Mapping flood risk in Spain from Extraordinary Risk Insurance Scheme data

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As discussed in the opening article of this same issue of the magazine, flood risk is the one that accounts for the largest share of indemnities paid out by the 'Extraordinary Risk Insurance' Scheme in Spain. In the past 25 years, flooding has been the cause behind 69 of every 100 euros paid out in compensation to insured parties by the Consorcio de Compensación de Seguros (CCS) for property damage in Spain. For purposes of coverage by the CCS, flooding is defined as follows in Rule 2(c) in the Implementing Regulations for the Extraordinary Risk Insurance Scheme: "the inundation of land caused by the direct action of rainwater, meltwater, or waters from lakes with natural outlets, rivers or inlets, or natural surface watercourses through overflow of their natural beds or channels, and coastal ocean wave battering. Inundations caused by waters from dams, canals, sewage systems, collectors, and other underground channels built by man that burst, break, or malfunction from causes other than extraordinary risks covered by the Consorcio de Compensación de Seguros, or by rain falling directly on the insured risk, or by rainfall runoff collected by rooftops, drainage systems, or courtyards will not be defined as flooding."

There is a further circumstance that makes the Consorcio de Compensación de Seguros data especially appropriate for studying this peril: the CCS is the only agent in our country that pays compensation for flood damage to insured property. Wind is a peril shared by private insurers and the CCS, in that the Extraordinary Risk Insurance Scheme compensates for damage only on attainment of the threshold of an atypical cyclonic storm (ACS or TCA for the Spanish), practice ordinarily when the threshold of 120 km/h is passed. In contrast, there is no threshold for fluvial, pluvial, or coastal flooding, and the CCS is the owner of 100 % of the risk. For this reason, Extraordinary Risk Insurance Scheme data make up the entire body of data on flood damage to insured property.

Based on the reworked insured damage data, flood risk is greater in provinces that combine nearness to the sea, substantial relief with short fluvial watercourses and low accumulation times, and plains or valleys densely populated by people. Thus, Guipúzcoa, Murcia, and Alicante, in that order, report the greatest per capita damage. To a lesser extent, this is also the case for the rest of the Mediterranean coastal region – except for Granada, for the simple reason that most of the population does not live along the coast but in the metropolitan area of the capital city, and for Barcelona, because its extremely large population brings the average down considerably – and for the provinces of Cádiz, Pontevedra, and Santa Cruz de Tenerife.

The purpose of this article is thus to carry out a spatial analysis of flood risk by province, both because of the size of that peril and because the CCS holds all the insured damage data. It should be noted that this study based on insured damage data has been limited to fluvial and pluvial flooding; that is, coastal flooding (and wave battering damage) has not been included.

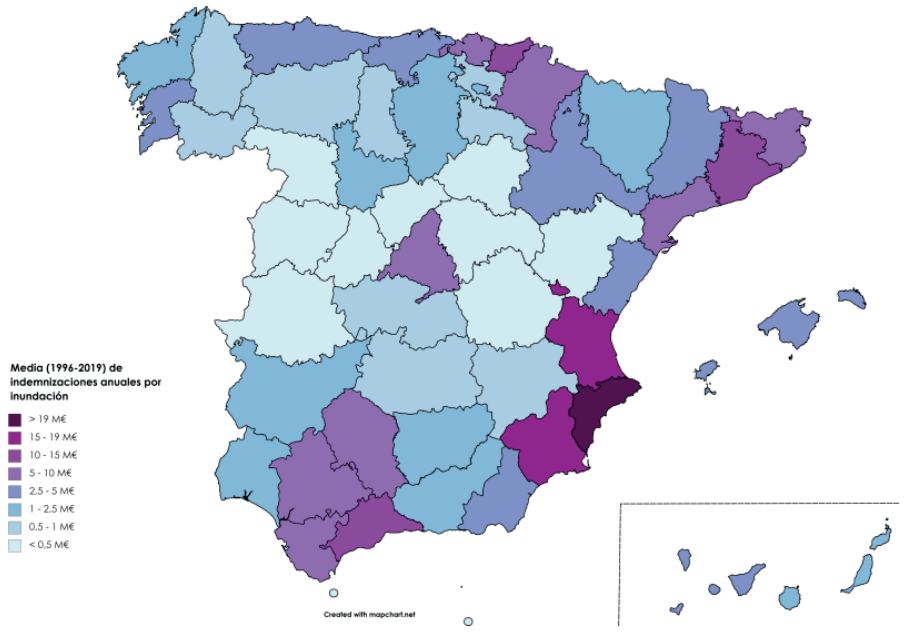

Figure 1. Average annual compensation for fluvial and pluvial flooding (1996-2019).

