

Extreme Weather and Human Health in Italy



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Abstract Italy is a very fragile country due to its recent geological formation. Frequent earthquakes and volcanic phenomena create situations of danger with a large number of victims. Moreover, earthquakes are sudden and unpredictable, and many structures and houses have not been built with earthquake-proof constructions. The situation is getting worse and worse due to climate change, which leads to irregularities in precipitation and temperatures. Some consequences of this situation are landslides and floods, which, on the other hand, involve the whole country. Therefore, the watercourses break their riverbeds causing floods and landslides, which the lack of vegetation cover makes frequent and dangerous.

Keywords Italy · Climate change · Earthquakes · Floods · Landslides · Health

1 Introduction

Climate change has a significant impact on Italy for the following reasons: (i) the extent of the country in latitude, (ii) the geological and morphological constitution, with relatively recent ridges, (iii) immersion in the Mediterranean, of which receives strong and changing influences. The consequences of these peculiarities are strong variations in temperature and precipitation in the same season and year by year, which produce floods and landslides throughout the territory. Many buildings are destroyed and many lives are lost. According to ISTAT (Italian Statistical Institute 2010) in the decade 2000–2009, the average annual temperature, equal to 13.3 °C, was higher by 0.8 °C compared to the climatic period 1971–2000.¹ Also the maximum temperature (18.0 °C) and the minimum temperature (8.5 °C) were higher than their respective climatic values of 0.9 and 0.6 °C, respectively. In all the years of the decade, with the exception of 2005, the average, maximum and minimum temperatures recorded climatic values always higher than the reference ones. In the decade 2000–2009,

¹The data of period considered are the more recent available.

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the average annual precipitation was 763 mm, with 30 mm of rain less than the climatic value of the period 1971–2000. The least rainy year was 2001 with 189 mm of deviation from the climatic value, while the wettest one 2002 with 88 mm more. Precipitation not only they differ between the north and south of the country, but above all present oscillations in the amount of annual rainfall fallen to soil, which is the most worrying aspect of the phenomenon, because in every territory it is necessary to manage years of heavy rainfall and years of strong water shortage, resulting in increased risk of landslides and floods in the first case and water shortages and droughts in the second. In Valle d’Aosta, for example, has gone from 1894 mm of precipitation in 2000 to 520 in 2005, while in Sardinia from 668 mm in 2004 to 351 of 2001. It should be noted that due to climate change not only temperature and rainfall differ from previous periods. In addition, the alternation of high and low temperatures, and high and low rainfall is rapid. Therefore, it is important to consider the short duration of the so-called good and bad weather (Fig. 1).

Exploitation of the territory, lack of interventions and climate change put more and more people in a dangerous situation. To date, seven million citizens live in areas at risk—a number that could increase in the future. In Italy, there are seven million people living under the threat of hydro-geological instability with the nightmare of landslides and floods. A constant threat is caused by years of wild building speculation, land consolidation and interventions that remain stationary and blocked by bureaucracy and appeals. And the future risks being already marked, with an exploitation of the territory that continues inexorable, while meteorological events are becoming increasingly violent and sudden.

1. Heat waves

Heat waves are another risk to human health due to high temperatures. In the summer of 2015, the statistics found in 21 Italian cities, 13% of deaths of people over 65 years of age are attributable to the heat. The deaths of individuals between 65 and 74 years

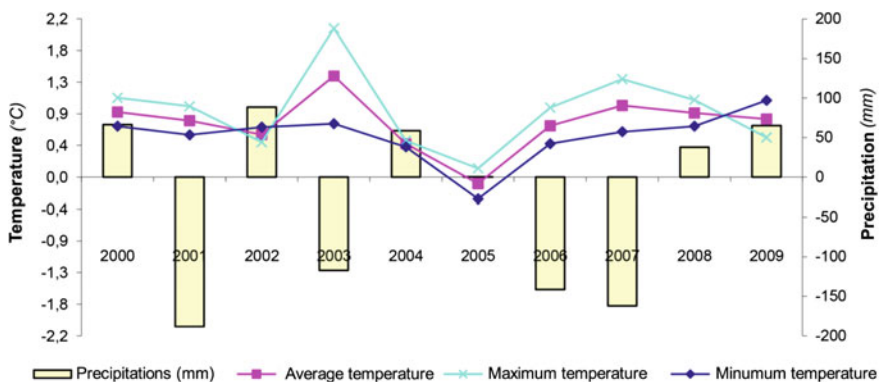


Fig. 1 Deviation of average, maximum and minimum temperature and total precipitation from the climatic value in Italy. Years 2000–2009 (temperature in degrees Celsius and precipitation in millimeters)

of age were 305 (9%), of individuals between 75 and 84 years of age were 791 (11%) and individuals of over 85 years of age there were 1559 (15%) (<http://www.salute.gov.it/caldo>).

