Maghreb al-Aqṣá and al-Andalus: a shared history of climate, famine and epidemics

Mágreb al-Aqṣà y al-Ándalus: una historia compartida de clima, hambrunas y epidemias

Claudia Patarnello[1]

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ABSTRACT

The links between the Maghreb al-Aqṣà and al-Andalus have been a constant throughout the centuries. And if they are approached from the perspective of paleoclimatology there is no exception. The main objective of this study is to reconstruct the climatic anomalies—particularly droughts and storms—identified in the writings of the chroniclers Ibn Abī Zarʿ and Ibn ʿIdhārī during the period known as the *Medieval Climatic Anomaly*, dated approximately from 10th to 14th centuries. The direct consequences of a year of crop failure or storms that wreck crop fields, due to climatic fluctuations, are fundamentally twofold periods of famine and the spread of epidemics. Thus, these consequences are also evident in the aforementioned Arabic texts and in the archaeological remains of both places.

Keywords: paleoclimatology, Maghreb and al-Andalus, famines, epidemics.

RESUMEN

Los vínculos entre el Mágreb al-Aqṣà y al-Ándalus han sido una constante a lo largo de los siglos. Y si se abordan desde la perspectiva de la paleoclimatología no cabe hablar de excepción. En este trabajo el objetivo principal será hacer una reconstrucción de aquellas anomalías climáticas, principalmente sequías y tormentas, que se han detectado en los textos de los cronistas Ibn Abī Zarʿ e Ibn ʿIḏārī durante el lapso temporal definido como "Anomalía climática medieval", que se fecha alrededor de los siglos X-XIV. Las directas consecuencias de un año de malas cosechas o de tormentas que destrozan los campos de cultivos debido a las fluctuaciones climáticas son fundamentalmente dos: épocas de hambrunas y el avance de epidemias. Así pues, estas consecuencias también se hacen patentes en los textos árabes mencionados y en los restos arqueológicos de ambos lugares.

Palabras clave: paleoclimatología, Mágreb y al-Ándalus, hambrunas, epidemias.

1. INTRODUCTION

The Maghreb al-Aqṣà and Al-Andalus since the first centuries of Islamic expansion have shared a deep and lasting historical link over time. This connection is not only geographical, as the two shores are separated by the Strait of Gibraltar, but also cultural, political, economic and religious. The marvelous architecture of the Alhambra or the spectacular mosque of Cordoba would be tangible proof of this link, along with numismatics, literature, science and philosophical thought, which still live on in our memory. The aim of this paper is to show how this interconnection is also evident from the point of view of climate and the impact its ravages had on the people of both places. We believe that the study of climate from a diachronic perspective can provide valuable information on how societies have responded to these challenges.

[1] Investigadora. Universidad de Salamanca – IEMYRhd.

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2. THEORETICAL FRAMEWORK AND SOURCES

The Middle Ages was undoubtedly a time of cultural, political and economic ferment for both sides of the Mediterranean, which is why the undertaken climatic reconstruction will cover the so-called Medieval Climate Anomaly. The first point to clarify has to do with the name of the phenomenon itself. Hubert H. Lamb in his initial studies referred to it as the Medieval Warm Period in 1965 (LAMB, 1965: 26), a terminology that would be used at least until 1998. However, advances in the discipline of palaeoclimatology suggested that it was necessary to look for another formula to describe it; this is, as already indicated, Medieval Climatic Anomaly. Defining it in this way would encompass all types of climatic anomalies that arose in this historical period, not just the temperature characteristic (STINE, 1998: 45).

Such a reconstruction is no easy task. If our field of knowledge is purely philological, limiting this research to this discipline would be counterproductive. For this reason, paleoclimatology and archaeological studies on the Iberian Peninsula and Morocco have been compiled in order to complete the analysis of the Arabic texts. The reference works chosen are two chronicles: the *Kitāb al-bayān al-mughrib fī akhbār mulūk al-andalus wa l-maghrib* [Book of the Amazing Story of the History of the Kings of al-Andalus and Maghreb] by Ibn ʿIdhārī from the 13th century and the *Kitāb al-ānīs al-muṭrib bi-rawḍ al- qirṭās fī akhbār mulūk al-maghrib wa tārīkh madīnat Fās* [The entertaining companion book in the gardens of pages from the chronicle of the kings of the Maghreb and the history of the city of Fes] by Ibn Abī Zarʿ from the 14th century. The integration of these sources, in conjunction with specialized paleoclimate studies, offers a unique opportunity to catalogue and establish a more detailed chronology of the climatological phenomena, which impacted medieval societies. These are mainly droughts and storms. The importance of this combination lies in the fact that textual information provides a social and cultural context that is not obtained from physical or archaeological data alone.

3. DISCUSSION

The Medieval Climate Anomaly is a phenomenon that spreads asynchronously and with equally different consequences, depending on the place of application. It would seem that, if in northern and central Europe the greatest impact and variation was more specifically on temperatures (GUIOT *et alii*, 2012: 35; BÜNTGEN *et alii*, 2006: 5617), the same could not be inferred in the case of the Iberian Peninsula and Morocco. In these territories, hydroclimate would be of primary importance in multiple aspects, as this research will explore. Experts in this field refer above all to the reconstruction of the North Atlantic Oscillation (NAO). This represents the main synoptic mode of climate variability, not only in the Mediterranean area and North Africa, but also in the entire northern hemisphere. The Iberian Peninsula and Morocco are located at the southern pole of the NAO, specifically in the subtropical pressure system of the Azores High (LEDUC, GERVAIS, 1985: 72)[2]; this parameter is essential to understand the aridity that, not infrequently, affected these two places (KARNAUSKAS, UMMENHOFER, 2014: 2259). Furthermore, scholars suggest that it is on the oscillation of the NAO from its positive to its negative phase, and conversely, that all the pluviometry changes influencing the territories analyzed in this article depend on (TROUET *et alii*, 2009: 78).

