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Temporal and geographical variation of geo-hydrological risk to the population of Italy.

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ABSTRACT: In Italy, landslides and floods are widespread, recurrent and dangerous phenomena. Using an historical catalogue of landslide and flood events with human consequences, we assessed individual and societal geo-hydrological risk levels in Italy. The historical catalogue covers the period from AD 68 to 2011 and list information on 6,345 landslide and flood events that caused more than 60,000 casualties. In the 7-year recent period 2005-2011 all the 20 Italian Regions have suffered at least one landslide or flood event with casualties. These figures indicate that geo-hydrological risk to the population is severe and widespread in Italy. In this country, establishing landslide and flood risk levels is therefore a problem of both scientific and societal interest. To study individual landslide and flood risk, we determined mortality, measured by the number of fatalities per 100,000 people in a period of one year, and we used census data to estimate the geographical and temporal variation of landslide and flood mortality in the 150-year period 1861-2010. The results of this study are significant for the quantification of the risk posed by natural hazards to the population of Italy.

Keywords: Individual risk, Landslide, Flood, Natural catastrophes

1. INTRODUCTION

Italy has a long history of climatically induced natural catastrophes (Guzzetti 2000, Guzzetti *et al*. 2004, 2005). Inundations and landslides in Italy are frequent and have a significant societal and economic impact. Increasing population density and the development of public and private buildings and of social and economic infrastructures could increase the amount of direct damage to people during geo-hydrological events, including those of limited extent and intensity. Detailed information exists on the damage caused by floods and landslides to the population in Italy that clearly show how the impact of geo-hydrological events on people is more a matter of social than scientific interest.

During various research activities we have conducted, first for the GNDCI (Gruppo Nazionale Difesa Catastrofi Idrogeologiche) and then for the National Department of Civil Protection, we have collected, organized and analyzed information on the impact that landslide and flood events have on the population in Italy. Using a wide range of information sources, including the historical and archival sources and Internet-based resources, we have recorded 3,560 landslides and 2,785 floods that occurred between the year 68 A.D. and 2011, and we have carefully identified 5,061 affected sites. Taken as a whole the landslide and flood events in the historical catalogue have resulted in 60,000 casualties and 915,000 homeless and evacuees, a number which is probably far less than the real figure.

The most recent portion of the catalogue (1861-2011), which we consider to be almost complete, has been utilized for the evaluation of different individual geo-hydrological risk levels and for the analysis of their geographical and temporal variation. In the same context we analyzed the geographical and temporal differences in the population density and we compared some demographic and social parameters available for Italy with the results obtained.

1.1 Glossary

In this work, we use the term *fatalities* to indicate the sum of the deaths and the missing persons caused by a harmful event. *Casualties* indicate the sum of fatalities and injured people. *Evacuees* were people forced to abandon their homes temporarily, while the *homeless* were people that lost their homes. *Human consequences* encompass casualties, homeless people and the evacuees. A *fatal event* is an event that resulted in fatalities. *Individual* risk is the risk imposed by a hazard to any unidentified individual.

2. RISK EVALUATION

Risk assessment is the final objective of many landslide and flood investigations and it involves different disciplines such as science, technology, economics and politics. Quantitative landslide and flood risk assessment can be used to determine the risk posed by landslides and floods to identified individuals or to the population as a whole (Fell and Hartford, 1997; Evans, 1997; Guzzetti, 2000; Wise *et al*., 2004; Nicol, 2004; Guzzetti *et al*., 2005b,c) and to compare the risk levels with other natural, technological and societal hazards for which acceptable risk levels have already been established (e.g., Fell and Hartford 1997; Salvati *et al*., 2003; Guzzetti *et al.*, 2005b).

2.1 Individual Risk

Individual risk levels are measured by mortality (or death) rates, which are given by the number of fatalities in a population, scaled to the size of the population, per unit of time. In Italy individual risk levels exist for different natural hazards and it is defined as the number of fatalities per 100,000 people in a period of one year. (Guzzetti 2000, Guzzetti *et al.* 2005a,b, Salvati *et al.* 2011).

Table 1 compares individual risk posed by different hazards and the variation of mortality with time at national scale. We calculated the average mortality rates for different periods: 1860-1900; 1901-1940; 1941-1980;1981-2010. From 1861 to 1980 earthquakes were the events that caused the highest number of fatalities and that shows the highest values. Since 1980 the trend has changed: landslide mortality has overtaken earthquake mortality, with 961 fatalities due to landslides, and 373 due to earthquakes. After 1980 few earthquakes occurred in Italy and when they occurred they did not caused a large number of fatalities. Starting in the 1970s on, laws and rules have been enacted by Italian lawmakers to reduce building vulnerability and, as consequence, reduce the number of fatalities due to total collapse of buildings. New buildings have been built with seismic design requirements according to seismic codes and criteria. Adaptation and renovation of old buildings were also made. Unlike for earthquakes, very few information is available on building and infrastructure vulnerability for geo-hydrological hazards.