2. Floods occurred in Italy between 2000 and 2017

Floods are a rather common phenomenon in Italy, with the loss of buildings and human lives. This phenomenon is due to the irregularity of the rains, the hydrographic regimes and the construction of houses too close to the waterways. Many homes are illegally built in areas subject to flooding (Table 1).

In total, 189 were dead and 12 were missing. But we have to consider that in many cases houses and constructions (roads, railways, bridges, etc.) were destroyed. Many families were evacuated and lost their properties. The most severe damages of constructions and infrastructures were suffered by the population of Genoa, Liguria, Province of Alessandria and Milan on November 15, 2014: in Province of Alessandria, 238 mm of rain had fallen in a day. On May 3, in the commune of Senigallia, the waters and the mud of the River Misa covered the streets up to 3 meters up to the first floors of the buildings. On November 18, 2013, in Sardinia the rivers Cedrino and Posada flooded the village of Torpè with over 3000 cubic meters per second. On October 25, 2011, 520 mm of rain had fallen in 6 h in Lunigiana. In the same year 2011, on 11 June, the damages amounted to 7,200,000 Euros for individuals and businesses and about 450,000 Euros for public damages. About 185 families and 50 productive slabs were affected. Other extraordinary events have to be registered in Vibo Valentia (on July 3, 2006), in Province of Massa Carrara (on September 23, 2003), in Piedmont, Valle d'Aosta and Lombardy because of the Po flooding (on October 13–16, 2000) and in Soverato (Calabria) 441 mm of rain had fallen and 150 km of coast between Catanzaro and Reggio di Calabria were devastated by bad weather. The worst years were 2014, 2011 and 2000. Perhaps, this is an evidence of climate variability.

The resident population exposed to flood risks in Italy is equal to 2,062,475 inhabitants (3.5%) in the scenario of high hydraulic danger (return time between 20 and 50 years), 6,183,364 inhabitants (10.4%) in the scenario of average danger (time return between 100 and 200 years) and 9,341,533 inhabitants (15.7%) in the scenario of low probability of floods or scenarios of extreme events. The regions with the highest values of allotropic risk population in the medium hydraulic hazard scenario are Emilia-Romagna, Tuscany, Veneto, Lombardy and Liguria.

The families at risk of floods in Italy are 2,648,499 (10.8%) in the medium hydraulic hazard scenario. Emilia-Romagna, Tuscany, Veneto, Lombardy and Liguria present the highest number of families and flood risk in the scenario of average hydraulic hazard. The regions of Emilia-Romagna, Tuscany, Veneto, Lombardy and Piedmont present the highest number of buildings at risk of flooding in the scenario of average hydraulic danger.

The buildings at risk of floods in Italy are 1,351,578 (9.3%) in the scenario with medium hydraulic hazard. The regions of Emilia-Romagna, Tuscany, Veneto, Lombardy and Piedmont present the highest number of buildings at risk of flooding in the scenario of average hydraulic danger.

Table 1 Floods occurred in Italy between 2000 and 2017

Date	Geographical area	Dead
September 9–10, 2017	Livorno and Pisa	8
January 24, 2017	South Italy and Islands	1
September 14, 2015	Emilia	3
November 15, 2014	Genoa, Liguria and Milan	1
November 10, 2014	Liguria	2
October 14, 2014	Tuscany Maremma	2
October 9–10, 2014	Genoa	1
August 2, 2014	Prov. of Treviso	4
May 3, 2014	Prov. of Ancona	1
January 19, 2014	Prov. of Modena	1
November 18, 2013	Sardinia	18
November 12, 2012	Prov. of Grosseto	6
November 11, 2012	Prov. of Massa e Carrara	1
November 22, 2011	Prov. of Messina	3
November 4, 2011	Genoa and province	6
October 25, 2011	La Spezia and Lunigiana	13
June 11, 2011	Prov. of Parma	1
March 3, 2011	Marche and Romagna	5
November 1–2, 2010	Veneto	3
October 5, 2010	Prato and province	3
October 4, 2010	Genoa and Savona	1
September 9, 2010	Costiera Amalfitana	1
October 1, 2009	Province of Messina	36
July 18, 2009	Province of Belluno	2
October 22, 2008	Province of Cagliari	5
May 29, 2008	Villar Pellice (Turin)	4
April 30, 2006	Naples	4
July 3, 2006	Vibo Valentia	4
September 23, 2003	Prov. of Massa Carrara	2
September 8, 2003	Prov. of Taranto	2
August 29, 2003	Prov. of Udine	2
November 6 and 23, 200	Prov. of Imperia and Savona	7
October 13–16, 2000	Piedmont, Valle d'Aosta, Lombardy	23 + 11 missing
September 9, 2000	Soverato (Calabria)	13 + 1 missing

