migration of populations to follow water sources like springs, which were often named after the tribes that first settled there, as is customary among Berbers.
- The emergence of depressions filled with water attracted nomads to settle and cultivate around them.

As for the water resources relied upon by humans during this period, they included:

1. **Lakes**: Lakes were essential in attracting humans seeking water and grazing land. Once rainfall ceased, migrations increased as people searched for water and pasture. Researcher Jean-Loïc Le Quellec noted that the Merzoug "arouq" (in Tassili) was a lake around 8445 BCE, give or take 160 years, evidenced by rock art depicting animals associated with rivers and lakes, such as hippos and elephants.
2. **Rivers and Valleys**: These are considered the most important resource since all other resources are secondary. Lakes are essentially outlets for these rivers. Among the valleys that nourish water collection areas is WadiTaffasset, which descends from the Tassili heights and eastern Hoggar, continuing southwest towards the upper Niger River. Conversely,

WadiIgrigar also originates from Hoggar heights heading northwest to flow near Shatt Melghigh at the current Tunisian-Algerian border.

Other evidence supporting the presence of these water features includes fossilized remains of tropical animals that only inhabit riverbanks and lakeshores, as well as fish found at sites like Amekni and Tihoudain in western Hoggar [Chaline, 1974, p.222].

Despite the importance of economics and politics in shaping the course of history, which have received significant attention in historical studies, religion remains the fundamental factor influencing many historical events and their outcomes for humanity and society.

Water has carried multiple values throughout history, and ancient peoples recognized these values. Around its sources, the earliest civilizations began their journeys and crafted their identities. The ancient Greeks deified water, associating it with fearsome elements like lightning and thunder. Similarly, in Mesopotamia, the Babylonians and Sumerians expressed their understanding of the creation of the universe and humanity through water. The civilizations of ancient North Africa were no exception, as they also revered water.

Second: The Connection Between Beliefs, Climate, and Water

In Ancient times, Africans venerated seas and rivers. The Slavs believed in the presence of spirits and djinn around fountains, while Native Americans (such as the Maya, Inca, and Sioux) offered diverse sacrifices to gods of rain and lakes [Oumghar, p.03]. Even today, Hindus perform purification rituals in the Ganges River, reflecting the enduring worship of water as a source of cosmic life. According to the Greek philosopher Thales (late 7th century BCE), water was the primary element that gave life to all other natural elements. Aristotle (384-322 BCE) classified water as one of the four essential elements in the physical world [Grolier Encyclopedia, 1985, p.120].

These geographically and temporally distant examples demonstrate humanity's long-standing veneration of water as a creator of life. In Genesis, land separated from water is portrayed as floating on primordial waters. Similarly, Vishnu's boar avatar lifted the earth above these waters, while Shinto mythological heroes solidified it. Water is often depicted as female- a mother from whom all beings emerge- and as a virgin penetrated by tools like a plow. Rain (water) is seen as the seed of heaven, its sole fertilizing agent for earth.

This perception led humans to revere water and link it to the earth in various myths about the creation of the universe and the birth of the world (creation myths), such as Polynesian myths, the myths of the Iroquois tribes in America, the Karadjeri tribes in Australia, and Japanese creation mythology. Even religious scriptures, particularly the Quran, emphasize this intimate relationship between earth and water, affirming some of its features without being purely mythical. For example, the Quran highlights the earth's role as a

vessel for life and a site for global fertilization enabled by water sent by God. It metaphorically illustrates how God caused all living things to grow from the earth, including humans and animals [Deeb, 1986, pp.42-64].

Water has carried multiple values throughout history, and ancient peoples recognized these values. Around its sources, early civilizations began their journeys and shaped their identities. The ancient Greeks deified water when they associated it with fearsome elements like lightning and thunder. Similarly, in Mesopotamia, Babylonians and Sumerians expressed their understanding of creation within the scope of water. From rivers like Tigris and Euphrates ("Apsu," the universal father) and salty waters ("Tiamat," the mother), many offspring came into existence. From the union of freshwater emerged gods representing accumulated silt in riverbeds [Waseem, 2007, p.37].