Table 1: Mortality rates for different natural hazards

Periods	Flood	Landslide	Earthquake	Vulcanos
1860-2011	0.050	0.080	2.310	0.005
1860-1900	0.040	0.041	0.288	0.000
1901-1940	0.095	0.068	8.286	0.017
1941-1980	0.054	0.167	0.181	0.002
1981-2010	0.018	0.054	0.021	0.000

A limitation of mortality rates lies in the fact that they depend on the size of the population with which they are associated. To better understand the temporal variation in mortality it is necessary to know where and how large the population increase has been.

2.2 Demographic information

To calculate mortality, information on the number of fatalities and on the size of the population per year is required. In Italy information on the size of the population and its temporal and geographical variation is available from the general censuses that have been carried out by the Italian National Institute of Statistics since 1861. In this 150-year period, the Italian population has almost tripled from 22.2 to 60.3 million and the population density has increased from 87 inhabitants per square kilometer in 1861 to 200 inhabitants in 2009. The increase was largest in the plains, moderate in the hills and lowest in the mountains. Together with the increase in the population there has been a large increase in the number of infrastructures and public and private buildings. In 1861 only about 16% of today's rail network had been built and in 1930s there were only 4% of today's major roads. (http://seriestoriche.istat.it/)

3. LANDSLIDE AND FLOOS MORTALITY

Estimates of landslide and flood risk levels for Italy exist for different periods and were carried out at different administrative and physiographical scales (Guzzetti et al 2005, Salvati et al. 2003, 2010, 2011).
Given the strong connection between climate and hydro-geological events, for this study we examined mortality on the basis of a climatic subdivision already available for Italy shown in Figure 1A.
To classify the Italian territory we used the Pinna Modified Köppen climatic classification of Italy (Rivista Geografica Italiana 1970). In the Köppen system all climates that are not dry and have a mean temperature between -3 °C and +18 °C in the coldest month are classified as mild mid-latitude climates, or temperate climates, and are marked with the letter C in Table 2. Most of Italy falls within the C Class which therefore includes both areas subject to freezing, such as the Po Valley and much milder areas like those of the Mediterranean coast.
Using the Italian population data at a municipal scale, we analyzed the increase in the population and in the population density in each climatic area since 1861. Population density was used because the climatic areas have very different geographical extent (Figure 1. B). The highest increase was registered for the CS (sub-tropical temperate climate), for which the density increased from 170 inhabitants per square kilometre to 450 in 2011. This area includes small part of the coastal area of southern Italy, where in the last 50 years a large increase in tourism has occurred. A very similar trend was found in the Cfa (temperate with warm summers climate), which encompasses most of the largest and most industrialized plains of Northern Italy. However, the mountain areas of Northern Italy that comprise the Cfc (continental temperate climate), the Dw (cool temperate climate), and the H (high-altitude climate), regions show very little increase.

Table 2: Italian climatic classification

Koppen Code	Pinna description	Koppen System
CS	Sub-tropical temperate climate	C - mild mid-latitude; S - Steppe
Csa	Warm temperate Mediterranean climate	C - mild mid-latitude; s - dry season in summer; a - warmest month above or equal to22° C
Csb-Cfb	Temperate Mediterranean sub-coastal climate	C - mild mid-latitude; s - dry season in summer /f constantly moist; b - warmest month below 22° C
Cfsa	Transition Temperate Mediterranean to temperate sub-continental climate	C - mild mid-latitude; f/s - transition to constantly moist and dry summer; a - warmest month above or equal to22°C
Cfa	Temperate with warm summers climate	C - mild mid-latitude; f - constantly moist; a - warmest month above or equal to22°C
Cfc	Continental temperate climate	C - mild mid-latitude; f - constantly moist; c – less than four months over 10°C
Dw	Cool temperate climate	D – cold mid-latitude climates; w– dry season in winter
H	High-altitude climate	H – for highland climates
EFH	Permanent snow	E – for polar climate; F – polar frost

3.1 Mortality Rates comparison

Using yearly information of the population of each climatic subdivision we calculated the yearly landslide and flood mortality rates, the corresponding average values for three periods of fifty years each (1861-1910, 1911-1960, and 1961-2011) and analyzed their temporal variation.

