5. ENVIRONMENTAL RISK

Introduction

Risk consists of the expected number of human losses and injuries, property damage and shutdowns of services or economic activities resulting from a given event of natural or anthropic origin.

The term risk is often used as a synonym of the likelihood of a loss or a hazard. In technical terms, risk represents the expected number of human losses and injuries, damage to property, shutdowns of services and economic activities, as a result of a specific event of natural origin or one caused by human activity. As a rule, risk is expressed as the product of three parameters: R = P x V x E, where P indicates the level of hazard, V the vulnerability and E the value exposed. The level of hazard is the probability that a given event will occur at a certain intensity in a given area and within a certain interval of time. Vulnerability expresses the capability of manmade works and environmental resources to resist a given calamitous event. Exposure expresses the value of the full set of elements at risk (human lives, infrastructures, historic, architectonic, cultural and environmental resources) inside of the area exposed.

In the present analysis of the problems tied to Risk, it has been decided to subdivide the topic into two parts: Natural Risk and Anthropogenic Risk. This approach is taken because, though there exist connections between natural risk and that caused by human activity, the topics treated herein present distinctive characteristics that deserve to be addressed separately. It should be noted that this chapter shall address the components of natural risk that directly involve the geo-sphere and the components of anthropogenic risk that regard industrial activity.

5.1 Risk of Natural Origin

The natural evolutionary processes of the territory, the soil and subsoil, interacting with human components (population, inhabited zones, infrastructures, etc.) frequently give rise to conditions of risk. Natural risk is the expected damage to man and the environment following the occurrence of certain events that can be subdivided into two main categories of underlying causes: events of endogenous origin, meaning those set off by forces within the earth, and those of exogenous origin, traceable to the action of forces that act on the external surface of the planet. Endogenous processes manifest themselves through volcanic and tectonic activity, while exogenous processes, often not necessarily tied to extreme meteorological events, operate on the terrestrial surface, tending to level the landscape through the erosion of elevations and the sedimentation of low-lying zones. Such actions (both endogenous and exogenous in nature), which include volcanic eruptions, earthquakes, landslides, floods (along riverbanks and coastlines), avalanches and accelerated erosion (of beaches and riverbeds), place the safety of individuals at risk, in addition to causing noteworthy damage to human infrastructures and settlements. The interaction between the natural events referred to above and activities of human origin is reciprocal, with the consequence that inappropriate modes of use and management of the territory frequently result in an amplification of the disturbances underway or in the triggering of new ones. This is especially apparent in the case of the deterioration of pedological coverings (soil, subsoil), which can compromise the functional efficiency of the soil (i.e. erosion from water, transformation to an impermeable state, compacting, salinisation, contamination) to the point of desertification, in addition to causing coastal erosion.

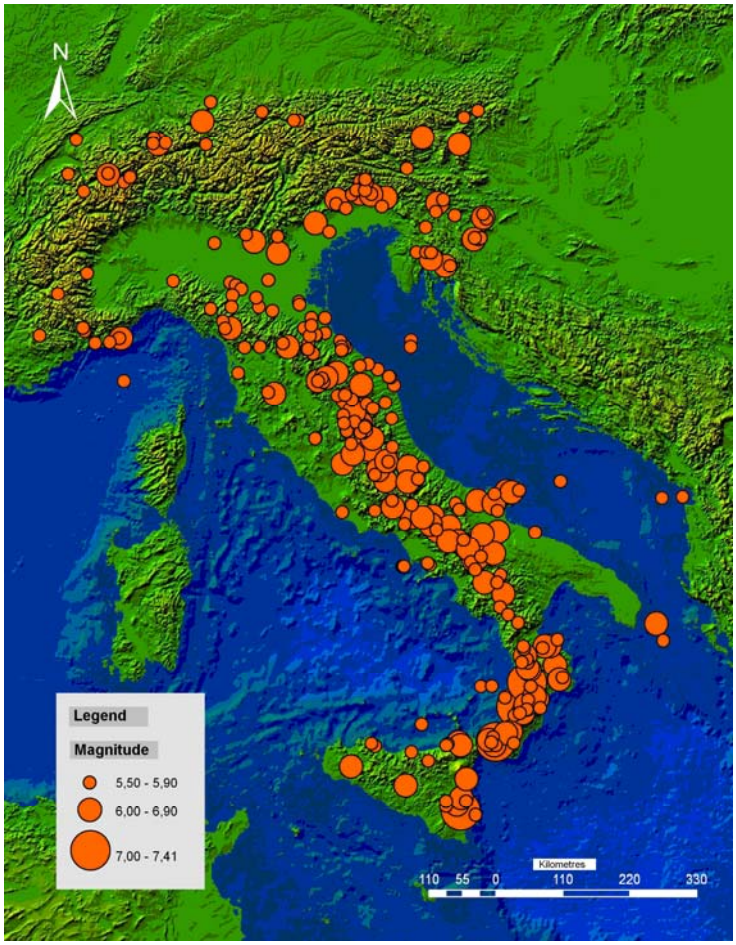
Natural risk manifests itself through the occurrence of events of endogenous origin (volcanic and tectonic activities) and of exogenous origin (erosion of elevations and sedimentation of low-lying areas), which events interfere with anthropogenic activities.

An inappropriate use of the territory by man may amplify disturbances underway or trigger new ones.

5.1.1 The situation

The specific location of Italian territory within the Mediterranean geodynamic setting (convergence of the European and African plates, interposition of the Adriatic micro-plate, opening of the Tyrrhenian basin) and the distinctive modes of surface response to dynamics deep underground make Italy one of the countries facing the greatest seismic and volcanic danger in the area. The elevated seismic and volcanic hazard, combined with the widespread presence of exposed elements, (population centres, infrastructures, the architectonic, artistic and environmental heritage) and the noteworthy vulnerability of the same, creates conditions of high to very high risk for extensive sectors of Italian territory. The areas facing the greatest seismic risk are found in the Friuli sector, along the central-southern spine of the Apennine range, and especially in the sectors of the inter-Apennine basin, along the Calabrian edge of the Tyrrhenian and in southeast Sicily (Figure 5.1).

Italy faces one of highest levels of seismic and volcanic hazard of any European country.

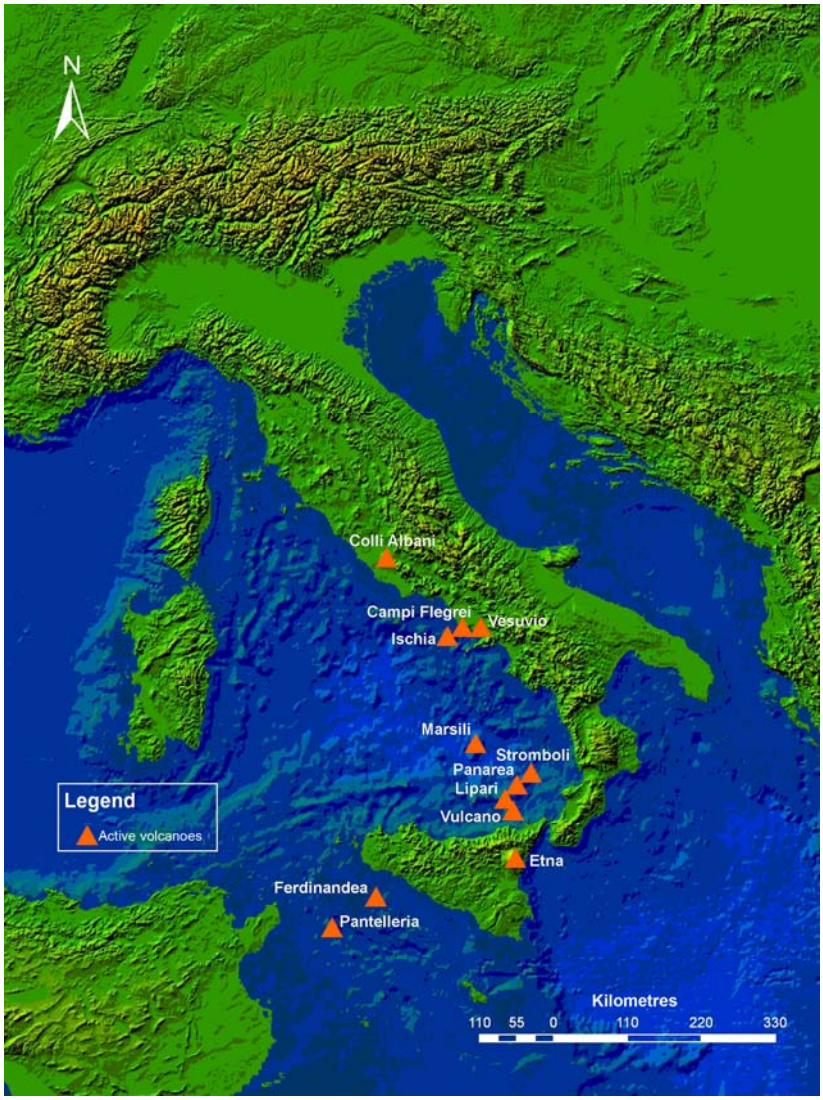


Italy faces one of the highest levels of seismic hazard in Europe.
The areas at the greatest seismic risk are those in the Friuli sector, along the central-southern Apennine spine (intra-Apennine basins), the Calabrian edge of the Tyrrhenian zone and southeast Sicily.