The first illustration, Figure 1, shows the average annual compensation for flood damage per province over the study period. This direct graphic representation in itself reveals several noteworthy features: higher levels of damage in the coastal provinces, particularly along the Mediterranean coast and the Bay of Biscay; greater damage in the basins along the largest rivers, especially the Ebro and the Guadalquivir rivers and to a lesser extent the Duero and the Guadiana rivers; plus an accumulation of damage in the region of Madrid.

Figure 2. Physical map of the Iberian Peninsula and the Balearic and Canary Islands.

Let us pause here for a moment to briefly consider the geography of Spain (Figure 2), which encompasses two quite different settings. The first consists of a peninsula and an archipelago (the Balearic Islands), plus Spain's autonomous city enclaves in North Africa, together making up an environment partway conditioned by Atlantic, Mediterranean, and continental African influences. The interaction of these influences and the markedly mountainous terrain that generally tends to be located quite close to the coast, particularly in the case of the Atlantic coast north of Portugal, along the Bay of Biscay, and the entire Mediterranean coast, including the Balearic Islands, gives rise to a patchwork of climates with few equals in Europe and a variety of sizeable repercussions for the hydrographic network. First of all, the proximity of significant topographical relief to the main source of moisture, the sea, heightens the impact of precipitation in the above-mentioned areas along the Bay of Biscay and the Mediterranean by forcing air masses to rise, which is conducive to condensation and increases the precipitation rate while at the same time blocking oceanic air flows, causing these to be longer lasting and resulting in greater accumulation. The small space available between the mountains and the sea means that river courses tend to be short, with steep slopes (and in the case of the Mediterranean, with highly irregular flow volumes), leaving only short windows for precipitation to accumulate from when it starts to fall to when it is discharged into the river network, in that way exacerbating the problem of flooding. Only the southwestern part of the peninsula allows oceanic air flows to penetrate inland, contributing to a more even distribution pattern of precipitation.

Figure 2b. Provinces of Spain (Source: Wikipedia).

Most of the large rivers empty into the Atlantic, but the Ebro, the river with the highest average volume of flow in the peninsula, discharges into the Mediterranean, while its headwaters have Atlantic features. This is why regions like Navarre record some of the highest rates of damage, and accumulated flows in the middle section of the river course also cause extensive damage in provinces like Zaragoza. Something similar can be said of the mountainous or highland areas that are the source of the tributaries to the middle section of the Guadalquivir River, causing flooding in the provinces of Córdoba, Seville, and Cádiz. The province of Málaga is affected by similar situations on the other side of the mountains.

Figure 1 distinctly shows that, in absolute terms, the greatest damage is concentrated in the provinces of Alicante, Valencia, and Murcia. It is here where the effects of the potentially heavy precipitation that usually falls in late summer

and early autumn combine with the effects of a very warm sea and inflows of cold air in the mid to upper layers of the atmosphere – the Spanish DANAs, or cut-off lows – and with the orographic effects of tall mountains near the sea and the presence of coastal plains which, while narrow, allow people and economic activities to gather there. And it is also here where all those watercourses, whether still extant or overrun by human occupation of the land, spill out and can go from dry to carrying large volumes of water in a matter of minutes.

The Canary Islands are the second setting we mentioned above. This archipelago consists of a group of islands, volcanic in origin, located in subtropical climes off the continent of Africa, part of a larger group of widely scattered islands of similar origin, called Macaronesia. While as a rule the Canary Islands suffer less flood damage than the rest of the country, their relief features are not so different: high elevations quite near the coast, little time for precipitation to accumulate, and watercourses that can go from dry to full with strong, heavy flows in just a few minutes. The islands are spared worse problems only because there is less active cyclonic circulation and convection there. However, major damage has occurred when these conditions have arisen, sometimes as a result of tropical storms or hurricanes, which seem likely to increase in the future.