Analysis of the histograms of Figure 1 C allow us to make some observations: the highest mortality values for both landslide and flood events were registered in the period 1911-1960, even though the increase in the population density was highest in this period. This means that proportionally during this period the fatalities have increased more than the population. In the period 1961-2011 a general decrease in mortality rates was recorded, with the exception of Dw (cool temperate climate) of the Alpine region. This general decrease in mortality, which might be due in part to the increase in the population is also related to the decrease in the number of fatalities.

For the same three periods we have defined the mean annual number of harmful events per year in each climatic area since 1861. In the histograms of Figure 1 C black curves show that the mean annual number of fatal landslide events per year strongly increased in Italy in the period 1910-1960. In the period between 1961-2011 there was a slight increase in mortality for the following classes: Csb/Cfb, Csa, Dw and a slight decrease for the classes Cfc, Cfa, Cfsa, CS. Similarly the mean annual number of fatal flood events per year strongly increased in Italy in the period 1910-1960 and slightly decreased (Cfc, Csa) in the period 1961-2011. This means that, in general, the number of harmful geo-hydrological events has increased in time, although the trend could be related to a larger number of information available after 1900s. The area where both mortality rate and the mean annual number of event decrease both for landslide and flood corresponds to Cfc climate that comprises the high altitude zones of Pre-Alpine and the Apennines. Here precipitation are frequent especially in autumn and spring but can be abundant also in the summer. This decrease could be related to a variation in the triggering factors. In Dw (cool temperate climate) of the Alpine region the mortality has a different behaviour. In the period between 1911-1960 the lowest value was found both for landslides and floods. We relate this behaviour to tourism and to the high increase of people who practice mountain sports in summer, the humid season with intense precipitation in this area, rather than to climatic variations.

4. ADDED VALUE TO INTEGRATIVE RISK MANAGEMENT

We think our study can improve the understanding of the risk posed by natural hazards to the population of Italy. The findings provide information for comparing the risk levels posed by natural hazards with the risk posed by other societal and technological hazards, including the leading medical causes of death in Italy (Guzzetti *et al.* 2005b). This could be very helpful to define levels of geo-hydrological risk perceived and accepted by society in Italy. Our study further provides the rationale for establishing insurance against different natural hazards.

5. CONCLUSIONS

We used a historical record of landslide and flood events with human consequences to update the estimates of the individual landslide and flood risk in Italy and to compare them with the other natural risk levels available for the period 1861-2011. Given the strong connection between climate and hydro-geological events, we examined mortality on the basis of a climatic subdivision available for Italy and we discuss the differences obtained for the various climatic areas. The highest mortality values for both landslide and flood events were registered in the period 1911-1960, when numerous and very intense hydro-geological events occurred in Italy causing many damages to the population. The analysis has shown that trends in mortality rates are similar in almost all climatic zones.