Figure 5.1: Distribution throughout the national territory of the major seismic events (magnitude ≥ 5.5)[1]

The conditions of greatest volcanic risk are naturally tied to the proximity of Italy's active volcanoes, meaning that they regard the Vesuvius and Phlegraean area, the Island of Ischia, the Etna sector, the Aeolian Islands and, in all probability, the Alban Hills (Figure 5.2). A decidedly lower level of risk, though not one entirely to be ignored, is connected with the underwater volcanoes, found in both the Tyrrhenian Sea and the Canal of Sicily. In the Tyrrhenian basin it would appear to be confirmed that the Marsili is active, while data are not available on the possible activity of the other underwater volcanic edifices in both the Tyrrhenian area and the Aeolian arc. In any event, the danger of such volcanoes is tied not only to their possible activity, but also to the probable activation of gravity slides resulting in tidal waves.

[1] Source: Data taken from the Parametric Catalogue of Italian Earthquakes – INGV



Italy is one of the countries presenting the greatest volcanic risk, with the highest levels found in the Vesuvius and Phlegraean areas, the Island of Ischia, the Etna sector, the Aeolian Islands and the Alban Hills.

Figure 5.2: Distribution of the main active volcanoes in Italian territory[2]

Seismic and volcanic events can often manifest themselves in tandem, as frequently occurs in the Etna area. Furthermore, in addition to the damage tied solely to the seismic quake (and at times exceeding that damage), further harm is done by natural events brought about by or related to the earthquake, such as landslides and falling rock, liquefaction, consolidation, tsunami and surface faulting. Quite frequently volcanic events also present related phenomena, such as: activation of mud and/or debris slides (*lahars*); instability and subsequent collapse of the flanks or top portions of the volcanic edifice (which can generate tsunami in the case of volcanoes that develop directly on the sea bottom, as occurred at Stromboli in 2002); instances of secondary quakes (typical of the Phlegraean fields).

There were no extreme examples of seismic or volcanic activity during the year 2006.

Though there were no massive manifestations during 2006,

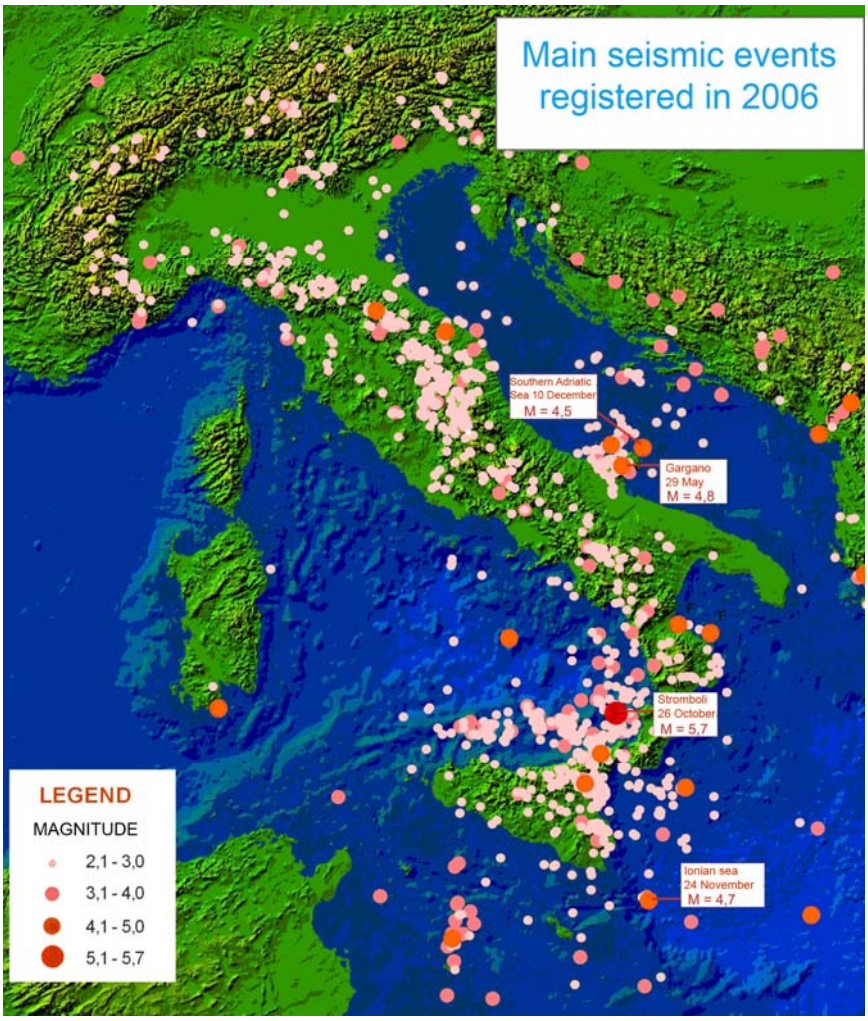
During the year 2006, only 4 seismic events reached or exceeded the

[2] Source: Data taken from the Parametric Catalogue of Italian Earthquakes – INGV

threshold magnitude of 4.5 (Figure 5.3). The strongest event occurred at Stromboli on 26 October, with a magnitude of 5.7, even though, on account of the noteworthy depth of the epicentre, no significant damage occurred.

seismic and volcanic events remain sources of elevated risk in Italy.

The events in the Ionian Sea (24 November, M=4.7) and in the southern Adriatic (10 December, M=4.5) did nothing more than frighten the local population; the lone damage of note caused by the Gargano seism (29 May, M=4.8) was the collapse of the Castelvenere tower in the Province of Benevento.



Though there were no massive manifestations during 2006, seismic and volcanic activities remained sources of elevated risk in Italy.
In 2006 there were four seismic events of a magnitude greater than or equal to 4.5. The most intense event was that of Stromboli on 26 October, at a magnitude of 5.7.

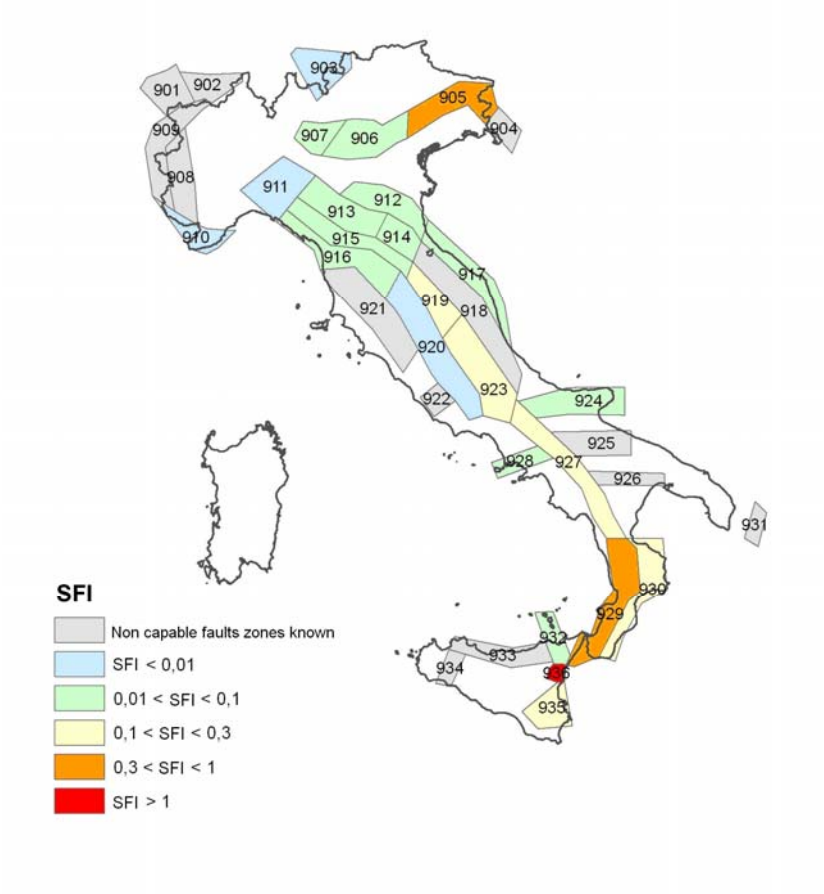
Figure 5.3: Main seismic events registered during 2006, with indication of the 4 earthquakes of elevated magnitude[3]

In the absence of earthquakes of a magnitude at least approaching 6, no effects of surface faulting have been registered.