Researchers such as Ait Brahim Yassine, Ortega Pablo, Cook Edward and others

[2] The Azores High, also known as the Azores anticyclone in Europe and North Africa, is an atmospheric high-pressure system located in the North Atlantic around 30° N. This subtropical anticyclone, which covers a large oceanic region, does not have a completely fixed position or intensity, although it allows monthly averages to be calculated. In the subtropical North Atlantic, it directs the trade winds towards the ocean. At the beginning of their journey, these winds are very dry, but as they cross the Atlantic, they are loaded with moisture; something similar happens with the westerly winds. This atmospheric pattern has a great influence on the climate and weather conditions of large areas such as the United States, Europe and North Africa.

have reconstructed a continuous alternation between periods of drought and others of more humidity throughout the Middle Ages, both in the Iberian Peninsula and in Morocco. In general, all these studies point to a clearly humid period before the 9th century that would gradually change more decisively from the 11th century onwards. Although paleoclimatology is not a perfect science, as it cannot provide exact dates for these climatic phenomena, specialists agree that between the 12th and well into the 13th century the trend was towards drought (AIT BRAHIM *et alii*, 2017: 2; ESPER *et alii*, 2007: 2). After this period of aridity, the climate would return to a more abundant rainfall from the second half of the 14th century and the beginning of the 15th century, to finally begin a phase of instability at the beginning of the 16th century onwards (ORTEGA *et alii*, 2015: 71; COOK *et alii*, 2019: 1568; THATCHER *et alii*, 2023: 2380). However, due to the non-static nature of the climate, occasional moments of higher rainfall must be considered, despite the trends marked by biomarker simulations. In this sense, Wassenburg Jasper and other collaborators noted in their study on Grotte de Piste the year 1140, in which they detected a slight recovery of rainfall with respect to the previous situation (WASSENBURG *et alii*, 2013: 298); similarly Till and Guiot (1990: 349), in their dendrological analysis of cedar trees, indicated that: in the years 1108, 1255 and 1272 there was rainfall above the milliliters expected at this time, which, as already concluded, tended to be dry. These same data were confirmed in the work of Esper Jan and others (2007: 2).

This climatic oscillation would also be corroborated in the two chronicles examined. According to our interpretation of both sources, only one chronological difference stands out in comparison with the studies mentioned above. If the researchers claimed that before the 9th century —included— the climate turned out to be humid according to biomarker predictions, for both Ibn ʿIdhārī and Ibn Abī Zarʿ seemed to indicate the contrary. Both authors pointed out, for instance, a drought that began in both places in the year 232/846 (IBN ʿIDHĀRĪ, 2013: 259; IBN ABĪ ZARʿ, 1972: 96) and another in the time span between the years 253 - 265/867 – 878 (IBN ABĪ ZARʿ, 1972: 96). Similarly, the chronicler Ibn Abī Zarʿ reported that the year 190/806 had copious rains (IBN ABĪ ZARʿ, 1972: 30). With a careful reading of these data, it can be concluded that, in fact, paleoclimatic studies do not contradict the evidence provided by these sources. It was pointed out earlier that reconstructions using proxy indicators are not always accurate; therefore, if this plausible margin of error is considered, the medieval texts and the studies do amalgamate correctly. Furthermore, the climatic trends shown by the proxy simulations reveal a pattern; however, within this, exceptions or slight variations may always arise, since the very nature of these meteorological events is neither permanent nor stationary. The rest of the reconstruction coincides aptly with the dates provided by both chroniclers. Thus, in the 10th century, cold and with abundant rainfall, the time range between 349/960 and 355/970 stands out, where these authors described the climate as stormy, where the violent wind caused destruction, and with very low temperatures (IBN ʿIDHĀRĪ, 2013: 122; IBN ABĪ ZARʿ, 1972: 100). On the other hand, the droughts, whose consequences were dramatic, were dated in the work of the 14th century chronicler in the years: 407/1016, which would worsen a few years later on both shores to become a prolonged drought; during the interval of time that covered the years 687/1288 and 690/1291 another one occurred and finally, it should be noted that of the year 723/1323 (IBN ABĪ ZARʿ, 1972: 118, 401 and 408). Thus, paleoclimatic and archaeological studies of xerophytes and Artemisia-type plants, together with the study of these texts presented, provide a coherent reconstruction. In particular, the analysis of xerophytes and artemisia plants confirms the lack of rainwater in the central centuries of the medieval climatic anomaly (CAMUERA *et alii*, 2023).

In view of the data presented in the previous paragraph, there is no doubt that the territories of Al-Andalus and the Maghreb al-Aqṣà have shared much of their climatic history. Consequently, also the secondary effects triggered were linked to both places. Droughts,

first of all, affected the yield of cereal, which in these times of prolonged aridity was not harvested in the desired quantities as we will see. Special emphasis is placed on crop production, consisting mainly of wheat or barley collection, because it depends on the changes in the rainfall regime; therefore, harvests were, on many occasions, unpredictable (ROSENBERGER, 2001: 17-18). As a result, it seems no coincidence that, to the periods of drought mentioned above, both chronicles associated periods of famine and starvation. Thus, in the 9th century Ibn ʿIdhārī mentioned the year 260/874, when famine would dominate especially in the Maghreb al-Aqṣà and in the 11th century the year 444/1052 on both shores (IBN ʿIDHĀRĪ, 2013: 70 and 159); Ibn Abī Zarʿ, in his work, indicated the following dates: the 260/874, already reported by the previous chronicler, the 571/1175 and the 724/1324 (IBN ABĪ ZARʿ, 1972: 96, 267 and 401). The latest, in addition to providing a detailed chronology, also narrated the cause of these periods of famine. According to him, the east wind, which was to blame for the lack of rain in the most important month of the year, is that to say the month of April, prevented the proper development of the rainfed agriculture (IBN ABĪ ZARʿ, 1972: 44 and 408). This wind, nowadays, is known to be the so-called Chergui. These are air masses coming from the east, as the name itself indicates, and they are fast and persistent. Such wind not only blows at a high speed, as it can reach 130km/h, but it brings with it hot air and comes devoid of water, so it never rains with its passage (PASCUAL, NACHITE, 2006: 167). Related to the previous point, it is interesting to make a brief note about locust plagues. It is known that locusts are not originally harmful, on the contrary, they were part of arid and semi-arid ecosystems. However, it is an insect sensitive to drought. This is because when rainfall was scarce, so was their diet, which consisted mainly of vegetation. When locusts are forced to migrate in search of food, crop destruction occurs. The latter is attributed to the fact that, when grouped together, they move rapidly; their movement, moreover, is facilitated by air masses and mountain breezes (MORA, 2021: 26). Ibn Abī Zarʿ ratified what has just been suggested; he affirmed that in the year 624/1226 one of these plagues struck both Al-Andalus and the Maghreb al-Aqṣà, destroying all crops (IBN ABĪ ZARʿ, 1972: 274). The latter, furthermore, supposes the approach of a possible drought in years prior to this plague, which, perhaps, was not compiled by these chronicles. However, the behavior of this insect pointed to it.

