

EXTENDED ABSTRACT

TOURISM AND NATURAL HAZARDS IN MACARONESIA. COMPARATIVE ANALYSIS

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The Macaronesian archipelagos (The Azores, Cape Verde, Madeira and the Canary Islands), comprise of more than 40 islands and islets, that have similar climatic and geomorphologic features. All of them are volcanic and located in the North Atlantic Ocean. Most of the islands are mountainous and heights of 1.800 m, are exceeded in all archipelagos. The relief and the isolation specific of the islands generate abundant biodiversity and endemism. The landscapes, the great amount of internationally protected areas (National Parks, Biosphere Reserves, and Human Heritage Sites), and mainly, the moderately warm climate constitute the principal touristic attractiveness of Macaronesian archipelagos.

In this sense, the four archipelagos form fragmented territories where the most prevalent economic sector is Tourism; although there are very important differences amongst the archipelagos and islands. The Canary Islands and Madeira are more mature as tourist destinations. The Azores and Cape Verde have a more recent touristic history, and have consequently, shown a minor flow of visitors (Table 1).

At peak, we find 15 million tourists per year in the Canary Islands against the 600,000 in the Azores (2016). Simultaneously, among the islands of each archipelago, an elevated disparity is evident. Tenerife, in the Canary Islands, is the most visited island, accounting for more tourist influx per year than the whole of Macaronesian archipelagos. In Cape

Verde, Sal surpasses the other islands, as does Sao Miguel in the Azores, and Madeira island in Madeira's archipelago. Conversely, the smallest islands hardly take advantage of the arrival of tourists. This is the case in El Hierro in the Canary Islands, Sao Nicolau in Cape Verde or Graciosa in the Azores (Figure 4).

The disparities in tourist arrivals distribution are undeniable, not only in terms of how it impacts the GDP of the archipelagos, but this disparity is evident in the increasing number of tourists over the last decades.

The visitor's affluence shows also disparities between the archipelagos, depending on the seasons and the tourists' nationality. For instance, British tourists are the most numerous in general, accounting for the largest portion of tourists in the Canary Islands and Cape Verde, concurrently with the Germans in Madeira. Only the Azores show a different tendency, whereby the majority of visitors come from Portugal, and therefore, the only case dominated by domestic tourism.

These differences between the visitors and essentially the climatic conditions are contributing to explain the seasonality trend in the islands, clearly, quite dissimilar amongst them. The Azores show a significant seasonal model, where peak season is concentrated in the summertime like the typical Mediterranean destinies. On the Contrary, in Cape Verde, the peak season occurs during the winter, coinciding with the mild temperatures and the dry period.

The Canary Islands only show seasonal differences, and lastly, Madeira's visitors are mainly condensed within the warmer months, but with a long season and without a peak minimum flux of tourism as considerable as in the Azores.

The four examined archipelagos, despite the indicated differences between them and among the islands, present a high demographic pressure increased by the massive influx of tourists. This population increase entails a high level of exposure to the natural hazards characteristic of the region.

As previously mentioned, all the islands are volcanic but only some of them are affected by this threat.

Many of the Macaronesian islands have not experienced volcanic activity in the last millennia, so we can sustain that they are not currently volcanically active. However, some of them present a significant activity (Figure 8). Thus, while in Madeira's archipelago the volcanic events are not currently a great threat, in the rest of the islands 68 historic eruptions have been registered (Torres *et al.* 1997; Romero, 1991; Madeira, 2005; Ribeiro, 1960; GVP, 2018), though unequally distributed amongst them. Despite the fact that Fogo, in Cape Verde, has registered the most volcanic eruptions, Sao Miguel in Azores and Tenerife in the Canary Islands are considered as the highest volcanic risk due to the population density and touristic development.

Another eminent geological hazard present in Macaronesian archipelagos are the earthquakes, although, in Madeira and Cape Verde, the magnitude is low and these are infrequent. It is evident that the volcanic activity is the triggering factor for the majority of the earthquakes in this region, but besides it, in the Azores, significant tectonic earthquakes have been registered. This archipelago has been hit by severe disasters with substantial damages. In fact, the seismic events of 1522, 1939 and 1980, presumably are the most harmful disasters among those collected in this work. There have been 33 earthquakes

with an intensity higher than VII causing 6,300 deaths (Caldeira *et al.*, 2017). The Azores archipelago is also the most affected by tsunamis: the most severe occurred in November 1975 generating serious damages, specifically in Terceira.