There are 31,137 (15.3%) flooding cultural assets in Italy in the medium hydraulic hazard scenario and reach 39,426 (19.4%) assets in the low-priced scenario. The highest number of cultural assets at risk in the medium hydraulic hazard scenario is recorded in Emilia-Romagna, Veneto, Liguria and Tuscany. Among the municipalities with the highest number of cultural assets at risk of flooding in the scenario of average danger are the cities of art of Venice, Ferrara, Florence, Genoa, Ravenna and Pisa. For the protection of cultural heritage, even the scenarios of low probability of occurrence assume particular importance, considering that in the case of event the damages to the cultural heritage would be priceless and irreversible.

In Fig. 2, the population at risk landslides is highlighted. The populations most affected are those of the Po Valley, as these lands are affected by major Italian waterways such as the Po and its tributaries. In ancient times and even in very recent times, the Po is overflowing, given its nature as a hanging river, i.e. the watercourse flows above the lands crossed. Another population at risk is the one that resides in the areas crossed by the Arno. The flood of the Arno in Florence in 1966 is very well known, when not only houses were damaged, but also a part of the artistic and book heritage. Another area damaged by the floods is that of northeastern Sardinia, where the mouths of the rivers are often invaded by marine waters. The Rome region is also subject to floods due to the presence of surface and underground rivers. The capital itself is often flooded in the streets, because the sewage system does not receive enough rainwater. The same applies to Naples and its region. For decades, Italy has been the victim of floods, even with deaths, but successive governments have done almost nothing to alleviate the health conditions of the population.

3. Landslides in Italy

Italy is one of the most affected by landslides countries with 629,808 landslides on an area of 23,700 km², equal to 7.9% of the national territory. About a third of the total landslide is due to rapid kinetic phenomena (collapses, rapid mud and debris flows, characterized by high speeds, up to a few meters per second, and by high destructiveness, often with consequences in terms of loss of human lives. One of the first Italian geographers who dealt with landslides was Roberto Almagià in the early twentieth century (Almagià 1907, 1910). The most recent study is that of Walter Palmieri in January 2004, with a good bibliography (https://www.researchgate.net/publication/259358789_La_storia_delle_frane_in_Italia_e_gli_studi_di_Roberto_Alماجيا_2004 (author Palmieri W)). The population at risk of landslides in Italy, residing in high and very dangerous areas, amounts to 1281,970 inhabitants, equal to 2.2 of the total. Campania, Tuscany, Emilia-Romagna and Liguria have the highest values of population at risk landslides. The families at risk in areas of high and very high landslide danger are 538,034, equal to 2.2% of the total.

The cultural heritage at risk of landslides in Italy totaled 37,847, equal to 18.6%. The highest number of cultural heritage sites with high and very dangerous landslides can be seen in Tuscany, Marche, Emilia Romagna, Campania and Liguria. Numbers are the historical *borghi* affected by landslides triggered or reactivated even in recent years, such as the cliff of San Leo (Rimini) Volterra (Pisa) and Civita di Bagnoregio

