

GEOGRAPHICAL ANALYSIS OF FLASH FLOODS IN TOURISM AREAS IN THE NORTH OF THE PROVINCE OF ALICANTE

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1. INTRODUCTION

Tourism is one of the most important economic sectors worldwide, and has shown continuous expansion and diversification over the last six decades (UNWTO, 2016), during which time it has also demonstrated impressive elasticity to economic crises (MARTÍNEZ-IBARRA, 2015; UNWTO, 2016).

Weather and climate also have a significant influence on tourism (BESANCENOT, 1990; DE FREITAS, 1990; GÓMEZ-MARTÍN, 2000; GÓMEZ-MARTÍN, 2006; MARTÍNEZ-IBARRA, 2006; MARTÍNEZ-IBARRA *et al.*, 2013). The attractiveness of a tourist destination depends not only on its normal climate conditions but also on extreme weather events (BESANCENOT, 1990; DE FREITAS, 2003; DORTA, 2004). This makes tourism especially sensitive to natural risk (MARTÍNEZ-IBARRA, 2006; BESANCENOT, 1990; PERRY, 1997 and DE FREITAS, 2003).

One of the most important natural risks in the Mediterranean region is flooding, and in particular flash floods (GAUME *et al.*, 2009), which unlike other kinds of floods are often associated with the loss of human life (GAUME *et al.*, 2009; JONKMAN & VRIJLING, 2008), as has been the case in Spain (AYALA-CARCEDO, 2002; LLORENTE ISIDRO *et al.*, 2008).

This problem has been exacerbated in Spain by the fact that many flood zones have been occupied since the development of the tourism industry in the 1960s. Between 1987 and the year 2000, 12% of the surface area occupied by river beds was lost (7508 hectares), as a result of channelling and other forms of human intervention (CAMARASA-BELMONTE *et al.*, 2012).

To this end, in this research we will be focusing on different examples of flash floods (ordinary and extraordinary) in popular tourist resorts in the north of the province of Alicante: Benidorm, Calpe, Jávea and Denia.

2. SOURCES AND METHODOLOGY

For our analysis of ordinary floods, we made two case studies of what is the urban-tourist sector par excellence of Benidorm (the area around the Levante beach). These ordinary floods are the result of problems related exclusively to surface run-off in urban areas.

We also analysed three tourist areas affected by the extraordinary flooding of 12th October 2007 (see SEGURA-BELTRÁN, 2009; MARTÍNEZ-IBARRA, 2010 and 2012; and CHJ, 2013). In this case catastrophic damage was caused, with the overflowing of intermittently dry creeks. We analysed the following specific tourist areas: (1) the river mouth of the dry river bed Quisi-Pou Roig and those that drain towards the lagoon created by a tombolo in the town of Calpe; (2) by the inland delta of the river Gorgos and what a former lagoon in the Jávea area; (3) and the final stage of the river mouth of the river Girona in the town of Denia.

In both cases (i.e. ordinary and extraordinary flash flooding) fieldwork and observation were fundamental in that they enabled us to characterise the nature and extent of these events, as in the research by SEGURA (2009). Although, we should make clear that according to the magnitude of the flood, for safety reasons, the fieldwork was approached in a different way.

In the case of the ordinary floods studied in the city of Benidorm, we analysed all the reports published in paper format by the local press over a 35 year period between 1969 and 2003.

Having established the most problematic areas related with ordinary floods, we selected two spaces in which to carry out our fieldwork during torrential rainfall.

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In addition for the case of the extraordinary floods that took place in the north of the province of Alicante on 12 October, 2007, we carried out exhaustive fieldwork after the catastrophic event. During visits to the affected areas, we took photographs and measured some of the heights reached by the water and located the places where the water burst its banks and the associated water flows. We also interviewed people affected by the flood.

Finally, with the analysis and geolocation of the images (1530 photographs), and the results obtained with the fieldwork, we were able to draw up a specific cartography about the event.

For the study of both kinds of floods, we also consulted different sources: historic, geological and geomorphological maps, publications containing place-names of interest for the analysis of floods and technical reports on the episode we analysed. We also compared aerial photographs from different years.

3. DISCUSSION AND CONCLUSIONS

Fieldwork during floods and post-flood analysis are good methods for studying ordinary and extraordinary flash floods. In the former case they allow us to characterise urban run-off and identify the areas with drainage problems. While in the case of extraordinary flash floods, this analysis allows us to identify the areas where rivers have burst their banks and the flows associated with them, flooded areas and depths. In both cases we were able to produce maps of the flooded areas, basic elements in spatial planning.

In the case of the north of the province of Alicante our analysis of ordinary floods has shown how the run-off created in short spells of intense rainfall can produce large flows that can cause serious problems for urban and tourism-orientated areas. These situations arise because of the occupation of small ravine channels especially in which the concentration of flows combines with small depressions. On occasions, the counter slope that causes the build-up of water is accentuated by the presence of seaside promenades built on what were once sand dune cordons.

In addition and with regard to the extraordinary floods in tourist areas in the north of the province of Alicante various exacerbating factors have been noted: the urban development of low lying stages of the river mouth normally associated with the existence of the overflow channels for inland deltas and the presence of areas of poor drainage in the most distant areas thereof. This problem is often combined with that of counter slopes on the coast (seaside promenades built on what were once dune cordons) and the poor functioning of the coast-inland communication channels, associated with salt flats operations. These two factors make the evacuation of relatively modest river channels much more difficult, especially when these can generate considerable flow levels when filled by very intense precipitation over just a few hours.

In short, in the area we studied, as in other parts of the Mediterranean since the mid 20th century, sudden, accelerated territorial transformations in both qualitative and quantitative terms brought on by the expansion of beach tourism converted the coastal areas with the greatest risk of flooding (flood plains, inland deltas with active overflow channels or endorheic areas) into attractive spaces for frenetic urban development. This led to an increase in exposure and vulnerability to flooding.

Nonetheless, ever since the first master plans for flood defence were drawn up, the authorities have been promoting a series of proposals aimed at reducing the risk of flooding: (1) building dams for flood abatement; (2) hydrological/forestry recovery; and (3) establishment of special protection zones to limit urban expansion in high flood risk areas.

Improved signposting and police monitoring can also help to reduce the effects of floods on the population. In cases in which vulnerability to flooding is especially high, relocation should be encouraged.

Lastly and with regard to the reduction of ordinary floods, it is vital to stress the importance of increasing the capacity of the rainwater drainage system, as has already been projected in Benidorm in the "urban torrent" we studied.

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