Most of the mountainous islands of the region have registered landslides with serious damages. The most severe were located in Sao Miguel (The Azores) in October 1997 (Cunha, 2003; Marques *et al.*, 2009) and the Rosiana's landslide in Gran Canaria (Linares *et al.*, 2001). In Madeira, the landslides have been also abundant.

As well as the geological events being geographically clustered in several islands, they present long return periods, conversely, the climatic phenomena are more recurrent and show a wider distribution among the islands. For this reason, this kind of hazard today has turned out to have one of the major impacts over touristic activity.

Among the climate hazards, intense and torrential rains that result in flash floods, together with heat waves are remarkable. Moreover, the last caused wild forest fires. Occasionally tropical storms are also present.

The worst flood disasters have been focused along the coastal zones of the islands of complex topography. These kind of events are frequent and the total injuries and fatalities are significant. This phenomenon has been present in all the regions, reaching a maximum rainfall record of 300 mm in 24 hours. February 2010 in Madeira or March 2002 in Tenerife were events that stood out. In both cases the flash floods have affected the capital cities of several islands, generating significant economic losses and more than 50 fatalities together.

On the other hand, the Azores, Madeira and the Canary Islands archipelagos hold abundant forest areas that are a part of the touristic attractiveness of some of the most visited islands. It is the case of Tenerife, Gran Canaria or Madeira, where the combination of an extensive forest, summer drought typical of Mediterranean rainfall regimens, and the sporadic arising heat waves, often cause wildfires. Amongst the most serious wildfires, we find the events of August 2010 and 2016 in Madeira, and July 2007 in Gran Canaria and Tenerife, where more than 35,000 ha of forest were burnt.

The unstable weather phenomena of tropical origin, tropical storms and cyclones are typical of the Western Atlantic near (in global terms) to the latitude fringe of the Macaronesian region. However, during the last decades, the data has started to show how this kind of phenomenon appears occasionally to only affect the study area. The Azores is affected more frequently, having registered a set of very old events. It is, therefore, the rest of the islands where these phenomena represent a certain novelty. Along the recent XXI century, several unusual weather phenomena have taken place in the region, showing certain clumpiness in the last lustrum.

It is precisely this sequence of events, together with the expansion in heat waves, the severity of the droughts and the increase of rainfall intensity, that demonstrates how climate change is already affecting the four observed archipelagos. This issue represents a threat in itself.

All of the mentioned threats and their unequal distribution between the islands and the archipelagos, thus as they manifest differences amongst the number of tourists, are generating diverse kind of risks that arise with different intensity.

The territory of Sao Miguel probably shows the largest variety and intensity of threats. It is affected by earthquakes and diverse climate hazards, mainly tropical cyclones. Tenerife also shows relevant natural hazards, primarily potential volcanic eruption, heat waves and torrential rains with flood flash effects. A high population density is present both, Tenerife in the Canary Islands, and Sao Miguel, in the Azores, are one of the most populated islands of Macaronesia, and they receive the greatest number of visitors within the corresponding archipelagos. The combination of the indicated threats and high exposure (residents plus visitors) make these places the utmost affected by natural risks.

Secondly, Gran Canaria in the Canary Islands, and Madeira in the namesake archipelago, similarly experience a substantial risk, specifically on extreme climate events, floods, landslides and heat waves, also due to the high pressure of population and the number of tourists with relation to the small dimension of the islands.

The rest of the territories, while still showing significant threats, exhibit a minor exposure, and therefore, a lower vulnerability.

Finally, this work reveals the state of the tourism industry and its strength as a socioeconomic sector in Macaronesia, but also a long variety of hazards that are affecting the region. This circumstance implies the needed to improve the resilience of the residents and visitors. Some of the recent and mentioned events are showing the high vulnerability of a densely populated territory, and also exploited from a touristic point of view.

The information provided by this work is driven to develop more suitable planning for risk reduction and risk knowledge. In this sense, it attempts to contribute to increasing the resilience of the Macaronesian society, and its actions to face, not only the current threats but the future ones, like those related to climate change.