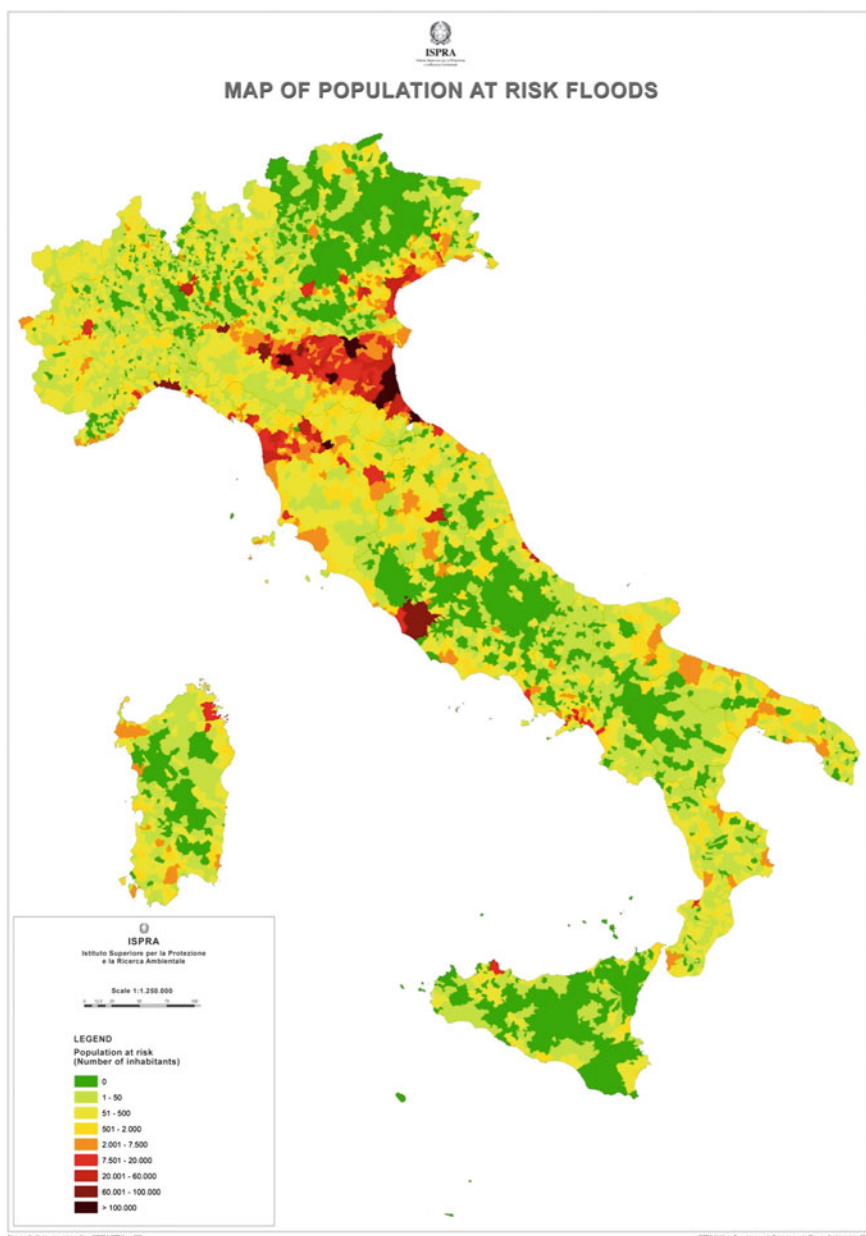


Fig. 2 Map of population at risk floods in Italy. *Source* ISPRA

(Viterbo). In recent decades, several historic centers have been the object of consolidation and reduction of hydrogeological risk, such as in Certaldo (Florence), Todi (Perugia) and Orvieto (Terni).

Buildings at risk in areas of high and very high landslide hazards are 550,723, equal to 3.8% of the total. The regions with the highest number of buildings at risk of landslides in areas of high or very high danger are Campania, Tuscany, Emilia-Romagna and Calabria: On a provincial basis, the provinces of Salerno and Genoa have the highest number of buildings at risk of landslides (ISPRA 2018).

It should be noted that the fragility of the Italian territory for geological, hydrographic and morphological reasons is accentuated by the work of a man who has built houses often abusive in areas at risk, such as in areas near the waterways or even building roads burying the waterways. Even the buildings built at the foot of the ridges are at risk (Table 2).

In Fig. 3, areas with the greatest danger of landslides are highlighted. Compared to the most frequent floods in the plains, landslides are prevalent in mountainous and hilly areas and therefore very intensely distributed throughout the national territory. They constitute the greatest danger especially in winter when they are caused by heavy rains and copious snowfalls. The major problem, besides the instability of the climatic events, is also the improvidence of the man who built in unsuitable land, with unsuitable materials and deforestation, which is no longer able to retain the geologically recent lands.

2 Conclusion

Italy's fragility is due to two essential factors: (i) the frequency of earthquakes and (ii) the irregularity of the rains. Moreover, in the consequence of climate change, temperatures and rains with sudden changes accelerate the frequency and danger of landslides and floods. Added to this is that not only earthquakes but also landslides and ravines are unpredictable and this causes damage to people and property. In recent years, the damages are more considerable.

The latest governments have paid more attention to emergencies than to forecasts, especially since many administrators do not believe in climate change and that often governments lack the ability to make long-term projects.

Not only that but often the controls are not constant or accurate as happened at the recent collapse of the Genoa Bridge. The privately owned motorway company that manages the network does not effectively control the infrastructure nor it is controlled in turn by the responsible ministry.