Similarly, not only drought and the passage of this wind would be harmful, but also in the opposite case, namely strong storms. Its violent nature destroys the cultures in the same way; then, when this takes place, all the benefits of obtaining a quantity of rain that irrigates the fields are, in this sense, lost. This last point, again, would be made clear by both authors. Ibn ʿIdhārī narrated that in the year 349/980 in the two places there was not only extreme cold, but the winds of such storms were so fast that they destroyed all the plants (IBN ʿIDHĀRĪ, 2013: 122). In the same vein, Ibn Abī Zarʿ a century later confirmed the fierce character of these storms, stating that between the years 350 - 355/966 - 970 throughout the Islamic western world there were a series of very strong storms, but, in the Maghreb al-Aqṣà and in Al-Andalus they were directly devastating (IBN ABĪ ZARʿ, 1972: 100). The destruction caused by these extreme weather events, in this case, depends on the Gharbi winds, originated from the west. These usually occur from November to March and only temporarily, although with a certain intensity (GARCÍA DE PEDRAZA, 1990: 198). This brief collection of data allows us to observe how climatic events influenced the lifestyle of people; in this case, the societies of Al-Andalus and the Far Maghreb, were forced to react and adapt to such phenomena.

Another important consequence of such an unstable and fundamentally extreme climate in both cases has to do with the economic aspect. In this sense, the territories examined in this research were always connected from the commercial point of view, since the western Maghreb was practically the granary of Al-Andalus, or at least cereal was exported to the south and west of the Iberian Peninsula

during the Middle Ages. From the 11th century until 1492 the sale of cereals to Al-Andalus and also to Christian Spain did not cease (VERNET, 1980: 332-333). Apart from the foregoing, the frumentary crises always entailed an increase in the prices of the so-called *qamḥ*, which means wheat. Ibn Abī Zarʿ made this clear. In fact, by way of example, I should point out that in the years 624/1226 and 724/1324, both marked by a prolonged drought that prevented adequate harvesting, the price of cereal increased (IN ABĪ ZARʿ, 1972: 274 and 401). This would mean an additional effort for a population already affected by famines. The shortage of foodstuffs, which is practically always of the cereal type, leads to a rapid and abrupt rise in prices, thus making it unaffordable for the population (PERE BENITO, 2011: 126).

Medieval societies, therefore, already accustomed to the aftermath caused by the ravages of extreme weather events, adopted their own strategies to cope with it. First of all, mention should be made of culinary adaptation. If bread cereals could not be purchased, other alternatives were sought, such as the use of leguminous plants (ROSENBERGER, 2001: 141). This is supported by archaeobotanical studies; the rates of occurrence of leguminous plants show that, before the Islamic period, three species constituted the basis of the agro-livestock populations, with more than 10 % of the occurrences in this period: pea, faba bean and lentil. This preeminence was also affirmed during the Islamic epoch (RUAS, 2018: 169). However, the subject of diets, although very interesting, will not be developed in this article, since other researchers such as Rosenberger Bernard have already addressed it excellently. Secondly, it would be necessary to deal with irrigation systems and arboriculture. In the face of uncertainty dictated by the weather, diversifying agricultural production became crucial to avoid hardship when harvests were not sufficient. This prompted the rapid development of hydraulic systems designed to regulate and channel rainwater, thus avoiding its waste. When the climate was still favorable, around the 10th century, irrigation experienced significant development in Al-Andalus thanks to hydraulic works that enabled the combination of dry farming with horticulture and arboriculture (MALALANA, MORÍN DE PABLOS 2018: 119). So, if the rainfed agricultural zone represented subsistence on both shores, the irrigated areas would mean its salvation.

Arboriculture, mostly irrigated, became the primary strategy for diversifying cereal cultivation. This was made possible by the construction of irrigation channels, waterwheels, and khettaras, whose archaeological studies have gradually shed light on their remains throughout the Middle Ages, both in Al-Andalus and the Maghreb al-Aqṣà (GOZALBES BUSTO, GOZALBES CRAVIOTO, 1996: 171). The importance and necessity of these systems is evident in numerous agronomic texts, such as the *Kitāb al-Filāḥa* (Book of Agriculture) by the 12th-century Andalusian scholar Ibn al-ʿAwwām. In all these sources of that sort, fruit trees played an essential role, particularly olive groves, vineyards, and fig trees across the Mediterranean region, as well as date palms and argan trees in southern Morocco (MALALANA UREÑA, MORÍN DE PABLOS, BARROSO CABRERA, 2013: 338). Beyond the interest of agronomists, it is worth emphasizing their adaptability to different climates. Olive, grape, and fig trees, along with other fruit trees, are typical of the Mediterranean climate —with cold, rainy winters and hot, dry summers— but they are also capable of adapting to semi-arid and arid conditions (RHIZOPOULOU, 2007: 382; COMPÉS LÓPEZ, SOTÉS RUIZ, 2018: 157-158). In the case of the argan and date palms, these are not only shrubs well-adapted to xerophytic ecosystems, but they also play a fundamental ecological role. The structure of their root systems allows them to reach deep into the soil, tapping into groundwater and effectively "self-irrigating". Thus, they serve as "water elevators," a function that not only benefits the plants themselves but also supports neighboring crops (EL ALAOUI, 1999: 47). This characteristic of the argan and date palm makes them resilient in periods of prolonged drought (CHERIF *et alii*, 2015: 668).