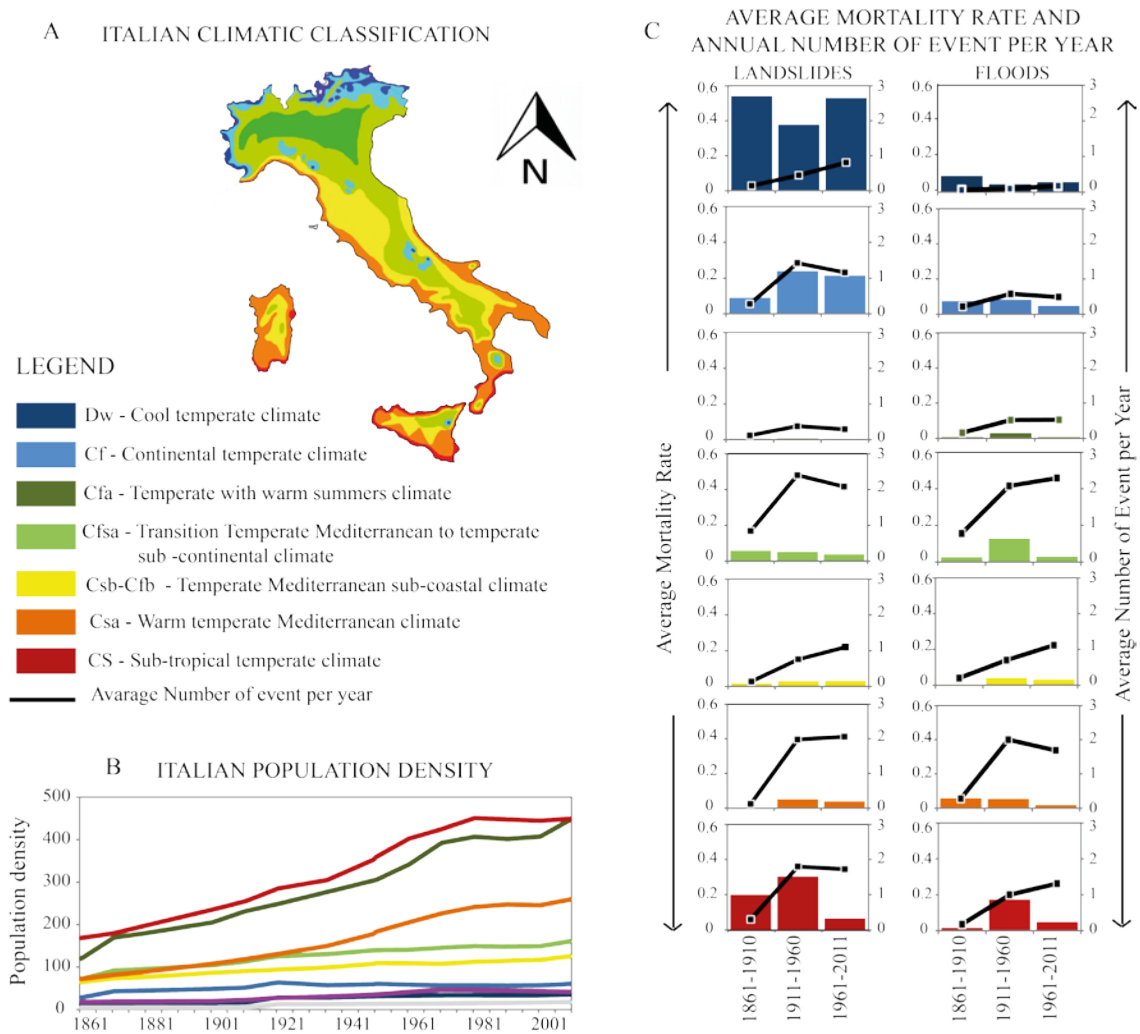

Fig. 1 Comparison between the average mortality rate and average number of event per year (C) related to the population density (B) in different climatic areas (A) in Italy

6. REFERENCES

Evans, Stephen G (1997) Fatal landslides and landslide risk in Canada. In: Cruden, D.M. and Fell, R. (eds.) Landslide risk assessment, A.A. Balkema Publisher, Rotterdam, 185-196.

Fell, Robin; Hartford Does (1997) Landslide risk management. In: Cruden, D.M. and Fell, R. (eds.) Landslide Risk Assessment, A.A. Balkema Publisher, Rotterdam, 51-109.

Guzzetti, Fausto (2000). Landslide fatalities and the evaluation of landslide risk in Italy. Engineering Geology, 58, 89-107.

Guzzetti, Fausto; Tonelli, Gabriele (2004). SICI: an information system on historical landslides and floods in Italy. . Natural Hazards and Earth System Sciences, 4:2 213-232.

Guzzetti, Fausto; Stark, Colin P.; Salvati, Paola (2005a). Evaluation of flood and landslide risk to the population of Italy. Environmental Management, 36, 15-36.

Guzzetti, Fausto; Salvati, Paola; Stark, Colin P. (2005b). Evaluation of risk to the population posed by natural hazards in Italy. In Hungr, Oldrich; Fell, Robin; Couture, Réjean; Eberhardt, Erik (ed.), Landslide Risk Management, 381-389, Taylor & Francis Group, London.

Pinna, Mario (1970). Contributo alla classificazione del clima in Italia. Rivista Geografica Italiana, 77 (2), 129-152.

Salvati, Paola; Bianchi, Cinzia; Rossi, Mauro; Guzzetti, Fausto (2010). Societal landslide and flood risk in Italy. Natural Hazards and Earth System Sciences, 10, 465-483.

Salvati, Paola; Bianchi, Cinzia; Guzzetti, Fausto (2011). Flood risk in Italy. In Z.W. Kundzewicz (ed.), Change in Flood risk in Europe, 277-291 CRC Press Taylor & Francis Group, A.Balkema Group.

Wise, Mike; Moore Glen; Vandine Doug (2004). Chapter 2: Definitions of terms and framework for landslide risk management. In Wise et al. (eds.) Landslide Risk Case Studies in Forest Development Planning and Operations. B.C. Ministry of Forests, Forest Science Program, 56, 5-11.

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