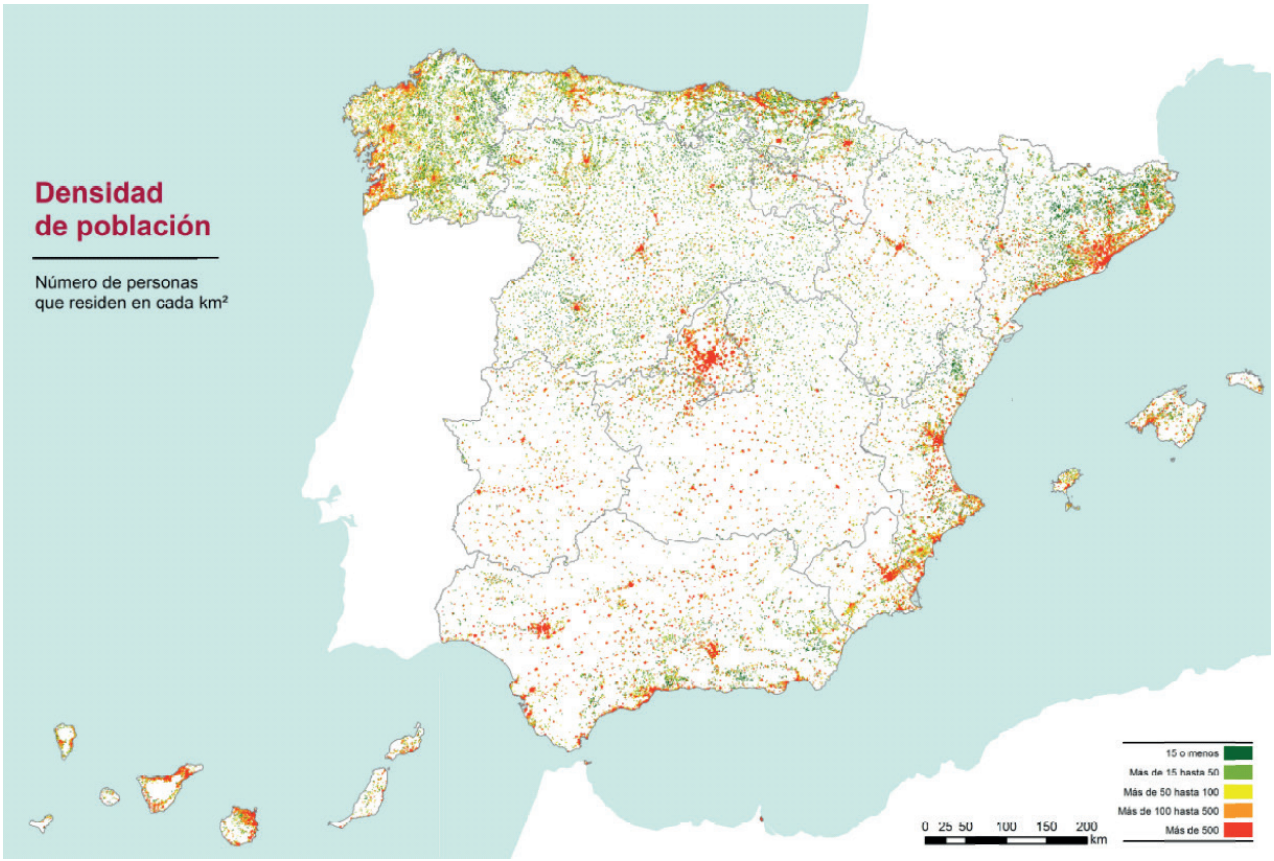

Figure 3. Population density in Spain. Source: INE [Spain's National Institute of Statistics], 2011.

A little earlier we mentioned a factor that is just as important as physical geography, namely, human occupation. Ultimately, when speaking of damage, we are speaking of exposed property, something that is inherently human. Figure 3 depicts population density in Spain and clearly shows that the country mimics a certain "atomic" structure, with most inhabitants divided between the "nucleus" (Madrid) and the "shell" (the coast, sometimes extending inland, as in Galicia, Catalonia, and Andalusia). This is the now-famous notion of "empty Spain", the prevailing situation in most of the country, which is also reflected in indemnities for damage. In the islands too, most of the population is concentrated along the coast, clearly discernible, for instance, on Tenerife and Grand Canary Island. Therefore, an exercise in which the damage for each province is divided by its population to even out the effects of exposure and more accurately determine the level of risk is worthwhile. The results are illustrated in Figure 4.