The Romans assigned a deity to every natural phenomenon, considering nature imbued with sanctity and religious values because they viewed the universe as a divine creation. All cosmic natural phenomena were believed to be governed by gods in a harmonious system that amazed humans. Since water is one of these key natural phenomena- it descends from the sky, bursts forth from the earth, fills seas, and nurtures crops- it was revered for its close connection to life. Water worship became a significant religious concern for Roman societies both before and after Christianity. They believed specific gods controlled water: pleasing them brought prosperity, growth, healing, while angering them caused disasters and death.

Neptune was the greatest water deity often depicted as a standing man with a beard and thick hair holding a trident. He enjoyed immense popularity and sacredness expressed through gifts, sacrifices, and dedicated temples. On land, he was considered the god of fresh water protecting rivers, springs, fountains, and all waters; on coasts, he was seen as the god of seas, waves, mermaids, and also had a role as a healing deity.

In North Africa, particularly regarding therapeutic springs, water worship persisted despite religious revolutions in the region. These practices adapted to new religions rather than being completely eradicated; even Islam did not entirely abolish them but transformed them slightly—replacing water deities with righteous saints. An example is SidiMassoud's shrine at Hammam al-Salihine (the Bath of Righteous). These sites received great reverence and care with temples and baths built around them.

In North Africa, Romans found that local populations revered water—a practice that continues today through respect for water resources in society and constant discouragement of wasting it unnecessarily. Water became associated with major symbols such as prosperity, growth, and progress [Bouhassoun, 2020].

Ancient Morocco was no exception among civilizations that revered water. Given Morocco's climate dominated by periods of drought where water becomes scarce or insufficient, it gained sacred value from early times. Numerous wells and springs scattered across ancient Morocco became sites of sanctity [Ghanem, pp.17-18].

Third: Rainmaking Rituals

The request for rain has long been associated with various magical rituals aimed at invoking rainfall, especially during periods of drought or delayed rains. Some of these rituals have persisted to the present day [Charles, 1954, p.10]. Herodotus recounts that the Nasamones(Les Nassamons: One of the largest Libyan tribes, located west of the oasis, practices seasonal migration, leaving their herds to graze near the sea in summer and descending to a site called Ajdabiya (Libya) to harvest dates from palm trees growing in this area [Khshim, 1975, pp.34-35].

They would take soil from the ground and suspend it when no liquids were available, performing this ritual outdoors in groups to express their dire need for rain. They believed drought was a punishment and a sign of divine anger. Herodotus also mentions the "Battle of the Virgins" ritual among the Maxyes tribe in the region of Lesser Syrtis. In this ritual, virgin girls were divided into two groups and engaged in fierce combat using stones and sticks. Those who died were deemed not virgins. The most beautiful participant was then adorned in Greek attire and paraded in celebration on a chariot, symbolizing the goddess Athena [Ghanem, pp.12-13].

One enduring rainmaking ritual described by ethnographers is the "Bougnja Festival." According to a European observer, during times of drought, elderly women accompanied by children would gather, carrying large spoons wrapped in cloth and leather that transformed into a large doll. They would chant songs pleading for rain while walking through villages [Ghanem, p.13].

Others would join them along the way and offer gifts such as flour, oil, and meat. These offerings were used to prepare food at a shrine or tomb. The festival concluded with a stick game called "Anzar's Game," where marriageable girls gathered around one acting as Anzar's fiancée. They divided into two groups, each wielding sticks to hit a ball until it fell into a designated hole. The fiancée would then chant: "The earth and I are two brides... we married a man we did not see." The ball was buried, and the women returned to their village before sunset, storing the large spoon for future celebrations [Ghanem, p.14]. The Amazigh myth of *TislitUAnzar* (Anzar's Bride) in North Africa offers an illustrative example of the connection between water and earth among Amazigh communities and their reverence for water: [Genevois, 1978, pp.393-401].