It should be noted, however, that Italian territory presents number of capable faults (active faults able to produce noteworthy dislocations/deformations of the topographic surface). An analysis of the distribution of urban areas with respect to the aforementioned faults clearly demonstrates that, in many sectors of Italian territory, critical

[3] Source: APAT processing of INGV data

levels of exposure to surface faulting are reached (Figure 5.4).



Italian territory is characterised by the presence of numerous active faults capable of producing noteworthy fracturing of the terrain, at times with displacements of more than a metre.

The most critical zones are found in southeast Sicily, the Tyrrhenian side of Calabria and the Venetia-Friuli Alpine foothills.

Figure 5.4: Classes of the Surface Faulting Index (SFI) for each of the seismogenetic ZS9 zoning areas[4]

The SFI index (Surface Faulting Index), determined by using as input data on the capable faults taken from the ITHACA (*ITaly HAzard from CApable faulting*) dataset, the distribution of the urban areas mapped by the *CORINE Land Cover 2000* and the ZS9 Seismo-genetic Zoning show that the most critical zones are located in eastern Sicily, the Tyrrhenian portion of Calabria and the pre-Alpine sector of Venetia-Friuli (Figure 5.4).

As for "hydrogeological disarrays" (or, better yet, "geological-hydraulic" disarrays), the data on flooding tied with the main weather events that have occurred in Italy from the post-war period to the present (1951-2006) show that, despite the recent calamitous events in Sarno (1998), Soverato and Piedmont/Val d'Aosta (2000), there has been a certain downward trend in the damage and the victims produced by flooding over time. The average number of victims caused by flood events has gone from roughly a hundred per year in the 60's to a few dozen a year during the last three decades, though some of the results

Hydro-geological disarrays: in recent years there has been a downward trend in victims and damage produced by extreme events.

[4] Source: APAT

registered can be ascribed to individual meteorological events (1954, Salerno; 1998, Sarno) of an extreme nature. Of the events considered, there were many that caused more than 5 victims, while the threshold of a hundred victims was exceeded by 4 events (Figure 5.5).
In terms of estimated economic damage, information taken from the assessments carried out by the regions and the provinces points to damage of no less than 5 billion euro during the period 2001 – 2006.

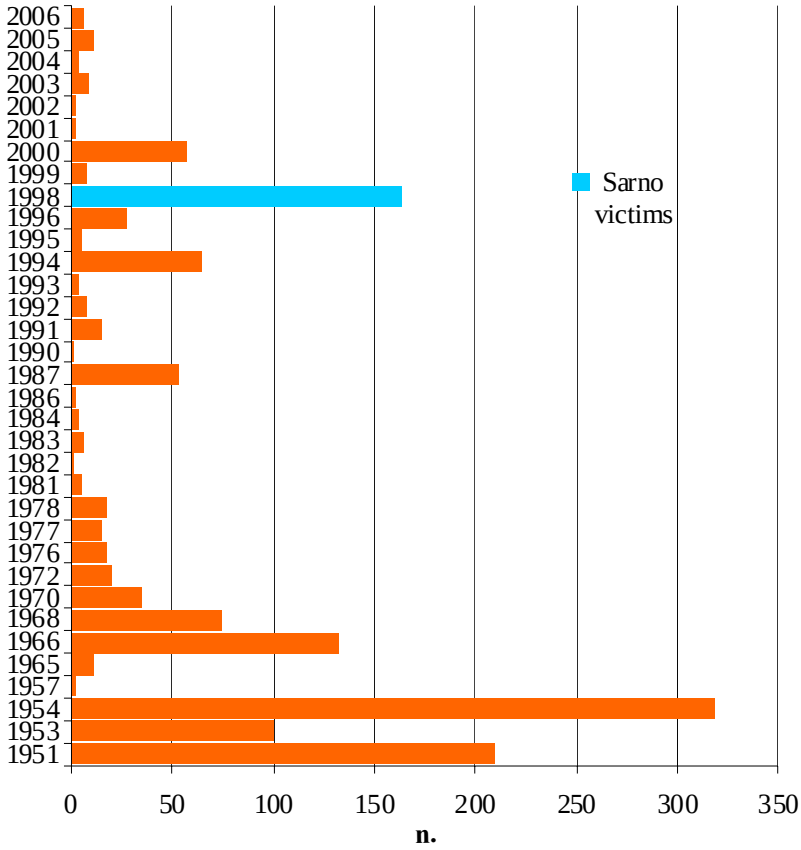


Figure 5.5: Victims of the principal floods in Italy from 1951 to 2006[5]

Landslides and flooding continue to be major causes of natural risk in large portions of the territory.
In recent years there has been a decrease in the damage and victims produced by extreme events.
Only 4 events exceeded the threshold of a hundred victims, taking place in 1998, 1966, 1954, 1951.

The decrease observed in the number of victims and the amount of damage resulting from flood events could be the result not only of improvements in the systems for safeguarding the territory and mitigating risk, but also of a natural fluctuation in the intensity and duration of the events. The extent of the damage has also been influenced to a significant extent by parameters tied to the management of the territory by man, such as the adaptation to human activities and the modification of riverbeds, variations in the use of the soil and practices for managing farmland.
In the decade 1990-2000, urbanised areas increased by approximately 6%, meaning that the areas involved lost their capacity for absorption and retention of water by the soil, with a consequent increase in surface runoff and a heightened possibility of flash flooding. Similar effects are produced by instances of compacting, which definitely involve - though there is still no overview with information drawn up on a uniform basis -

The decrease in damages is probably due to the onset of a variety of factors, such as improvements in the systems for defending the territory and mitigating risk, plus the natural fluctuation in the intensity and duration of the events.

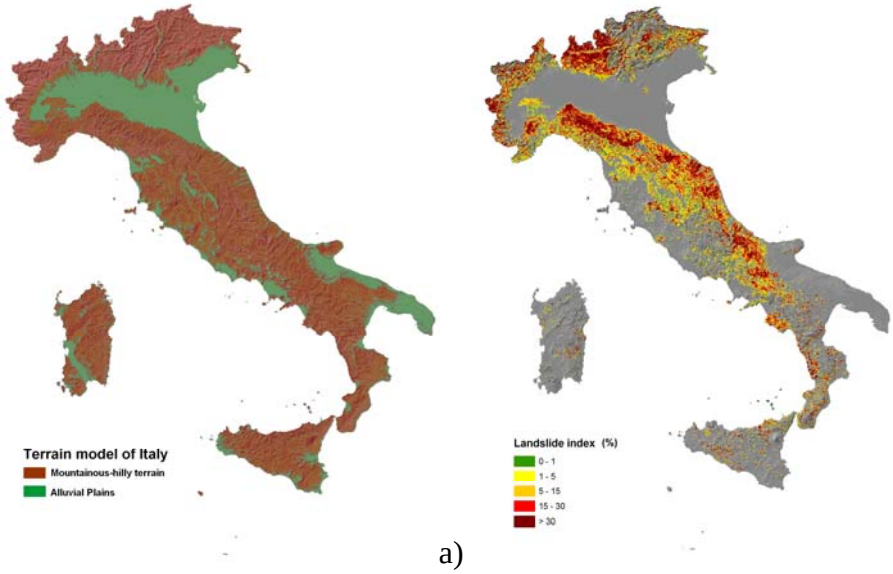
[5] Source: APAT

a large portion of the national farmland used for intensive growing.

In terms of hillside and mountainside disturbances, Italy presents an especially high risk of landslides (Figure 5.6), on account of its morphological characteristics (75% of the territory is mountainous-hilly).

Landslides are the natural disasters that occur with the greatest frequency and, after earthquakes, cause the greatest number of victims and the most damage to urban areas, infrastructures and environmental, historical and cultural resources. In the last twenty years alone, memorable catastrophic events have occurred in the Val Pola (1987), in Piedmont (1994), in Versilia (1996), in Sarno and Quindici (1998), in northwest Italy (2000) and in Val Canale - Friuli Venetia Julia (2003). As of December 2006, almost 470,000 landslide events has occurred and been recorded in Italy, involving an area of approximately 20,000 km^2, equal to 6.6% of the national territory. This census was carried out under the IFFI Project (Inventory of Landslide Events in Italy) undertaken by the APAT and the regions and the autonomous provinces, for the purpose of identifying and mapping landslides on the basis of a standardised and widely accepted approach. The landslide index, equal to the ratio between the area subject to landslides and the total surface area calculated using a grid size of 1 km, provides an overview of the distribution of landslides in Italy (Figure 5.6b).