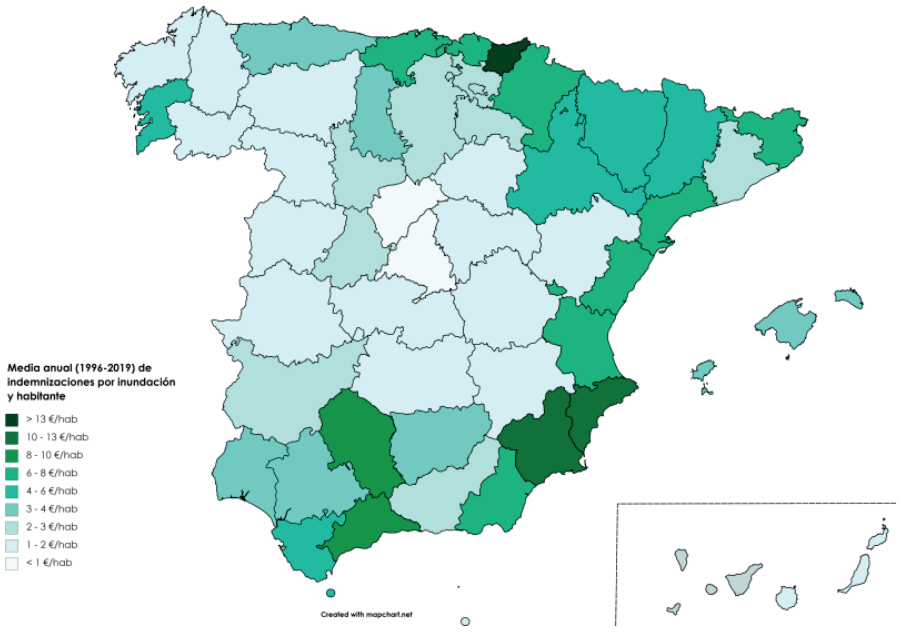

Figure 4. Average annual compensation by flood and by population (1996-2019).

Figure 4 shows that certain effects clearly attributable to cumulative exposure dissipate, e.g., in the province of Madrid. There is a similar effect in Barcelona.

In any case, this map displays a view of real average compensation paid by the CCS per flood over the study period in reference to compensation for damage to insured property only, not to all the damage caused. It is very hard to ascertain all the damage produced by a disaster. Another article elsewhere in this same issue of the magazine addresses this problem and how hard it is to account for all damage. The fact that the data for indemnities for insured damage per flood in Spain all come from a single source, the CCS, simplifies the problem greatly, but still we cannot be sure of the total amount of damage, because not all property is insured. For certain types of property, for instance, infrastructure, insurance penetration is rather low, because it is owned by governments, which self-insure, that is, any damage that is sustained is repaired by the government itself, charged to the budget. Nevertheless, the system allows property of this kind to be insured, and in fact certain levels of government, above all local and regional governments, do insure part of their infrastructure. The CCS estimates that, on the whole, it covers around or somewhat more than half of the total damage caused by flooding. The main source of this gap in damage coverage is presumably infrastructure, proportionally much more costly than other types of property. In its annual "Estamos Seguros" reports, the Spanish insurers' association, Unespa, estimates the percentage ratio of primary residences that are insured to the total number of primary residences by region (Autonomous Community). These are the only data we can use to obtain a closer approximation to what the total amount of damage would be *if all homes were insured*. Nationwide, the proportion of homes insured is around 72 %, though with large fluctuations from 88 % in the Basque Country to 38 % in Ceuta.