Table 2 Landslides in Italy 1964–2013 (50 years)

Region	Dead	Missing	Wounded	Total victims
Abruzzo	8	–	3	11
Basilicata	14	–	27	41
Calabria	38	–	150	188
Campania	289	–	410	699
Emilia-Romagna	49	–	79	128
Fiuli-Venezia Giulia	12	–	6	18
Lazio	23	–	81	104
Liguria	37	–	45	82
Lombardy	117	–	121	238
Marche	7	–	4	11
Molise	–	–	4	4
Piedmont	125	8	73	206
Puglia	12	–	4	16
Sardinia	12	–	25	37
Sicily	62	6	298	366
Tuscany	62	1	89	152
Trentino-Alto Adige	349	–	234	583
Umbria	12	–	31	43
Valle d'Aosta	25	–	27	52
Veneto	44	–	20	64
Total	1289	15	1728	3032

Source <http://polaris.irpi.cnr.it/cinquantaanni-di-frane-ed-inondazioni-in-Italia1964-2013>

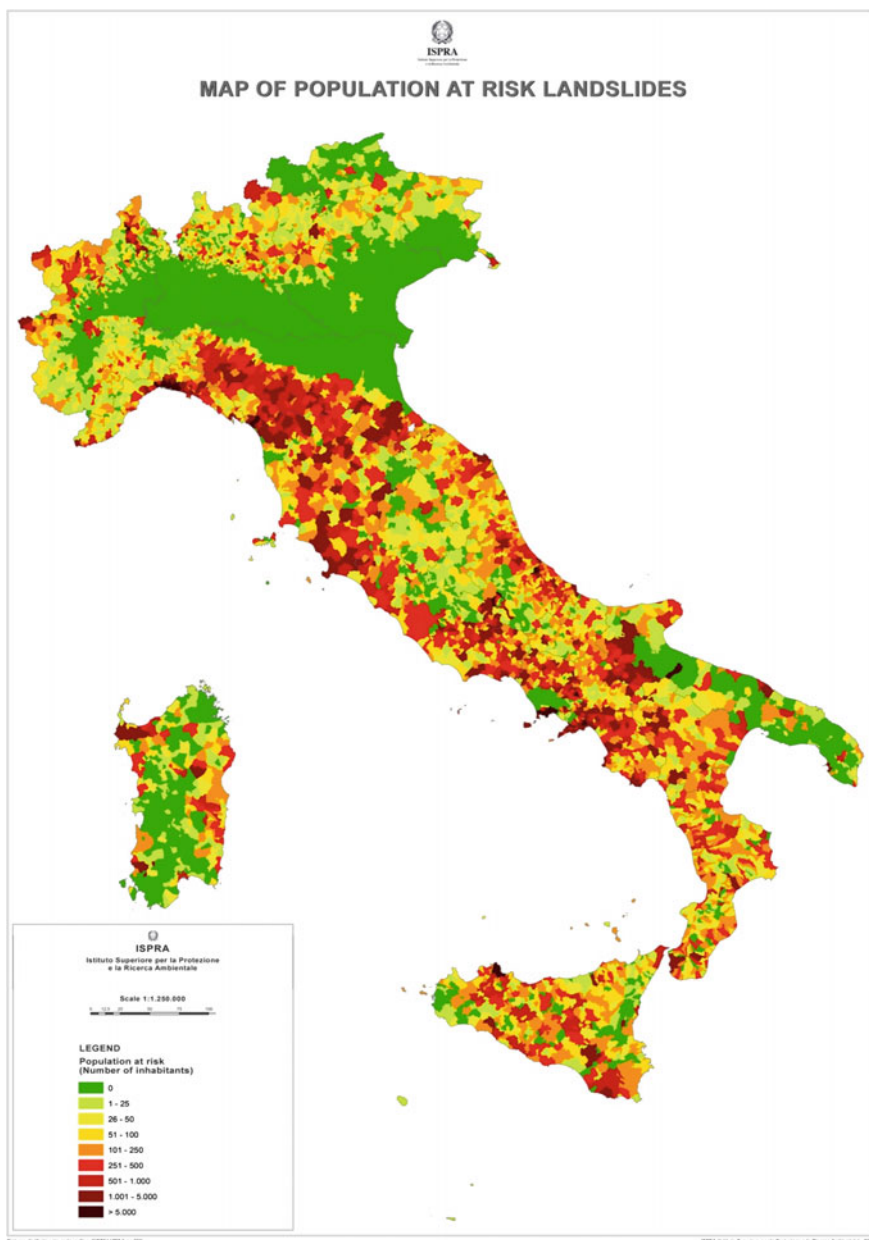


Fig. 3 Map of population at risk landslides in Italy. Source ISPRa

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