Landslides, in addition to being the most frequent natural disaster, are also, after earthquakes, the ones that cause the most victims. Almost 470,000 landslides were catalogued in Italy until 2006, involving an area of approximately 20,000 km^2.



The risk of landslides in Italy is especially high, on account of the country's morphology (75% of the territory is mountainous-hilly). As of December 2006, the landslides identified covered 6.6% of the national territory.

Figure 5.6: a) Terrain contour model of Italy; b) Landslide index (%)[6]

The data gathered by IFFI show that the most frequent types of movement (classified on the basis of the prevalent component of the movement) are rotational/translational slide, at approximately 33%, slow earth flow, at 15.5%, rapid debris flow, at almost 15%, and complex landslides, at 11.6%. A large portion of landslide events are reactivated

[6] Source: APAT

over time; quite often, dormant periods lasting a number of years, or even centuries, alternate, on the occasion of extreme meteorological events, with periods of renewed mobilisation, as is the case for almost all the landslides in the Apennine zones of the Emilia Romagna Region, characterised by slow paced movements. In contrast, newly formed scenarios most frequently feature rapid kinetics, such as rockfalls or mud/debris flows

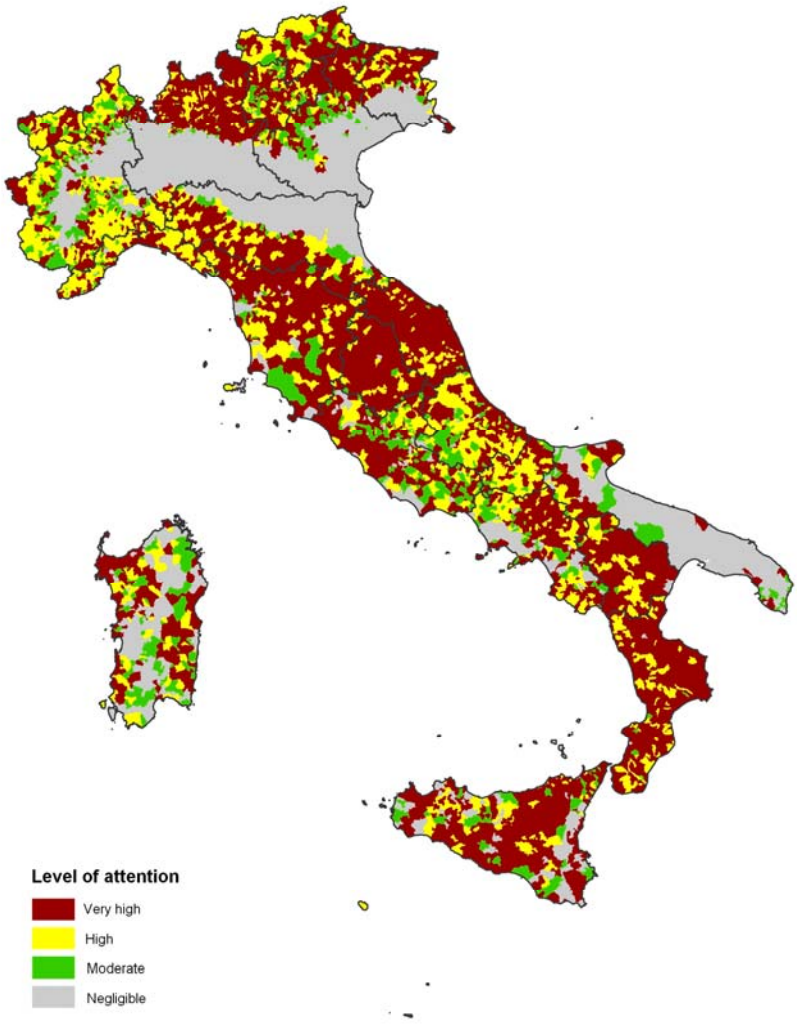
Italian municipalities affected by landslides currently number 5,596, equal to 69% of the total.

The Italian municipalities affected by landslides currently number 5,596, or 69% of the total. In order to obtain a preliminary landslide risk assessment of Italian territory, landslide features of the IFFI Project have been overlaid with the exposed elements by GIS processing (Figure 5.7). A total of 2,839 municipalities were classified at very high levels of attention (with intersections between landslides and the continuous and discontinuous urban texture, as well as industrial or commercial areas), 1,691 municipalities call for high levels of attention (intersections between landslides and the highway, railway and road networks, areas used for mining, dumping and worksites), 1,066 present a moderate level of attention (intersection between landslides and wooded territories and arable lands, green urban areas and sports and recreation areas), and 2,505 call for negligible levels of attention (municipalities in which no landslides have been registered).

Not all landslides present the same level of hazard, with those involving high-speed movement (rock falls and rapid mud and debris flows) and noteworthy volumes of rock or soil causing the greatest damage.

Italy is a fragile territory, with approximately 10% classified as being at high risk of flooding, landslides and avalanches, and with more than 2/3 of the areas at risk consisting of urban centres, infrastructures and production areas.

At present, roughly 10% of our country is classified as facing a high risk of flooding, landslides or avalanches, with involvement of all or a portion of the territories of more than 6,600 Italian municipalities. The census updated to January 2006 shows that, out of approximately 30,000 km^2 of areas in a highly critical situation, 58% are found in landslide zones and 42% in areas prone to flooding. These results point to a situation of extreme fragility in Italian territory, exacerbated by the fact that more than 2/3 of the areas at risk consist of urban centres, infrastructures or production areas closely tied to the country's economic and social development.



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A total of 2,839 municipalities are classified as requiring extremely high levels of attention, 1,691 municipalities high levels of attention, 1,066 municipalities average levels and 2,505 negligible levels.

Figure 5.7: Level of landslide alert on the municipal level[7]

Erosion of soil by water has major economic repercussions.

A factor of noteworthy economic importance is the erosion of soil caused by water. The damage occasioned by erosion, which can take the form of loss of soil, fertility and biodiversity, frequently makes necessary corrective action, especially in the case of prized agricultural land of significant economic value. The analyses show that roughly 30% of Italian land presents a risk of erosion above the threshold of tolerability. These estimates, derived from nationwide models, are weakened by the approximate nature of the data utilised. An overview that more accurately reflects the actual situation is currently being drawn up under the projects for harmonising the regional information coordinated by the APAT, with the participation of the CRA, the JRC and the Italian regions (SIAS Project).

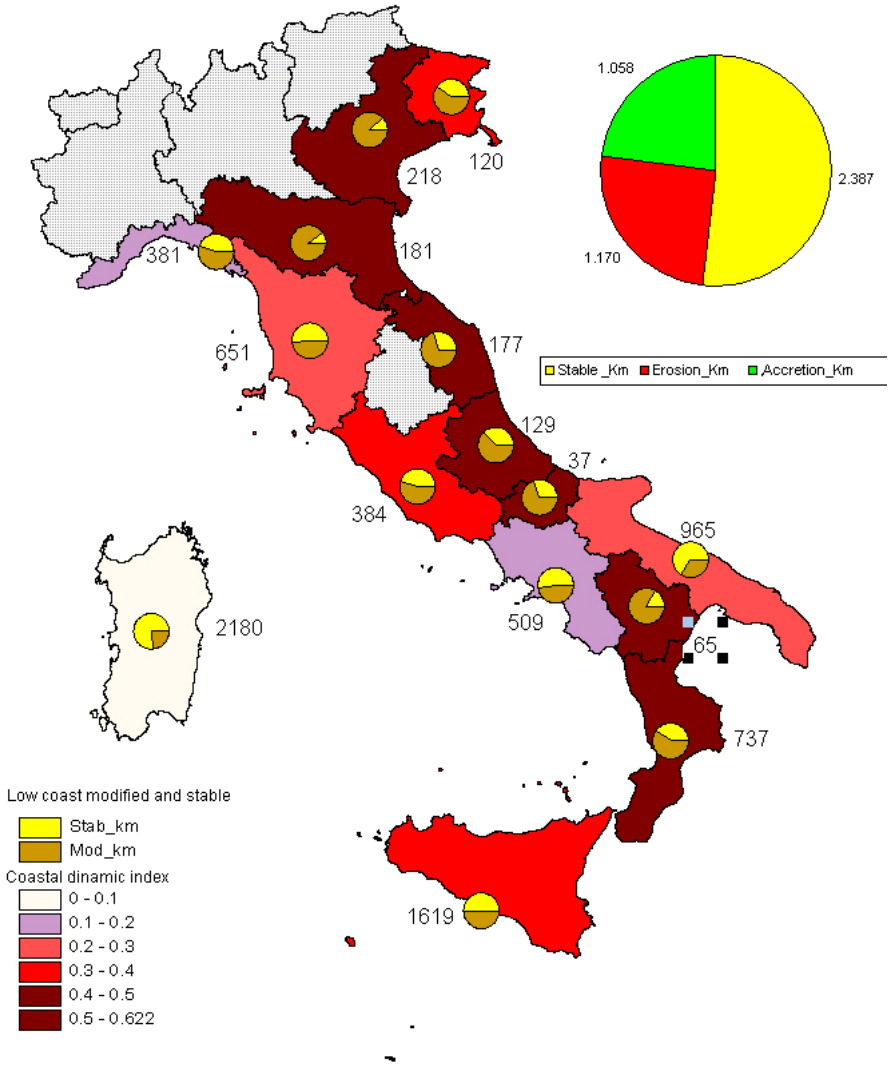
20% of the total Italian coastline (8,350 km) suffers from an evident state