"Long ago, there was a being named Anzar, the King (Lord) of Rain. He wished to marry a stunningly beautiful girl whose radiance rivaled that of the moon. She often bathed in a shimmering silver river. Whenever Anzar descended to earth, she grew frightened and fled. One day, he approached her and said: 'I tear through the heavens for you, star among stars; grant me your gift, or I shall deny you water.' She pleaded: 'I beg you, King of Waters, crowned with coral; I am devoted to you but fear people's gossip.' Hearing her words, he turned away and spun his ring. Instantly, the river dried up, leaving no trace of water. The girl cried out as tears streamed down her face- water was her soul. She removed her silk garment and stood bare, calling to the sky: 'Anzar! Anzar! Flower of the plains! Restore the river's flow; come take your revenge.' At that moment, Anzar appeared as a bolt of lightning, embraced her, and restored the river's flow. The earth turned green once again." [Oumghar, p.06].

This myth parallels global creation stories that emphasize the union of sky (water) and earth as essential for fertility. According to this tale, Anzar (the rain deity) fertilizes his bride [Oussous, 2007, pp.13-17]. (the earth), resulting in rain (*Aman n Anzar*), which symbolizes life-giving fluid produced by their cosmic union.Rainmaking rituals thus serve as reenactments of myths and celebrations of their events. As theorists like Gusdorf suggest, rituals reaffirm myths through action; Van Der Lew [Oussous, 2007, pp.13-17]. even posits that rituals are myths in motion.

A common thread across most rainmaking rituals in this region is their close association with women as symbols of fertility and birth. While these rituals vary in practice and detail, their shared purpose is to bring rain after droughts. On the surface, they seek divine intervention for water- a sacred element essential for life- but upon closer examination, they blend tribal customs with religious worship. This fusion highlights cultural diversity within these practices while uniting symbolic elements like water, earth, and women.Ultimately, these rituals reflect how rain fertilizes the earth to renew life through crops and vegetation ; a cosmic cycle of rebirth tied deeply to cultural beliefs about nature's sacredness [Fatima & Ben Maamar Boukhedra, 2031, p.224].

6.Conclusion

This study has demonstrated that the Algerian Sahara's environmental history is not one of static aridity, but rather a dynamic chronicle of significant climatic fluctuations that profoundly shaped human settlement and adaptation. By integrating a multi-temporal approach inspired by Fernand Braudel, our research has revealed a compelling "adaptation asymmetry" between prehistoric and modern human communities.

The evidence from paleoclimatic reconstruction and rock art analysis confirms that prehistoric Saharans successfully managed a landscape of rivers and lakes during humid periods. Their sophisticated water management techniques and thriving communities stand in stark contrast to the vulnerabilities of modern Algeria, which, despite having advanced infrastructure, continues to struggle with intensified droughts. This highlights a crucial point: while modern solutions are technologically advanced, they may lack the deep-seated resilience models and environmental understanding that prehistoric communities developed through centuries of direct interaction with their environment.

Furthermore, this study has contributed to the decolonization of historical narratives by using indigenous knowledge and material culture to challenge Eurocentric claims of civilizational stagnation. We have shown that the environment is not merely a passive backdrop for history, but a primary catalyst for sociocultural transitions. The civilizational achievements of the prehistoric Saharans were a direct reflection of their innovative responses to an ever-changing environment, proving that environmental conditions, rather than any inherent human capacity, are key drivers of development.

Ultimately, understanding the historical relationship between climate and human interaction in the Algerian Sahara offers critical lessons for the future. The resilience of ancient communities provides a valuable blueprint for developing sustainable strategies for water management and resource utilization in the face of ongoing climate change. A nuanced, multi-dimensional approach to environmental history is essential not only for understanding our past but also for ensuring a more sustainable future for Algeria and similar arid regions worldwide.

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