We have made a projection of the damage, and the results are shown in Figure 5. On the basis that 34 % of all indemnities paid under the Exceptional Risk Insurance Scheme is for the category of "homes and condominiums", if the proportion of insured homes were 100 %, the total damage for this category would be given by the following formula: DMCP = DMP [0.66 + 0.34(1/PR)], where DMCP is the average adjusted per capita damage by province, DMP is the average per capita damage by province, and PR is homeowners insurance penetration in the Autonomous Community where the province in question is located. We realise that this exercise entails certain problems, such as the fact that some of the homes that are uninsured are probably less expensive than the homes that are insured or that there may sometimes be large differences in insurance take-up among provinces in the same Autonomous Community, but this is as close as we can come to reality. Namely, about 34 % closer to the actual situation, because insurance penetration in

business and industry is still unknown (though we would venture to say that it is as high as or higher than home insurance), and the same holds for infrastructure (distinctly lower). In the case of damage to motor vehicles, all motor vehicles in operation are covered, because the Extraordinary Risk Insurance Scheme has been applied to all automotive insurance policies since July 2016, including compulsory civil liability policies only.

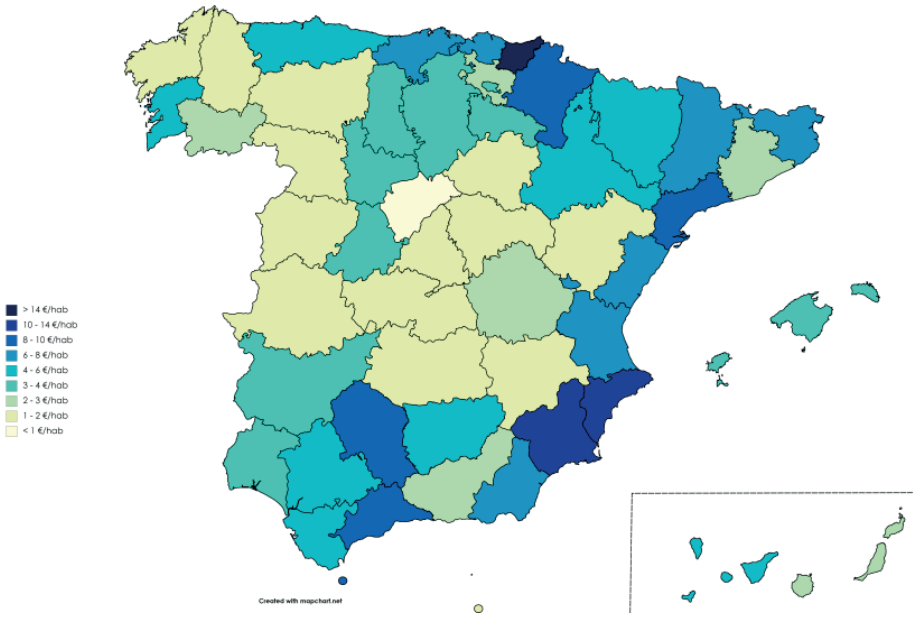

Figure 5. Average annual per capita flood damage by province (1996-2019) adjusted by homeowners insurance penetration.

Figure 5 appears to be relatively consistent, notwithstanding the assumptions that have had to be made. Based on the reworked insured damage data, flood risk is greater in provinces that combine nearness to the sea, substantial relief with short fluvial watercourses and low accumulation times, and plains or valleys densely populated by people. Thus, Guipúzcoa, Murcia, and Alicante, in that order, report the greatest per capita damage. To a lesser extent, this is also the case for the rest of the Mediterranean coastal region – except for Granada, for the simple reason that most of the population does not live along the coast but in the metropolitan area of the capital city, and for Barcelona, because its extremely large population brings the average down considerably – and for the provinces of Cádiz, Pontevedra, and Santa Cruz de Tenerife.

Other provinces like Navarre, Huesca, and Lérida also stand out on this map, even though they are more or less distant from the sea. The reason is the combination of mountains that act to heighten precipitation, watercourses that fill rapidly with water flowing at high energies, and human occupation of fluvial floodplains. Damage occurs also where high flow volumes accumulate and reach the main river channels, such as in provinces like Córdoba and Zaragoza. On the whole, the courses of the Ebro and Guadalquivir rivers, and to a lesser extent those of the Duero and Guadiana rivers, stand out rather clearly for this reason.

To conclude, we would point out, just by way of an interesting titbit of information, that according to the data employed and the results of this study, Segovia is the province with the lowest flood risk in Spain.