The data on the erosion and flooding of coastal areas, events present to a significant degree within our territory, point to a general retreat of Italy's sandy coastlines from the 70's to the present. Today, approximately

[7] Source: APAT

1,500 km of Italy's roughly 4,600 km of low-lying coastline, including coastal plains, already suffers from an evident state of erosion and is at risk of flooding, meaning nearly 20% of the total of approximately 8,350 km of Italian coastline.

of erosion and is at risk of flooding.



Erosion and flooding of coastal areas has a noteworthy effect on our territory.

From the 70's to the present, the trend has been for Italy's sandy coasts to retreat.

20% of Italy's total coastline (8,350 km) suffers from an evident state of erosion and is at risk of flooding.

Figure 5.8: Variation > 25m of the low-lying coastline and the index of coastal dynamic[8]

The need for wide-scale, integrated management of coastal areas, with the taking of appropriate steps to contrast coastal erosion, has led to the formulation of numerical indexes for the evaluation of conditions of risk in coastal zones, through application to Italy's coasts of the methods proposed under the EUROSION Project.

First of all, the coastal area indicated as RICE[9], a zone potentially

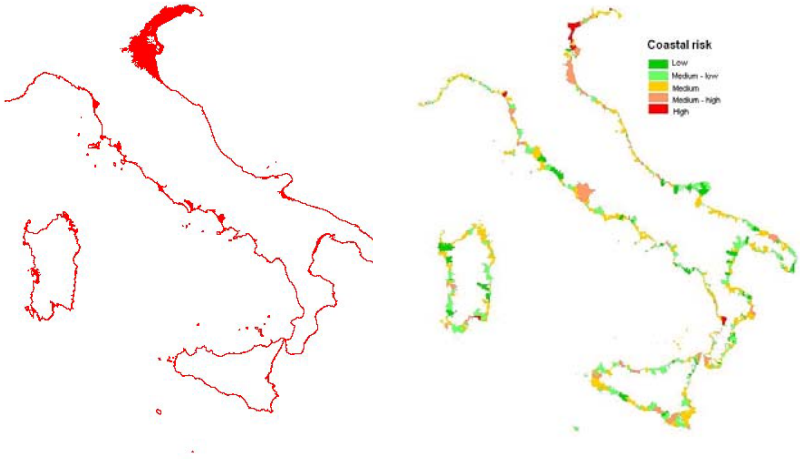
The integrated management of coastal areas calls for the formulation of numerical indexes for assessment of the conditions of risk.

[8] Source: APAT

[9] *Radium of Influence of Coastal Erosion* is the geometric site of points that satisfy at least one of the following two conditions: distance of no more than 500 metres from the coast; altitude of no more than 5 metres above sea level. In order to take into consideration errors connected with the definition of the DTM (Digital Terrain Model), and avoid underestimating areas with altitudes of no more than 5 metres, the curve taken for the limit level was that corresponding to 10 m

subject to erosion and flooding within the next 100 years (Figure 5.9a) was identified. Of note is the fact that the area potentially at risk occupies 954,379 ha, equal to 3.17% of the entire national surface area, and houses 5,276,535 of the country's inhabitants, or 9.12% of the entire population. Within this zone, it is estimated that a surface area of 336,746 ha (1.12% of the national surface area) and a population of 2,133,041 (3.69% of the total population) are exposed to a moderate-high or high risk (Figure 5.9b).

The area potentially subject to erosion and flooding within the next 100 years occupies 954,379 ha, equal to 3.17% of the entire national surface area, and holds approximately 5.3 million inhabitants, equal to 9.12% of the entire population. Out of this area, it is estimated that a surface area of 336,746 ha (1.12% of the national surface area) and a population of 2,133,041 (3.69% of the total population) is exposed to a moderate-high or high risk.



a) b)

Figure 5.9: a) RICE area in Italy and b) Map of coastal risk by municipality[10]

5.1.2 The causes

As noted earlier, events such as earthquakes and volcanic activity are due to the specific geological context of our country. These phenomena, being tied to natural processes, present a risk connected with their occurrence, as well as with interaction involving factors tied to human activities.

The evolution of the primary examples of land instability on the Italian peninsula is influenced by both natural and anthropic factors.

The evolution of the main instances of land instability on the Italian peninsula, whether caused by gravity or the action of water, is also influenced by both natural and anthropogenic factors. The natural considerations include, apart from the morphological conformation of the territory, which depends on the geological-structural layout and on the lithological characteristics, the type and extension of the vegetative coverage and conditions of weather and climate. The precipitation monitored over the last few decades, which has shown an average reduction, as well as a variation in the distribution of precipitation over time (with a heightened occurrence of intensive events of brief duration,

The physical mechanisms that regulate the onset and the evolution of critical hydro-geological events

[10] Source: APAT

referred to as “extreme”), while it may have reduced the number of flood events of average intensity in certain areas, could also have favoured an increase in the instability of mountainsides and hillsides. The physical mechanisms that govern the onset and evolution of critical hydro-geological events are often highly complex and extremely non-linear. The extent to which levels of rain correspond to landslides or flooding is influenced by a number of factors, which can set off different effects from one place to the next, even in situations that would appear to be similar.

are very complex and highly non-linear. Anthropogenic causes are taking on increasing weight.

Among the causes of “hydrogeological disarrays”, those of anthropogenic nature are playing an increasingly important role, being tied to a use of the territory that does not pay sufficient attention to the characteristics and the delicate hydro-geological balances of Italian terrain. The demands arising from socio-economic and demographic development have resulted in a use of the territory that does not always respect its natural tendencies. An unmistakable example is the marked expansion, in the post-war period, of population centres and industrial areas in flood plain areas. Such development, together with undeniable socio-economic benefits, has also placed what amounts to a “plaster cast” on the territory, on account of increasingly invasive works (such as embankments, dikes, canals, reclamation works and retaining walls), that have prevented evolution according to natural dynamics. Similar projects, which show varying levels of effectiveness over the brief-medium period, also call for increasingly costly and large-scale maintenance work.

Use of the territory that pays insufficient attention to the characteristics and the delicate geological-hydraulic balances of Italian terrain can currently be considered one of the primary causes of hydro-geological disturbances.

In mountain areas, on the other hand, gradual depopulation has led to the abandonment of traditional crops, with negative effects on the defence of the soil as well.

In hill areas and plains, the development of growing practices tied to intensive farming underlies the significant increase in loss of soil as a result of water-based erosion, with consequences that include a decrease in fertility, as well as an increase in the transport of solids in waterways and problems involving the silting-up of artificial basins.

Such farming practices are also responsible for the onset of compacting on the surface and in-depth (ploughing level), which limits/prevents the infiltration of water from precipitation, resulting in frequent submersions of the soil, with serious damage done to crops on account of root suffocation, at the same time as it increases surface runoff, reducing the retention time of the watershed.

Abandonment of traditional crops, together with the use of intensive techniques, has had a negative effect on the soil in terms of reduced fertility and increased compacting.

