



Comparing flood mortality in Portugal and Greece (Western and Eastern Mediterranean)



S. Pereira^{a,*}, M. Diakakis^b, G. Deligiannakis^c, J.L. Zêzere^a

^a Centre for Geographical Studies, Institute of Geography and Spatial Planning, Universidade de Lisboa, 1600-276 Lisboa, Portugal

^b Faculty of Geology and Geoenvironment, School of Sciences, National & Kapodistrian University of Athens, Panepistimioupoli Zografou, 15784 Athens, Greece

^c Mineralogy – Geology Laboratory, Department of Natural Resources Management and Agricultural Engineering, Agricultural University of Athens, 11855 Athens, Greece

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ABSTRACT

For the first time flood mortality is analysed and compared between a Western (Portugal) and an Eastern Mediterranean country (Greece). Flood fatalities are examined and compared in terms of frequency, temporal evolution, spatial distribution, deadliest flood types, gender of the victims, circumstances surrounding fatalities, and individual and societal risk.

A common flood fatalities database was formed for the period 1960–2010 by merging the DISASTER database for Portugal and the Greek database

Individual flood cases generated more deaths in Greece than in Portugal (excluding an outlier flash flood event in the latter). Despite some fluctuations evidence of a gradual decrease in fatality numbers were recorded for both countries. Since the 1980's the number of flood cases with multiple fatalities has been gradually declining, due to changes in qualitative characteristics of mortality. Flood fatalities predominantly occur during autumn in Greece and during winter in Portugal.

In both Greece and Portugal flash floods were responsible for more than 80% of the total mortality. The main metropolitan areas of each country were found to be hotspots of flood mortality; a trend connected, with the higher population density along the coastal areas combined with the expansion of urban fabric towards flood-prone areas.

Gender distribution of fatalities indicates that males are more vulnerable in both countries. The circumstances surrounding fatalities showed that fatalities occurring inside buildings have been gradually reducing in time, while vehicle-related deaths have been rising, showing that individuals hold an active role when they voluntarily enter in floodwaters during a flood.

1. Introduction

Flooding has been one of the most destructive natural hazards in the Mediterranean region, causing significant damages [1] and a noteworthy number of fatalities across Southern European countries on a yearly basis [2–6].

Flooding in the Mediterranean region can be mostly related to riverine flooding events in major rivers occurring mostly during autumn and winter months [6,7] as well as flash floods that typically occur during autumn in small watersheds and urban areas triggered by high-intensity rainfall [8–10]. Flash floods are responsible for important human losses [6,8], as they are characterized by rapid increase in flood discharge and short warning times. Moreover, within the context of climate change and the expected increase in extreme precipitation events in the Mediterranean [11–13], risk exposure to human life in the

region may increase even further.

There is a wide body of literature analysing the effects of flooding to human health [14,15] and particularly regarding direct mortality, examining risk factors concerning the victims and the environmental circumstances of flood-related accidents [16–23]. Comparative studies on mortality are difficult to perform due to the lack of common flood mortality databases, common terminology, risk factors analysed and common sources of mortality data [24]. For instance features on fatalities caused by floods can be found in natural hazard databases (e.g. EM-DAT, SICI, DISASTER) based on documentary sources [9,24–26], demographic statistics, death certificates from hospitals, civil protection authorities and non-governmental agencies.

In the case of natural hazards databases there are some constraints related with the inclusion criteria of mortality data. For instance, the Emergency Events Database (EM-DAT) only records natural disasters

* Corresponding author.

E-mail address: susana-pereira@campus.ul.pt (S. Pereira).

that have caused at least 10 fatalities while national databases usually include flood occurrences that caused fatalities regardless of their number [25–28]. Global databases such as EM-DAT and the Natural Hazards Assessment Network (NATHAN) of the Munich Re are useful to identify catastrophic events, but must be carefully used when regional or local studies are developed because great part of the recorded events, for instance in the Mediterranean countries, are not included [29]. Documentary sources have been used before to complete and improve flood catalogues. The use of archives (e.g. press) as data source to collect mortality data usually creates some limitations about data reliability, which are well described in the relevant literature [30]. Despite these concerns, databases on natural hazards can improve data quality and completeness for the study of mortality in terms of temporal trends, spatial distribution, detailed descriptions and epidemiological characteristics.

Nevertheless, there is limited literature or initiatives on international reliable datasets in the field of floods [31] or in direct comparison of findings between national mortality studies, especially in the Mediterranean [28,32–34]. In the region, efforts have been made to create a common database on floods and on its societal impacts in the framework of the HYMEX project [28]. The HYMEX project database gathered flood data, including the number of casualties and circumstances related with the deaths, from four representative regions of the NW sector of the Mediterranean: Catalonia, Balearic Islands (Spain); Calabria (Italy); and Languedoc-Roussillon, Midi-Pyrénées and Provence-Alpes-Côte d’Azur (France) [28]. In addition, flash flood mortality in southern France was already explored [35,36] in the period 1988–2013 by analysing the demographics of victims (i.e. age, gender), the circumstances of fatal incidents, risk behaviours, as well as seasonal and spatial distribution of fatalities.