Along with dietary changes and the use of arboriculture to counteract periods of famine,

it is worth briefly discussing the use of storage systems. Hispano-Muslim treatises and the exploratory work of archaeologists, especially in the southern plateau of Al-Andalus (though not exclusively), have revealed silos and granaries for the long-term preservation of cereals, some dating back even earlier (MALALANA UREÑA, MORÍN DE PABLOS, BARROSO CABRERA, 2013: 338-341). For example, in Mérida, in a rural settlement which is called in Arabic as a *qarya*, five silos were found dating between the 9th and 10th centuries (FRANCO MORENO, 2008: 283). Another outstanding vestige is the inverted funnel-shaped dungeons of the Alhambra, measuring approximately 2-3 meters in diameter (TORRES BALBÁS, 1944: 209). At first, they were possibly smaller, however, over time, they widened until they reached 6-8 meters in diameter in their heart. On occasions the excavation or reinforced foe was regularized by means of brick walls attached to the ballast, covered with plaster and whitewashed. It had a circular structure built with a brick support attached to the walls and a central recess about 15 centimeters deep, delimited by a ring of brick laid flat. Between the ring and the bench, there are compartments or "beds" framed by radial partitions, some of which still retain a brick floor, and niches excavated in the wall, some with arches and a protruding brick at their base. In the dungeon of the Alcazaba (dated to the 14th century), clay jars were found buried next to these beds, and a small channel leads the liquid waste to a drain (TORRES BALBÁS, 1944: 210). It is plausible to think that during times of favorable hydroclimatic conditions, such as these two centuries mentioned before, there would have been a surplus of cereals. Additionally, it was known that, for commercial reasons, grain had to be stored and kept in good condition before being sold to prevent spoilage. Likewise, archaeological and textual remains of the use of these storage systems were also found in the Maghreb al-Aqṣà. Nevertheless, if in Al-Andalus they were located on the plateaus, in Moroccan territory it would not be the same. These structures were found in inaccessible places, such as on the steep slopes of the Atlas Mountains. In Arabic they are called *maṭmura*. These are subterranean, dug in limestone rocks; they are bell-shaped with a convex section and a wider upper part in order to pour the grain more comfortably. Their size could also change: the most modest ones had a depth of 2 meters, while the largest ones were up to 4 meters deep (RODRÍGUEZ AGUILERA, RODRÍGUEZ FERRER, 2025: 23). Depending on the nature of the soil, the walls have a concrete coating to protect the grains against humidity. These silos were fortified; the very choice of their construction site tells a lot about them and their importance (MEOUAK, 2001: 446). In the root "ṭ-m-r" of this word is implied the meaning of "to hide" or "to bury" (TORRÓ, SEGURA, 2000: 146). The etymology of this term is very interesting, as the idea of making these silos "invisible" or difficult to access in, as if the environmental conditions themselves acted as natural protection. By the same token, this urgency would most certainly derive from the requirement of not being able to lose a single cereal harvest, since famines were very frequent in medieval times.

Nonetheless, it should be noted that famines would not be the only problem that the communities of Al-Andalus and the Maghreb al-Aqṣà would have to face. The Middle Ages, in both territories, was hit by numerous epidemics. Many of them, although not all, would be linked to the conditions of excessive sultriness in the air, represented in our chronicles as times of storms. Therefore, if most episodes of thunderstorms and storms were detected especially in the 10th century, it is not surprising to observe how in the years 344/955 and in 379/989 or in 407/1016, whose previous year was marked by ferocious storms, they were characterized by the presence of epidemics on both shores, although the available evidence does not allow for their identification with later well-known plague outbreaks (IBN ABĪ ZARʿ, 1972: 100 and 118). So, climate changes, especially those that involve a lot of humidity, have consequences for people's health. In fact, steaminess prepares the perfect conditions so that the vector of the disease, whatever it may be, can live with longevity, this means that, the longer the life span, the greater the spread of

the illness (BERBERIAN, ROSANOVA, 2012: 44). Apart from the climatic devastation, other factors must be considered that would have facilitated the advance of infectious maladies. Among them, and as has already been pointed out throughout this article, trade was a determining factor. From the 12th century, commerce by sea would expand, so many of the diseases could have been contracted during these exchanges (VALÉRIAN, 2019: 238-239). The public health issue would worsen from the 14th century onwards with the bubonic plague or the so-called Black Death. Before the year 1348, all the epidemics mentioned by these chroniclers could not be associated with this specific disease, as it would not reach that time (ECHAVARREN, MARTÍN CARRO, MEDINA FERNÁNDEZ, 2014: 444). In fact, it was not even a distinct variant of the plague known in the 14th century, because it is known that it was unprecedented in history. The Greeks and Romans had already lived with deadly or highly morbid pestilences, however, they did not have the multicontinental character, as they were localized epidemics. The same thing happened later until the moment when the plague that we all know arrived (GOZALBES CRAVIOTO, GARCÍA GARCÍA, 2013: 67). So far, only the plague has been mentioned, since in history it is the one that has left the most physical and especially psychological consequences in the memory of the human being. However, it was not the only disease that would afflict Al-Andalus and western Maghreb; other sicknesses have been documented through textual analysis such as: bacterial affliction, namely conjunctivitis, food and urinary infections, cholera, among others; those of sexual transmission, viral including rabies or smallpox, fungal types for instance candidiasis and finally those due to parasites, an example would be scabies (CASAL GARCÍA, CASAL ROMÁN, 2004: 355).