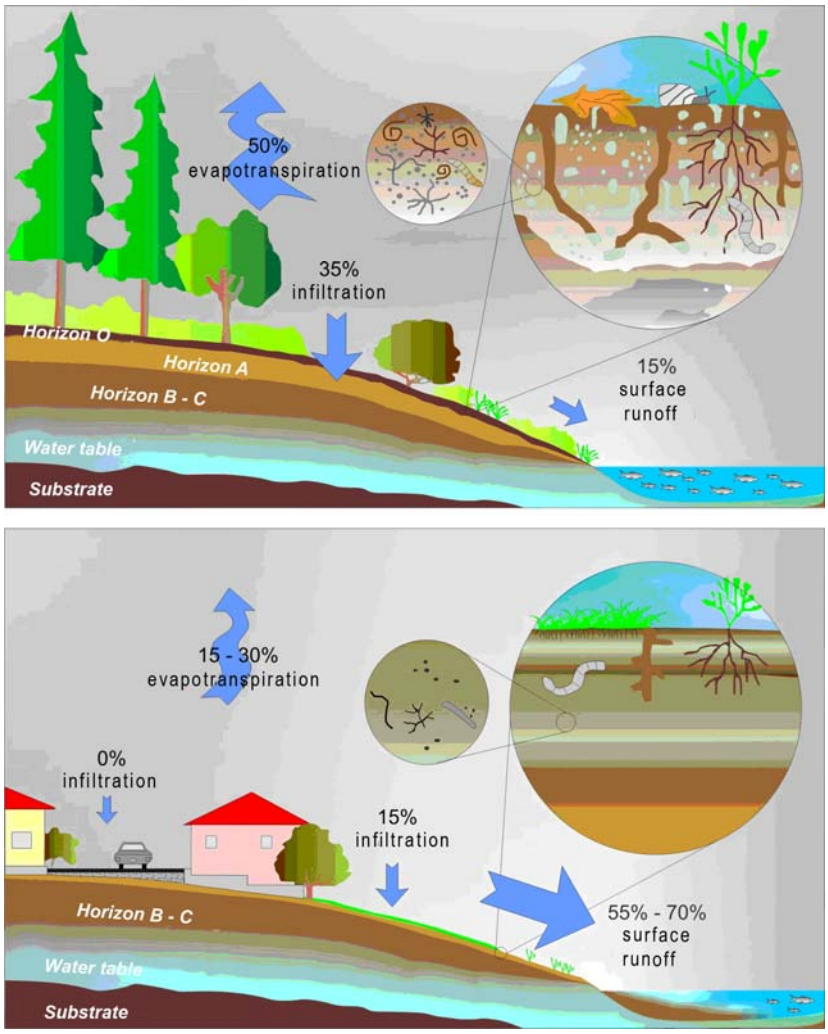


Figure 5.10: Chart illustrating a natural terrain and an anthropised one

Soil in its natural condition is capable, thanks to its porosity, permeability and humidity, of retaining a large quantity of water from atmospheric precipitation, contributing to the regulation of surface runoff.
In an anthropised environment, on the other hand, the presence of surfaces rendered impermeable, the reduction in the vegetation, the removal of the surface layer, which is rich in organic substances, and the onset of compacting result in a serious deterioration of the soil's functional efficiency.
The decrease in evapotranspiration, and in the soil's capacity to absorb water, result in an increase in surface runoff and in the transport of large quantities of sediment in natural collectors.
The values shown in the figure are nothing more than rough estimates. They can vary, and to a significant degree, depending on a variety of parameters (the physical-chemical characteristics of the soil, the topography and geology, as well as the duration and intensity of precipitation etc.).

The actions of man also have noteworthy effects on coasts and watersheds.

Coastal environments and the watersheds underneath them (subdivided into physiographic units) also present a setting that is the end result of a complex interaction among numerous factors, the largest part of which are anthropic. The parameters in question include processes of erosion, transport and deposition, as well as the construction of rigid works for the defence of coastal areas from erosion and the instability of mountainsides and hillsides.

The causes of increased processes of coastal erosion and marine flooding also include, apart from increased urbanisation in the coastal sector:

- reduced supply of solid river materials to beaches, due to works for the stabilisation of hillsides and mountainsides, the control of rivers and dams, as well as the extraction of materials from riverbeds (primarily anthropic, as opposed to natural);
- the combined effects of tides and flood events, which cause heightened erosion at river mouths when the large volumes of

river water reach the sea;
- the rise of the sea level resulting from a lowering of the terrain caused by the simultaneous effects of natural and anthropic subsidence, as well as eustatic movements.

Though knowledge of the state of the coastal system is still insufficient, in terms of both uniformity on the national level and detail of scale, the data collected point to an ongoing loss of terrain at the seashore.

5.1.3 Solutions

To limit risk situations, attentive planning and the introduction of adequate regulatory instruments are called for.

Seismic and volcanic activities, flooding, landslides and coastal erosion are outcomes of the natural dynamics of the planet, meaning that there is little that man can do to control them. Nevertheless, risk conditions can be significantly reduced through careful territorial planning and the introduction of legislative instruments that place limitations on the use of the soil and/or establish technical-engineering standards. In order to arrive at effective risk mitigation, therefore, it is indispensable that the emergency approach, based on after-the-fact responses, be replaced with initiatives combining forecasting and prevention.

Forecasting can be carried out through specific studies of zones at risk. Prevention should take the form of decisions regarding the application of technical procedures designed on the basis of the knowledge obtained. Unfortunately, the decisions made in this field have not always been the right ones.

Forecasting can be carried out through specific studies of the zones subject to risk, in order to determine the probability of events recurring over time, whereas prevention entails selecting and applying technical procedures designed on the basis of the knowledge obtained. Unfortunately, the choices made in this field are not always the right ones: a large part of the buildings in our country do not comply with anti-seismic standards, both because the stock of structures from the past has only rarely been upgraded to meet the current anti-seismic measures and because the marked urban expansion from the post-war period to the present suffers from a lack of attentive territorial planning, as well as the all too frequent, and deplorable, tendency to build in violation of the regulations. The seismic classification of the national territory, whose evolution made significant progress following the 1980 earthquake in Irpinia, reflects the state of the art as far as knowledge of seismic risk in Italy is concerned (Figure 5.11). The classification provides a detailed presentation of the maximum horizontal acceleration values at ground level, making it possible to set adequate anti-seismic design criteria, the problem being that these standards are obligatory only for new structures, while no measures have been taken for the anti-seismic upgrading of existing buildings.

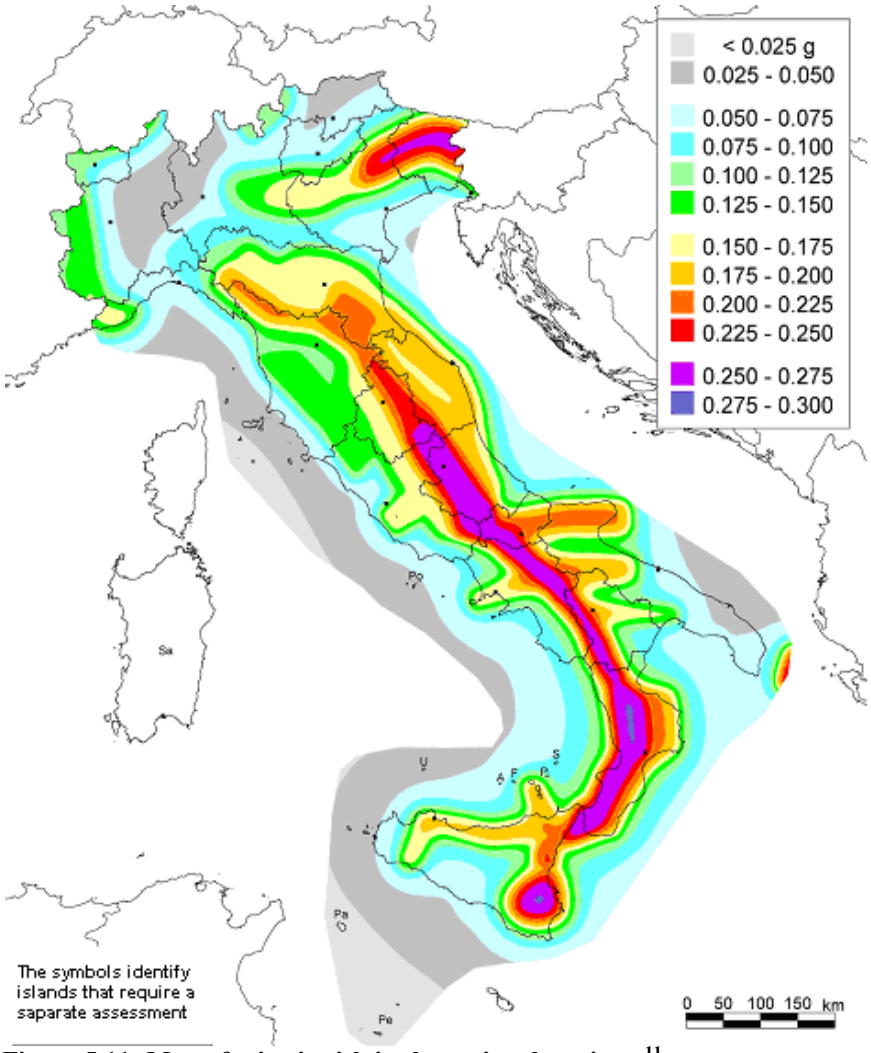


Figure 5.11: Map of seismic risk in the national territory[11]

The seismic classification of the national territory, which has made significant advances since the 1980 earthquake in Irpinia, reflects the state of the art in terms of knowledge of seismic threats in Italy.

