CONSTANTINO CRIADO-HERNÁNDEZ[*], CLAUDIO MORENO-MEDINA[**] & PEDRO DORTA-ANTEQUERA[*]

[*] Departamento de Geografía e Historia. Universidad de La Laguna

[**] Departamento de Geografía. Universidad de Las Palmas de Gran Canaria

ccriado@ull.edu.es | claudio.moreno@ulpgc.es | pdorta@ull.edu.es

Another image of the desert. The climate of the former Spanish Sahara between 1882 and 1890

Desert climates are difficult to analyse, mainly due to the lack of sufficiently long and reliable meteorological data. Studying such climates is further complicated if the goal is to research conditions from past time periods for which we have absolutely no data. In this context, this work attempts to reconstruct the climate from 1882 to 1890 of a part of North-western Africa: the former Spanish Sahara.

The area studied, which was the Spanish Sahara until 1975, is a broad swath of the western Sahara for which there is no relevant meteorological information until well into the 20th Century (Font Tullot, 1955). The geomorphology of this area is mostly flat and the climatic differences are found mostly between coastal sectors and the interior. The former is characterized by lower temperatures and high relative humidity. The latter manifests greater seasonal contrasts in temperatures and notably lower relative humidity percentages. In any case, the region, which covers an area of almost 300,000 km^2, clearly possesses a very dry, desert climate, located in Nicholson's precipitation zone 4 (2001*a*). Total rainfall is very low in the area studied, with around 100 mm/year recorded at the rainiest stations. Moreover, in some cases the variation coefficients surpass 60 %, indicating highly irregular precipitation. Finally, the total rainfall varies from the maximums registered during the winter rainy season to the North and the minimums during the summer rainy season in the inner and eastern regions. The former is caused by the low pressure activity of isolated storms from the polar front and the latter by the Sudano-Sahelian storms caused by Easterly waves (Font Tullot, 1955).

From a human perspective, the area examined in this work held communities whose economies were based on pastoralism and cultivating barley, a substantial part of the Sahrawi diet until well into 20th Century. In both cases these inhabitants lived a nomadic lifestyle as the main way to adapt to the variable conditions of the territory, especially regarding the irregular distribution of precipitation. This is quite evident in the exploitation of livestock, but also in barley production.

At the end of 19th Century the former Spanish Sahara was populated by numerous tribes, such as the Izarguiem, Filala, Arosien, Ulad Tidrarin and Ulad Delim or Erguibat, who cultivated barley by taking advantage of topographic depressions in which water and fine particles accumulated, favouring agricultural production, known as *graras* (Hernández-Pacheco et al., 1949). In some cases the *graras* would flood with water, becoming *daias* that would be used as watering holes for the herds of the tribesmen.

This nomadic economy provides important proxy data that allows us to determine precipitation patterns in the territory we are analysing. That is why the main sources of this study are documents reflecting, in one way or another, the daily life of the tribes mentioned above and its close ties to climatic conditions that favour or hinder agricultural or livestock production. There are numerous texts regarding this, from the oral chronicles of the tribes themselves, collected by J. Caro Baroja (1955) or Caunelle and Dubief (1955), to the travelogues of various authors (Douls, 1888; Cervera, 1886; Bonelli, 1887). This large repository of information can be used to trace

all kinds of natural phenomena, making it possible to reconstruct the climatic conditions at the end of the 19th Century. In addition, a very limited amount of meteorological data was also available (Nicholson, 2001*a*).

Among all the sources of information, the most notable is the data provided by Bonelli's two El-Madani expeditions in September and November of 1885. His descriptions reveal a generally arid territory that, however, contained pastures, acacias and *daias*, particularly inland, which allowed the tribes to sustain their herds. Their livestock included camels, goats, horses and, surprisingly, cattle. They also describe extensive areas dedicated to cultivating barley. More evidence was provided by the Cervera expedition in the summer of 1886, which describes a similar panorama as Bonelli, with the presence of livestock at the *daias* and large grassy areas. A third source of very interesting information was found in the accounts provided by Douls of the territories located a bit farther north than those travelled by the other authors and, therefore, far away from the Intertropical Convergence Zone (ITCZ). Consequently, this geographical area contained a harsher desert, but *graras* and *daias* were still found, according to Douls. There is even discussion of the existence of wells, revealing that the phreatic zone was closer to the surface in that region. However, Douls' account is especially eloquent when talking about how the Saguia el-Hamra flowed all the way to the ocean, when today it dies in a large field of dunes. Therefore, it is probable that in that era there could have been enough rainfall to generate sufficient runoff to open a path through the dune fields.

As a complement to the information found in the above sources, a significant amount of information was extracted from the oral tradition of the Sahrawi tribes mentioned earlier (Izarguiem, Filala, Arosien, Erguibat, etc.), which indirectly refers to the climate. These include references to areas of nomadic wanderings and the presence of rats or locust or directly mentions rainfall in the area.

Finally, the precipitation data recorded by Donald Mackenzie in Cape Juby is also highly relevant given that they are the only records that exist for that period. The two years with meteorological information, 1884 and 1885, reveal much greater precipitation than the averages commonly recorded today.

With all of this information —the travelogues, the oral tradition of the tribes and the precipitation data— it has been possible to reconstruct the rainfall conditions in the 1880s. It can be said that, at least from 1882 to 1890, the territory of the former Spanish Sahara clearly enjoyed greater amounts of rainfall than in later decades. It is also known that this wet phase affected the entire territory analysed, both the north, with rain produced by the polar front, and the south, due to the latitudinal ascent of the ITCZ. This rainfall bonanza allowed the nomads to maintain relatively large herds, as well as to cultivate large extensions of barley and it even led to a partial sedentarization of some Sahrawi tribes in more southern regions.

Analysing the results obtained in the context of other studies related to some climate teleconnections leads to very interesting conclusions. First of all, this work provides further context for some previous research (Nicholson, 2001*a*) into the characterization of the rainfall in certain periods. Secondly, it demonstrates that there is some relation between the classification of years with NAO indices and the Sahel rain index. Although the dataset employed is short, it can be said that positive Sahel indices usually determine rainy years, as do, to a lesser degree, negative NAO indices.

In any case, the most significant aspect of this article is that it shows the importance of using many different kinds of proxy data, as they can be very useful for climatic reconstructions that can later be used to check large models. Using indirect data has allowed the rainfall of a western African region that had virtually no meteorological data to be characterized.