Contrasting our Arab sources, we realize that the spread of diseases occurred especially in places of people's overcrowding, that is, large cities. It can be guessed that the high population in these metropolises, such as, for example, Marrakech, especially in the Almoravid and Almohad periods, or Fez and Cordoba, had as a consequence the accumulation of buildings, houses and markets. Overpopulation, therefore, can be identified as one of the biggest problems and transmission factors. The streets of the cities were sometimes dirty and, if we add natural disasters such as floods as an example, the situation would be even more dramatic, apart from favoring the appearance of illnesses (LEGUAY, 2002: 154 - 163). The chronicler Ibn Abī Zarʿ would give an idea of this situation of aggrandizement over the city of Fez (1972: 46), as he described it:

> *Thus, blessings appeared and agricultural products [khayrāt] were produced, buildings [ʿimāra] increased [...]. The tributes each year were 30,000 dinars [...]. The lands [arbāḍ] were many and the buildings were connected to each other around all sides of the city. Then inns [fanādiq], ḥammāmāt, mills, mosques, and souks were built from the Ifrīqiya gate to the Iṣlītn fountain. People also built on the north, south and east side.*

Just as it was narrated for Fez, in the case of al-Andalus an illuminating example would be Cordoba, during the reign of the Umayyad dynasty. The time of ʿAbd al-Raḥmān III (912 - 961), al-Ḥakam II (961-976) and Hišām II (976-1009) was especially splendid (FIERRO BELLO, 2011: 34; BARIANI, 2003: 39; MANZANO MORENO, 2018: 242-244). The many archaeological remains of the time such as the mosque of Cordoba or the amazing Medina Azahara bear witness (CAPILLA CALVO, 2008: 90). So, in the 10th century Cordoba became a cultural center, where books were translated from Greek, Latin and Hebrew. In other words, it was the literary and intellectual heart of al-Andalus, where all Islamic high society flocked. This prosperity encompassed very diverse disciplines would attract a great multitude of travelers, scholars, and diplomats (CALTOS, 2018: 94 and 164). In addition to what archaeology and remains carbonized cereals contributed, it should be emphasized that the 10th century was a time related to a wetter trend in the climate, so it is reasonable to think that, along with Umayyad policies, there was also agricultural prosperity. The set of these factors could favor the overcrowding of people in this place, which could promote the transmission of diseases. In this sense, the presence

of "hospitals", or rather "care centers" called *māristān,* would also confirm the presence of pestilences and ailments. These arose as early as the 9th century and are of eastern origin; its construction represented a measure to centralize institutions. These buildings arrived in the Iberian Peninsula late in the 14th century (FRANCO SÁNCHEZ, 1999: 143); actually, the first one founded in al-Andalus was in 1367 by Muhammad V. Its final appearance resulted in a rectangular building that housed a central courtyard decorated with plants, fruit trees and flowers whose dimensions amount to 38.3 m long and 26.5 m wide, with a rammed earth pool approximately 14 m long and 5 m wide, surrounded by dependencies around it like the Nasrid houses of the time (FERNÁNDEZ VÁZQUEZ, MAÑA ARES, 2016: 58). Anyhow, on the one hand, it does not seem a coincidence that one of the first Andalusian *māristān* was simultaneous with the breakdown of the Black Death. On the other hand, it should be added that, according to the research of Franco Sánchez Francisco, in centuries prior to the 14th century such as in Umayyad Cordoba it was not necessary to build these space-institutions, since medicine was practiced in private spaces according to specific resources and needs (FRANCO SÁNCHEZ, 1999: 162). Finally, and for greater scientific contribution, it is worth noting the valuable asset of archaeology, which managed to catalogue a series of instruments for surgical use of wide chronology and for the entire Islamic West. Among them, one can mention, for example, the needle, which sometimes also had cosmetic purposes, dated between the 10th-12th centuries, or the probes dated from the late 10th and early 11th centuries, among others that could be brought up (ROJAS GUERREO, 2017: 20-22).

4. CONCLUSION

In the first place, it can be inferred that the combination of paleoclimatic, dendrological, and archaeological studies are adequately making flush with the information extracted from the chronicles of Ibn ʿIdhārī and Ibn Abī Zarʿ. In general, both authors narrated about episodes of storms especially in the 10th century, coinciding with the simulation of biomarkers that indicated a wet trend, and the episodes of droughts centered between the 11th and 13th centuries, with a greater incidence in the latter. This data corresponds to a trend towards low water levels that, although it did not occur with the same ferocity throughout these three centuries, fits the reconstructions presented in this contribution.

Secondly, it has been observed how extreme climatic events have an impact on the daily life of societies on both shores, which, over the centuries, sought strategies to guarantee their survival, these have been the cases of the change of diet, the undertaking of hydraulic works to strengthen the irrigation system and the construction of storage structures, to conserve the cereal for as long as possible, which was the staple food of both places. If communities tried to cope with famines with all the adaptations just mentioned, they would not have the same luck with epidemics. These, as has been corroborated throughout the article, were linked to a condition of humidity in the air or to wetter weather, which we can understand as a kind of "pollution". In fact, the main focuses of these epidemics have been the metropolises, considered as overpopulated places, as was emphasized in the case of Fez and Cordoba. If we stop thinking about our current reality, this situation would not be so different from what was experienced with Sars-Covid19; cities with a high population were more affected than, for example, villages. Indeed, geographical isolation, even in the Middle Ages, could have been a barrier of protection against these waves of epidemics. For example, places in southern Morocco, far from the coast and urban centers, as there were no epidemic episodes (BENHIMA, 2010: 285).