The map illustrates the seismic threat in terms of maximum acceleration at the ground level, with a probability of exceedance of 10% in 50 years for rigid terrain (Vs_{30} > 800 m/s; cat. A, point 3.2.1 of the Ministerial Decree of 14 Sept. '05).

At the same time, uncontrolled urban development in areas of elevated volcanic risk, such as the Phlegraean Fields, Ischia and Vesuvius, places these zones among the most risk-prone in the world. In the case of Vesuvius and the Phlegraean Fields, the Italian Civil Defence Department has drawn up specific emergency plans, currently under revision, for the purpose of managing the emergency phases of any eruptions, eventually through the evacuation of the areas held to be at risk, based on the reference eruption standards. What is necessary, and should be aimed at, is a combination of planning and initiatives to arrive at the decongestion of an urban situation that is simply unfeasible in an area containing active volcanic structures, as well as efforts to instil in the general public a correct awareness of the inevitability of the event, of the possibility of lengthy waiting times and false alarms, as well as the possibility that the eruption could occur with an intensity and in a mode different from what has been forecast. It should also be noted that, in many sectors of Italian territory, urban development has taken place on active tectonic structures capable of producing significant

[11] Source: INGV

dislocations/deformations of the topographic surface (capable faults). In such cases, assessment of the seismic risk, traditionally based on the effects of the quake, proves to be underestimated, seeing that it does not take into account the effects of surface faulting.

The regulatory and planning framework for land preservation is still essentially governed in Italy, in an all-encompassing manner, by Law 183/89 (currently being modified/abrogated by Legislative Decree 152/06). This legislative measure has thoroughly innovated the defence of the soil, called for the special institutes established under earlier legislation to be combined within a new organisational-institutional structure. Based on this approach, planning for risk-mitigation initiatives has been drafted in accordance with the contents of the Basin Plan, which constitutes a territorial plan for the sector, as well as an instrument of research, regulation and technical-operative considerations used to plan and program actions and standards of use for the conservation, protection and optimisation of the land. In the interests of improved territorial planning, Law 183/89 contemplates the possibility of drawing up separate plans for individual functional sectors, correlated to the contents of the Basin Plan, though the latter remains the general, all-encompassing tool for planning.

As of September 2006, the state of implementation of the PAI (Individual Plans for the Hydro-Geological System) on the national level had reached the conclusive phase, with the approval of 27 PAI and the implementation of 8 PAI projects, while, in 3 cases, the planning was still underway.

As of September 2006, 27 PAI have been approved and 8 PAI projects have been implemented. In three cases, the planning is still underway.

A key contribution to application of the regulations and standards of land preservation was made by Legislative Decree 180/98 (referred to as the "Sarno Decree", converted into Law 267/98), issued in 1998 following the tragedy in Sarno (Campania Region), in order to accelerate application of Law 183/89 (largely unfulfilled at that point), with absolute priority given to areas at "high and very high hydro-geological risk". This Legislative Decree resulted not only in immediate identification of the most critical zones (Extraordinary Plans), but also in the introduction and formulation of "programs of urgent measures for the reduction of hydro-geological risk".

Within this regulatory context, the priority phases for the forecasting and prevention of disturbances are the preparatory research involved in collecting information on possible events (i.e. the IFFI Project, the AVI Project etc.), monitoring with instrument networks and the simulation of event scenarios. Proper territorial planning is carried out through the programming of both non-structural initiatives (the implementation of safeguards, the application of constraints regarding the use of the territory and activities of civil defence, with the formulation of emergency plans) and structural efforts (performance of various types of reclamation interventions, maintenance of riverbeds and protective works, plus delocalisation activities or, in more general terms, active modification of the dynamics and disturbances currently underway). To this end, the Ministry of the Environment, Land and Sea, starting from 1998, and in accordance with Legislative Decree 180/98, plus subsequent modifications and additions, has financed 2,270 urgent

For the forecasting and prevention of disturbances, the research phases have been formulated, together with the monitoring actions, utilising instrument networks and event scenarios, plus appropriate territorial planning.

The Ministry of the Environment, Land and Sea has financed 2,270

initiatives for the reduction of hydro-geological risk, largely of a structural type, at a total cost of more than 1.7 billion euro. The majority of the initiatives financed regard gravity slides (47%), followed by floods (21%) and mixed or avalanche events (in the case of 29% of the initiatives, the main type of disturbance is not indicated in the decree of approval).

initiatives for reducing hydro-geological risk.

A further contribution to the planning of initiatives to mitigate hydro-geological risk was made by the enactment of the ReNDiS Project (Repertory of Measures and Works for the Mitigation of Hydrogeological Risk in Italy), formulated by APAT for the purpose of providing a unified, systematically updated overview of the works and resources committed to land preservation, to be shared by all the administrative bodies active in the planning and implementation of such initiatives. ReNDiS is meant to be used as a tool for obtaining knowledge, potentially capable of improving coordination and thus optimising national spending on the defence of the soil. In publishing the data, the Repertory is designed to satisfy the need for "transparency" in the operations of the Public Administration regarding land preservation. The end goal is to contribute to heightening awareness of the problems involved in protecting the soil, and the close connection between such problems and a correct use of the land.

The ReNDiS project contributes to the planning of initiatives for the mitigation of hydro-geological risk, providing an updated overview to be shared with the administrative bodies.

The dissemination of information on landslide events among the central and local bodies of the Public Administration, as well as the general population, also plays a highly important role in the prevention of risk. The Italian Landslide Inventory (IFFI project) constitutes an important tool for gathering the basic knowledge needed for correct territorial planning. Heightening the awareness of citizens also provides them with increased knowledge of the risks involving their own territory, as well as the forms of conduct to be followed before, during and after the event. For this purpose, APAT has created an on-line cartographic consultation service for the IFFI project (www.sinanet.apat.it/progettoiffi), making it possible to query the database and obtain information on landslides, in addition to visualising documents, photographs and filmed pieces.

A valid instrument for the prevention of risk is the dissemination of information on landslide events among the general population and the bodies of the Public Administration, making possible a heightened awareness of the risks found in their territories.

Initiatives meant to mitigate the degradation of farmland have been undertaken, both nationally, through the new PSN (National Strategic Plan for Rural Development) and on the European level, based on the new CAP (Common Agricultural Policy), which requires that farmland be kept in good agronomic and environmental condition. In 2006 the European Commission implemented the "*Soil Thematic Strategy*", which includes a proposal for a "Framework Directive on the Protection of the Soil" (COM(2006)232). The proposal identifies the main threats that could compromise the functional efficiency of the soil (including erosion, transformation into an impermeable state, compacting and landslides), making it necessary to identify the areas at risk and prepare appropriate measures of mitigation. In the case of floods, which were originally covered by the strategy (COM(2002)179), a separate directive is currently being drawn up.

Tools such as the PSN and the CAP constitute valid initiatives for mitigating the deterioration of farmland.

The dissemination of data is also a factor of noteworthy importance when it comes to analysing coastal erosion. It is held to be highly necessary to make the best possible use of existing databases on a national scale (which are extremely accurate and, in theory, provide more cartographic information than is the case in other countries), in order to offset the major shortcoming represented by the lack of uniformity of the knowledge and the difficulty in obtaining access to it. What is missing at present is an established process for accessing and sharing these data. It is of fundamental importance, therefore, that the techniques and products used to collect data be coordinated, and that there be unconditional sharing of cartographic bases and "strategic" thematic write-ups between the various bodies and branches of the central, regional and local administrations.

The risk of coastal erosion makes necessary attentive planning and programming of actions, given their high cost.

The options for reducing the vulnerability of Italy's coastal areas all start from the assumption that it is not economically sustainable to undertake initiatives of protection regarding all of the more than 4,600 km of Italy's low sandy coasts. Even limiting efforts to the approximately 1,500 km where erosion, as of today, has already set in would call for enormous initial investments (on the order of 2 billion Euro) needing to be repeated over time, plus the use of quantities of sediment for replenishing on the order of 150-200 million cubic metres, only at the start, not to mention the quantities needed to maintain the actions. Moreover, these quantities of sediment must present physical characteristics and factors of quality that would prove difficult to find in all the zones affected by erosion, given the need to comply with current regulations in the sector as well.