A holistic understanding of the way people become victims of flood phenomena could benefit from data aggregation across larger areas and comparisons between different countries [7]. That is because the impact of different practices and policies on protection from floods can be assessed only when a comparative approach and national programs to prevent flood fatalities are implemented. Moreover, differences or similarities in accident circumstances can lead to useful conclusions regarding particular influential factors such as the local climate, land use or risk exposure behaviours.

In this context, a comparison between two countries with a temperate Mediterranean climate located at the two edges of the Mediterranean would be useful in providing a more holistic understanding of the conditions of flood fatalities in the region, complementing the existing regional studies.

This work aims to explore and compare the most basic characteristics of flood mortality between a Western (Portugal) and an Eastern Mediterranean country (Greece), to identify and discuss similarities and to improve our understanding on the conditions under which flood fatalities happen in the region. The study explores and compares: (i) the frequency of fatalities; (ii) their temporal evolution (annual, seasonal and monthly distribution); (iii) their spatial distribution; (iv) the deadliest flood types; (v) the gender of victims; (vi) the circumstances surrounding fatalities; and (vii) the individual and societal risk.

2. Data and methods

2.1. Data collection

For the purposes of this study, a flood case is defined as a unique flood occurrence that, independently of the number of affected people, caused harmful consequences (e.g. casualties, injuries, missing, evacuated, or homeless people), and is related to a unique geographic location (overflowing of a river in a single basin) and a specific period of time. Therefore a single flood event can affect several catchments and generate several flood cases. Flood fatal incident is defined as an accident that occurred during the flood case that leads to the death of

people in the same geographic location.

For Greece, primary data on flood cases were based on the Flood Database developed for the period between 1880 and 2010 [27]. This catalogue contains data on the exact location, number of fatalities as well as the date of each event and was used as the basic record upon which additional information was aggregated. Scientific papers [37,38] and press articles based on police reports, stored in national newspaper databases such as the Digital Newspapers Collection of the Greek National Library and the Greek National Newspapers Archive of the Library of the Hellenic Parliament, were systematically searched for flood reports using related keywords and were used to obtain details about the victims and the explicit descriptions of each fatal incident. In total, 235 press articles were analysed, published in 12 national newspapers. Analysis of the flood fatalities under different aspects was published in previous works [5,39,40]. Flood mortality data is considered complete for the period 1960 onwards.

In Portugal, mortality patterns of disastrous floods that occurred in the last 150 years were recently explored at national scale [6]. Flood cases that caused societal impacts (fatalities, injuries, missing people, evacuated and homeless people) independently of their number, were collected and formed the DISASTER database for the period of 1865–2010 [26]. The DISASTER database is the only database containing detailed data on the societal impacts of hydro-geomorphologic disasters (floods and landslides) in the country. A set of 11 newspapers (3 daily national newspapers and 8 weekly regional and local newspapers) was systematically surveyed in a day by day basis for data collection for the period 1865–2010 in order to find flood cases. Further details on data collection process can be found in previous works [6,26]. Each flood case includes details on the disaster characteristics and damages [26]. The first includes data on type (flood or landslide), subtype, date of occurrence, location, and triggering factor. The second includes structural damages (in buildings and road or railroad networks) and societal consequences (human damage, gender of fatalities, and circumstances surrounding the fatalities). The DISASTER database is considered complete for the period 1936 onwards.

Both Greek and Portuguese databases include all deaths that were immediately and directly attributable to a flood case. Long-term health effects and casualties caused by flood disasters are not examined in this work due to lack of available data.

This study analyses mortality in the period 1960–2010, within which the overlapping record is considered complete and reliable for both Portugal and Greece.

2.2. Methodology

A common flood fatalities database was formed by merging the two existing databases of Portugal and Greece. Each entry of the database, corresponding to a fatal incident with several attributes provides a detailed description including:

- the ID number of the flood case;
- the flood type (riverine flood, flash flood, urban flood, or not defined type);
- the date of the fatal incident (day-month-year);
- the location of the flood case (x and y coordinates)
- the number of fatalities;
- the gender of the victim (male, female, or gender not reported);
- the surrounding environment where the flood fatal incident occurred (i.e. outdoors on foot, outdoors inside a vehicle, or inside a building).

Flood type identification was based on the newspapers reports. Flash floods identification was obtained from reports describing short duration and intense precipitation events (normally less than 24 h) that affected small river catchments and with low concentration times. In some cases, rainfall data was consulted to elucidate doubts about the

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