To conclude, it seems interesting to highlight an important feature of these medieval texts. A special predominance of extreme events and their correlative aftermath in the 13th century is striking. It is true that, as has already been indicated, the dates offered by these chroniclers, although not each of them

has been mentioned, coincide with the greatest moment of rainfall regression during the so-called Medieval Climatic Anomaly. However, these dates seemed to tell not only a climatic story, but also a political one. In fact, the 13th century has been marked by an abundant number of conflicts and rebellions in both the Maghreb al-Aqṣà and al-Andalus. For example, the revolts between 1224 and 1244, which took place during the Almohad empire and would end his reign, are well known. From this moment on, there was a phase of consolidation of other political entities; during this phase of transition al-Andalus was reduced merely to the kingdom of Granada (VIGUERA MOLINS, 1997: 100-123; MARTÍNEZ ENAMORADO, 2006: 11-28). Many of these conflicts could be linked to the climatic events that occurred in this century, without forgetting the consequences of these events. In fact, it was already noted in this research that Ibn Abī Zarʿ reported a plague of locusts in the year 624/1226 that led to an increase in the price of grain and, therefore, to famine (IBN ABĪ ZARʿ, 1972: 274). From this scenario, a revolutionary decade against the Almohads began (GUTIÉRREZ DEL ESTAL, 1986: 50). In the same way, it is known, thanks to this author, that in the year 610/1213 there was a major epidemic that hit both shores (IBN ABĪ ZARʿ, 1972: 272); it does not seem a coincidence that in 1212 the Christian troops defeated the Muslims in the battle of Las Navas de Tolosa, the consequences of which were disastrous for the Almohad empire and would represent a rupture of the balances established between Muslims and Christians that until that time (FITZ GARCÍA, 2014: 13). These data are just a few examples of how history, politics, climate and society are intertwined in a single plot of history. For all the above, it is believed to be of utmost importance to continue researching all these issues in an interdisciplinary way, to have a narrative of the facts that is as complete as possible.

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The article submitted has not been submitted for evaluation and publication in other journals simultaneously or previously, nor has it been submitted for dissemination in other media (websites, e-books, etc.).

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BIBLIOGRAPHY

AIT BRAHIM, Yassine; CHENG, Hai; SIFEDDINE, Abdelfettah; WASSEMBURG, Jasper; CRUZ, Francisco; KHODRI, Miriam … BOUCHAOU, Lhoussaine (2017): "Speleothem records decadal to multidecadal hydroclimate variations in southwestern Morocco during the last millennium", *Earth and Planetary Science Letters, 476*, pp. 1 – 10. https://doi.org/10.1016/j.epsl.2017.07.045

BARIANI, Laura (2003): *Almanzor.* San Sebastián: NEREA.

BENHIMA, Yassir (2010): "Epidémies et mouvements de populations au Maroc (XIVe-XVIe siècle)", in *Interazioni fra economia e ambiente biologico nell'Europa preindustriale, secc. XIII-XVIII,* pp. 283 – 290. Firenze: Firenze University Press.

BERBERIAN, Griselda; ROSANOVA, María Teresa (2012): "Impacto del cambio climático en las enfermedades infecciosas", *Archivos argentinos de pediatría, 110*(1), pp. 39 – 45. https://dx.doi.org/10.5546/aap.2012.39

BÜNTGEN, Ulf; FRANK, David; NIEVERGELT, David; ESPER, Jan (2006): "Summer temperature variations in the European Alps, AD 755-2004", *Journal of Climate, 19,* pp. 5606–5623. https://doi.org/10.1175/JCLI3917.1

CALTOS, Brian (2018): *Kingdoms of Faith: A New History of Islamic Spain.* New York: Basic Books.

CAMUERA, Jon; JIMÉNEZ-ESPEJO, Francisco José; SOTO-CHICA, José; JIMÉNEZ-MORENO, Gonzalo; GARCÍA-ALIX, Antonio; RAMOS-ROMÁN, María José … CASTRO-PRIEGO, Manuel (2023): "Drought as a possible contributor to the Visigothic Kingdom crisis and Islamic expansion in the Iberian Peninsula", *Nature Communications, 14*, 5733. https://doi.org/10.1038/s41467-023-41367-7

CAPILLA CALVO, Susana (2008): "La ampliación califal de la mezquita de Córdoba: mensajes, formas y funciones", *GOYA-MADRID*, 323, pp. 89 – 106. https://www.researchgate.net/publication/270338826_La_ampliacion_califal_de_la_mezquita_de_Cordoba_mensajes_formas_y_funciones

CASAL GARCÍA, María Teresa; CASAL ROMÁN, Manuel (2004): "El tratamiento de las enfermedades infecciosas en al-Andalus", *Revista Española de Quimioterapia, 17,* 4, pp. 350 – 356. https://dialnet.unirioja.es/servlet/articulo?codigo=1065592

CHERIF, Hanene; MARASCO, Ramona; ROLLI, Eleonora; FERJANI, Raoudha; FUSI, Marco; SOUSSI, Asma … OUZARI, Hadda (2015): "Oasis desert farming selects environment-specific date palm root endophytic communities and cultivable bacteria that promote resistance to drought", *Environmental Microbiology Reports, 7,* 4, pp. 668 – 678. https://doi.org/10.1111/1758-2229.12304

COMPÉS LÓPEZ, Raúl; SOTÉZ RUIZ, Vicente (2018): *El sector vitivinícola frente al desafío del cambio climático. Estrategias públicas y privadas de mitigación y adaptación en el Mediterráneo.* España: Cajamar Caja Rural.

COOK, Edward; KUSHNIR, Yochanan; SMERDON, Jason; PARK, Williams; ANCHUKAITIS, Kevin; WAHL, Eugene (2019): "A Euro-Mediterranean tree-ring reconstruction of the winter NAO index since 910 C.E.", *Climate Dynamics, 53*, 3, pp. 1567 – 1580. https://doi.org/10.1007/s00382-019-04696-2

ECHAVARREN, Arturo; MARTÍN CARRO, Sergio; MEDINA FERNÁNDEZ, Esther (2014): Mediterráneos*: An Interdisciplinary Approach to the Cultures of the Mediterranean Sea.* Cambridge: Cambridge Scholars Publishing.

EL ALAOUI, Narjys (1999): "Paysages, usages et voyages d'Argania spinosa (L.) Skeels (IXe-Xe siècles)", *Journal d'agriculture traditionnelle et de botanique appliquée, 41,* 2, pp. 45 – 79. https://doi.org/10.3406/jatba.1999.3711

ESPER, Jan; FRANK, David; BÜNTGEN, Ulf; VERSTEGE, Anne; LUTERBACER, Jürg; XOPLAKI, Elena (2007): "Long-term drought severity variations in Morocco", *Geophysical Research Letters, 34(*17), pp. 1 – 5. https://doi.org/10.1029/2007GL030844

FERNÁNDEZ VÁZQUEZ, Alfonso; MAÑA ARES, Rubén (2016). "El legado islámico en los cuidados psiquiátricos. El Maristán de Granada", *Cultura de los Cuidados, 20,* 45, pp. 52 – 63. http://hdl.handle.net/10045/57351

FIERRO BELLO, Maribel (2011): *Abderramán III y el califato omeya de Córdoba*. San Sebastián: NEREA.

FITZ GARCÍA, Francisco (2014): "La batalla de Las Navas de Tolosa. El impacto de un acontecimiento extraordinario", in P. Cressier and V. Salvatierra Cuenca (eds.), *Las Navas de Tolosa, 1212-2012: miradas cruzadas*, pp. 12-36. Jaén: Universidad de Jaén.

FRANCO MORENO, Bruno (2008): *De Emerita a Marida: el territorio emeritense entre la Hispania gothorum y la formación de Al-Andalus (ss. VII-X): transformaciones y pervivencias.* [PhD], UNED, Madrid. https://dialnet.unirioja.es/servlet/tesis?codigo=40724

FRANCO SÁNCHEZ, Francisco (1999): *La asistencia al enfermo en al-Andalus: los hospitales hispanomusulmanes.* Junta de Andalucía: Consejería de Cultura. https://core.ac.uk/download/pdf/16698668.pdf

GARCÍA DE PEDRAZA, Lorenzo (1990): "Características de los vientos en la zona del Estrecho de Gibraltar" in *Calendario meteorológico* (ed.). Instituto Nacional de Meteorología, pp.188 – 201, Archivo climatológico y meteorológico institucional. https://core.ac.uk/download/pdf/217339265.pdf

GOZALBES BUSTO, Guillermo; GOZALBES CRAVIOTO, Enrique (1996): "El problema del agua y del regadío en el extremo occidental del Magrib en la Alta Edad Media" in L. Cara Barrionuevo and A. Malpica Cuello (eds.), *II Coloquio Historia y Medio Físico. Agricultura y regadío en al-Andalus,* pp. 165 – 75. Almería. https://dialnet.unirioja.es/servlet/articulo?codigo=1226643

GOZALBES CRAVIOTO, Enrique; GARCÍA GARCÍA, Inmaculada (2013): "Una aproximación a las pestes y epidemias en la antigüedad", *Espacio, Tiempo y Forma, Serie II, Historia Antigua, 26,* pp. 63 – 82. https://doi.org/10.5944/etfii.26.2013.13738

GUIOT, Joel; GOOSSE, Hughes; MANN, Michael; DUBINKINA, Svetlana; SALLAZ-DAMAZ, Yoann (2012): "The medieval climate anomaly in Europe: Comparison of the summer and annual mean signals in two reconstructions and in simulations with data assimilation", *Global and Planetary Change, 84 – 85,* pp. 35 – 47. https://doi.org/10.1016/j.gloplacha.2011.07.002

GUTIÉRREZ DEL ESTAL, Juan Manuel (1986): "Vicisitudes del reino taifa de Denia en los dos tercios últimos del siglo XIII", *Anales de la Universidad de Alicante. Historia Medieval, 4-5*, pp. 49-66. https://doi.org/10.14198/medieval.1986.4-5.02

IBN ABĪ ZARʿ, Abū-l-Ḥasan (1972): *Rawḍ al-Qirṭās fī akhbār mulūk al-Maghrib wa tārīkh madīnat Fās.* Rabat: Dār al-Manṣūr li-ṭabāʿa wa al-warāqa.

IBN ʿIDHĀRI, Abū-l-ʿAbbās (2013): *Kitāb al-bayān al-Mughrib fī ikhtiṣār akhbār mulūk al-andalus wa-l-Maghrib.* Tunis: Dār al-Gharb al-islāmī.

KARNAUSKAS, Kristopher; UMMENHOFER, Caroline (2014): "On the dynamics of the Hadley circulation and subtropical drying", *Climate Dynamics, 42*, pp. 2259 – 2269. http://10.1007/s00382-014-2129-1

LAMB, Hubert H. (1965): "The early medieval warm epoch and its sequel", *Palaeogeography, Palaeoclimatology, Palaeoecology, 1,* pp. 13 – 37. https://doi.org/10.1016/0031-0182(65)90004-0

LEDUC, Richard; GERVAIS, Raymond (1985): *Connaître la météorologie.* Montréal: Presse de l'Université du Québec.

LEGUAY, Jean-Pierre (2002): *L'eau dans la ville au Moyen Âge.* Rennes: Presse Universitaire.

MALALANA UREÑA, Antonio; MORÍN DE PABLOS, Jorge (2018): "La elaboración de compost en al-Andalus durante los siglos X-XI. Una reinterpretación del silo-basurero a partir de la arqueología" in *Actas RAM 2015 Reunión de Arqueología Madrileña,* pp. 118 – 126. https://dialnet.unirioja.es/servlet/articulo?codigo=7764892

MALALANA UREÑA, Antonio; MORÍN DE PABLOS, Jorge; BARROSO CABRERA, Rafael (2013): "Acerca de la funcionalidad de los denominados silos-basureros: una propuesta metodológica para el estudio de la agricultura andalusí en época califal y taifa", *Archeologia medievale: cultura materiale, insediamenti, territorio, XL*, pp. 337 – 352. https://dialnet.unirioja.es/servlet/articulo?codigo=4696160

MANZANO MORENO, Eduardo (2018): *Épocas medievales. Vol. 2 de la Historia de España, dirigida por Josep Fontana y Ramón Villares*. Barcelona/Madrid: Crítica/Marcial Pons.

MARTÍNEZ ENAMORADO, Virgilio (2006): "Algunas reflexiones en torno al fin del almohadismo. El siglo XIII en el Islam de Occidente", in *I Jornades de Recerca Històrica de Menorca. La Manūrqa de Sa'id*

ibn Hakam, un país islàmic a Occident. Publicacions des Borns, pp. 11-28. https://digital.csic.es/bitstream/10261/33291/1/Martinez_Enamorado_Algunas_reflexiones_en_torno.pdf

MEOUAK, Mohamed (2001): "Graneros y silos en las fuentes árabes del occidente islámico medieval", *Anaquel de estudios árabes, 12*, pp. 443-448. https://dialnet.unirioja.es/servlet/articulo?codigo=900714

MORA GARCÍA, Manuel Antonio (2021): "Influencia de las variables meteorológicas en el desarrollo y migración de la langosta del desierto", *Agencia Estatal de Meteorología,* pp. 20 – 34. https://tinyurl.com/2ynbd8w4

ORTEGA, Pablo; LEHNER, Flavio; SWINGEDOUW, Didier; MASSON-DELMOTTE, Valerie; RAIBLE, Christoph; CASADO, Mathieu; YIOU, Pascal (2015): "A model-tested North Atlantic Oscillation reconstruction for the past millennium", *Nature, 523,* 7558, pp. 71 – 74. https://doi.org/10.1038/nature14518

PASCUAL, Ana; NACHITE, Driss (2006): "Los foraminíferos bentónicos del estuario del Tahadart (N-O de Marruecos)", *Geogaceta, 41*, pp. 167 – 170. https://rabida.uhu.es/dspace/bitstream/handle/10272/8501/Los-foraminiferos.pdf

PERE BENITO, Monclús (2011): "Las crisis alimenticias en la Edad Media: caracteres generales, distinciones y paradigmas interpretativos" in *Comer, beber, vivir. Consumo y niveles de vida en la Edad Media hispánica: XXI Semana de Estudios medievales, Nájera, del 2 al 6 de agosto de 2010,* pp.123 – 158. Instituto de Estudios Riojanos. https://repositori.udl.cat/server/api/core/bitstreams/f044cddf-b829-49e2-a3b1-94efdc4c0ca6/content

RHIZOPOULOU, Sophia (2007): "Olea europaea L. A. Botanical Contribution to Culture", *American-Eurasian Journal of Agricultural & Environmental Sciences, 2,* 4, pp. 382 – 387. https://shorturl.at/lYu2T

RODRÍGUEZ AGUILERA, Ana Isabel; RODRÍGUEZ FERRER, José Manuel (2025): "Los silos de la Alhambra", *Cuadernos de la Alhambra, 54*, pp. 15-41.

ROJAS GUERRERO, Silvia (2017): *Prácticas médico-quirúrgicas en al-Ándalus y su huella en el registro arqueológico.* Bachelor's Thesis, Universidad de Granada, Granada. https://hdl.handle.net/10481/62841

ROSENBERGER, Bernard (2001): *Société, pouvoir et alimentation*. Rabat-Riyad: Alizés.

RUAS, Marie-Pierre (2018): "Fruits et légumes consommés au Maroc antique et médiéval: témoignages archéobotaniques", *Horizons Maghrébins, 79*, pp. 161-185. https://hal.science/hal-03005747/document

STINE, Scott (1998): "Medieval Climatic Anomaly in the Americas" in Arie S. Issar and Neville Brown (eds.), *Water, Environment and Society in Times of Climatic Change: Contributions from an International Workshop within the framework of International Hydrological Program (IHP) UNESCO, held at Ben-Gurion University, Sede Boker, Israel from 7–12 July 1996*, pp. 43-67. Dordrecht: Springer Netherlands.

THATCHER, Diana; WANAMAKER, Alan David; DENNISTON, Rhawn; UMMENHOFER, Caroline; ASMEROM, Yemane; POLYAK, Victor … GILLIKIN, David (2023): "Iberian hydroclimate variability and the Azores High during the last 1200 years: evidence from proxy records and climate model simulations", *Climate Dynamics, 60*, pp. 2365 – 2387. https://doi.org/10.1007/s00382-022-06427-6

TILL, Claudine; GUIOT, Joel (1990): "Reconstruction of Precipitation in Morocco Since 1100 A.D. Based on Cedrus atlantica Tree-Ring Widths", *Quaternary Research, 33,* 3, pp. 337 – 351. https://doi.org/10.1016/0033-5894(90)90060-X

TORRES BALBÁS, Leopoldo (1944): "Las mazmorras de la Alhambra", *Al-Andalus*, *9*, pp. 198-218. https://oa.upm.es/34128/1/1944_mazmorras.pdf

TORRÓ, Josep; SEGURA, Josep Maria (2000): "El Castell d'Almizra y la cuestión de los graneros fortificados", *Recerques del Museu d'Alcoi, 9*, pp. 145 – 164. https://raco.cat/index.php/RecerquesMuseuAlcoi/article/view/180990

TROUET, Valérie; ESPER, Jan; GRAHAM, Nicholas; BAKER, Andy; SCOURSE, James; FRANK, David (2009): "Persistent Positive North Atlantic Oscillation Mode Dominated the Medieval Climate Anomaly", *Science, 324*, pp. 78 – 80. https://doi.org/10.1126/science.1166349

VALÉRIAN, Dominique (2019): *Ports et réseaux d'échanges dans le Maghreb médiéval*. Madrid: Casa de Velázquez.

VERNET, Robert (1980): "Les relations céréalières entre le Maghreb et la Péninsule Ibérique du XIIe au XVe siècle" in *Anuario de Estudios Medievales*, pp. 321 – 335. Barcelona: Instituto de Historia Medieval de España, tomo 10.

VIGUERA MOLINS, María Jesús (1997): "Historia política", in M. J. Viguera Molins (ed.), *El retroceso territorial de al-Andalus. Almorávides y almohades, Historia de España de Ramón. Menéndez Pidal (VIII-2)*, pp. 41 – 127. Madrid: Espasa-Calpe.

WASSENBURG, Jasper; IMMENHAUSER, Adrian; RICHTER, Detlev Konrad; HACHENBERG, Andrea; RIECHELMANN, Sylvia; FIETZKE, Jan … ESPER, Jan (2013): "Moroccan speleothem and tree ring records suggest a variable positive state of the North Atlantic Oscillation during the Medieval Warm Period", *Earth and Planetary Science Letters, 375*, pp. 291 – 302. https://doi.org/10.1016/j.epsl.2013.05.048