There are a variety of possible approaches to enacting strategies of adaptation, entailing different expenditures of resources.

Possible solutions for enacting strategies of adaptation include:

- abandoning areas to their natural course of evolution;
- preserving and/or reconstructing natural zones that serve as "soft" interfaces between the land and the sea;
- preserving and/or reconstructing coastal dunes;
- the implementation of strategies of territorial planning, in order to avoid further deterioration, in terms of vulnerability, with one option being planning constraints;
- protection of land-sea positions through soft works (replenishing) rather than rigid ones;
- increased morphological resilience of the above-water beach (dunes) and the below-water portion (sandbars etc.);
- regulatory initiatives meant to establish the recommendations of the coastal management plans as a form of oversight for the Municipal Regulatory Plans (MRP) while introducing the Strategic Environmental Assessment (SEA) into the process for assessing coastal plains. In addition, the system of assessment should be independent of the subject that formulates the plan.

The risk of erosion makes necessary a balance between residential/productive

The first and second strategies are based on the principle of abandoning the struggle for position between land and sea by taking into consideration options that call for different approaches to coexistence in

coastal areas, establishing a new balance between populated and productive areas, on the one hand, and the values and dynamics of nature, on the other. This implies planning activities of a vast scope (at least regional, and possibly encompassing entire seacoasts), so as to take into account not only the impact of the work in the immediate vicinity, but also its interaction with the coastal system as a whole, all based on the principle that "projects which lead to erosion shall no longer be financed".

areas and natural values/dynamics. Consideration must be given not only to the immediate impact of the work, but also to its medium/long-term interaction with the coastal system.

The courage must also be found to remove, wherever possible, those traditional protective measures whose effectiveness has decreased on account of climate changes.

In light of the above, an increasingly urgent priority is the implementation of the EC recommendations on ICZM *(*Recommendations of 30 May 2002 of the European Parliament and Council concerning the implementation of Integrated Coastal Zone Management in Europe) through the formulation of national guidelines endorsed by the administrative organs and the authorities which currently hold responsibility for planning. Equally urgent is the need for a regulatory definition of the concept of "Coastal Plain", establishing the minimum extension of such areas on the basis of criteria of coastal dynamics (such as physiographic units), as opposed to administrative considerations, and placing them on a level that overrides municipal regulatory plans and other instruments of planning.

Given the size of the investments that will prove necessary for coastal planning, it is indispensable that a synergy be established between public and private investments, through legislative instruments that favour private investments which also contribute to satisfying the need for adaptation to climate change.

The actions necessary in the area of coastal planning call for: synergy between public and private investments; coordination between initiatives on the local and national levels.

There must also be a form of national collaboration on the topic of coasts (research, monitoring, methodologies, planning criteria etc.), so that those operating on the local level are not isolated from the general context, with the experiences currently limited to certain areas effectively becoming a collective resource and with optimal use being made of the results of research projects. The contribution of the inter-regional EU projects has not eliminated this shortcoming. It is proposed, therefore, that approaches be found for grouping initiatives, projects and programs to be undertaken in coastal zones on a central level, with one possibility being a national committee on the coasts, with the participation of representatives of institutions, the regional governments and the academic world.

5.2 Anthropogenic Risk

The term “anthropogenic risk” refers to the risk (direct or indirect) tied to human activities that pose a hazard to the environment and to human life. This broad definition includes so-called “industrial risk”, meaning that resulting from activities carried out inside of industrial establishments.

“Anthropogenic risk” is that which arises (directly or indirectly) from human activities that are potentially hazardous to the environment and to human life.

The definition “Major-Accident Hazards establishments” (MAH establishment) refers to an establishment that contains (using them in its production cycle or simply in storage) potentially hazardous facilities, at quantities that exceed the thresholds established under the “Seveso” regulations (Directive 82/501/EEC, plus subsequent modifications).

The storage and/or use of large quantities of substances classified as toxic, inflammable, explosive, combustible or hazardous for the environment can lead to the possible uncontrolled evolution of an accident that poses a serious threat, either immediately or after a certain delay, to man (inside or outside the establishments) and to the surrounding environment, on account of:

- the emission and/or dispersion of substances that are toxic for man and/or for
- the environment;
- fire;
- explosion.

In the 80’s, the European Community took this type of establishment into consideration for the first time, in order to reduce the incidence of major accidents in industry while increasing protection of local populations and the environment as a whole, doing so by issuing a specific directive (the aforementioned 82/501/EEC, also known as the “Seveso Directive”).

The purpose of the Seveso Directive, plus subsequent modifications and additions, is to reduce the possibility of the occurrence of accidents, together with their potential impact on man and the environment.

Operative application by the member states of the European Community brought to the fore the need for adjustments and modifications, with the result that the Seveso Directive has been updated twice over the years, in the form of Directives 96/82/EC and 2003/105/EC, which were transposed into Italian law under Legislative Decree 334/99 and Legislative Decree 238/05.

The purpose of these measures is to reduce the possibility of the occurrence of accidents, along with their subsequent impact on man and the environment. To this end, the operators of industrial establishments where a major accident may occur are required to meet specific obligations, including: mandatory production of technical documentation and specific information, plus the installation of specific systems for the safe management of the facility; in addition, they are subject to specific controls and inspections by the authorities.

5.2.1 The situation

The information on facilities at risk for accidents, sent by the operators to the competent authorities (including the Ministry of the Environment, Land and Sea, under the specific obligations contemplated in Legislative Decree 334/99, which calls for administrative or criminal sanctions for notifications that are not made or prove incomplete), is collected by APAT, in accordance with the Ministry of the Environment, Land and Sea, through the taking and updating of the National Inventory of Major-Accident Hazard establishments (MAH establishments), as stipulated under Legislative Decree 334/99 (art. 15, paragraph 4), at which point it is further confirmed through comparison with the information held by the regions and the regional environmental agencies competent in the area where the establishments are located.

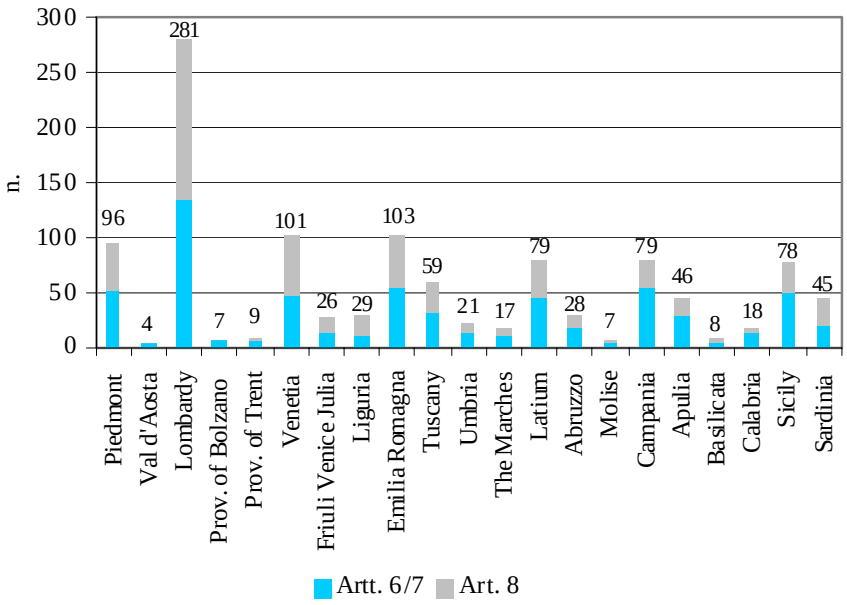
APAT, in accordance with the Ministry of the Environment, Land and Sea, collects the information on Major-Accident Hazard establishments provided by the operators to the competent authorities.

Thanks to the information stored in the aforementioned Inventory, a general overview of the pressures placed on Italian territory by the Major-Accident Hazard establishments can be drawn up.

This means knowing, for example:

- the “number of Major-Accident Hazard establishments in each region” (Figure 5.12);
- the “number of Major-Accident Hazard establishments in each province” (Figure 5.13);
- the “municipalities with 4 or more Major-Accident Hazard establishments” (Figure 5.14); the areas where an especially large number of MAH establishments are concentrated can be highlighted, making it possible to implement controls and precautionary measures which ensure that an accident in an individual facility does not spread to the others (domino or knock-on effect), with enormous consequences for both man and the environment.

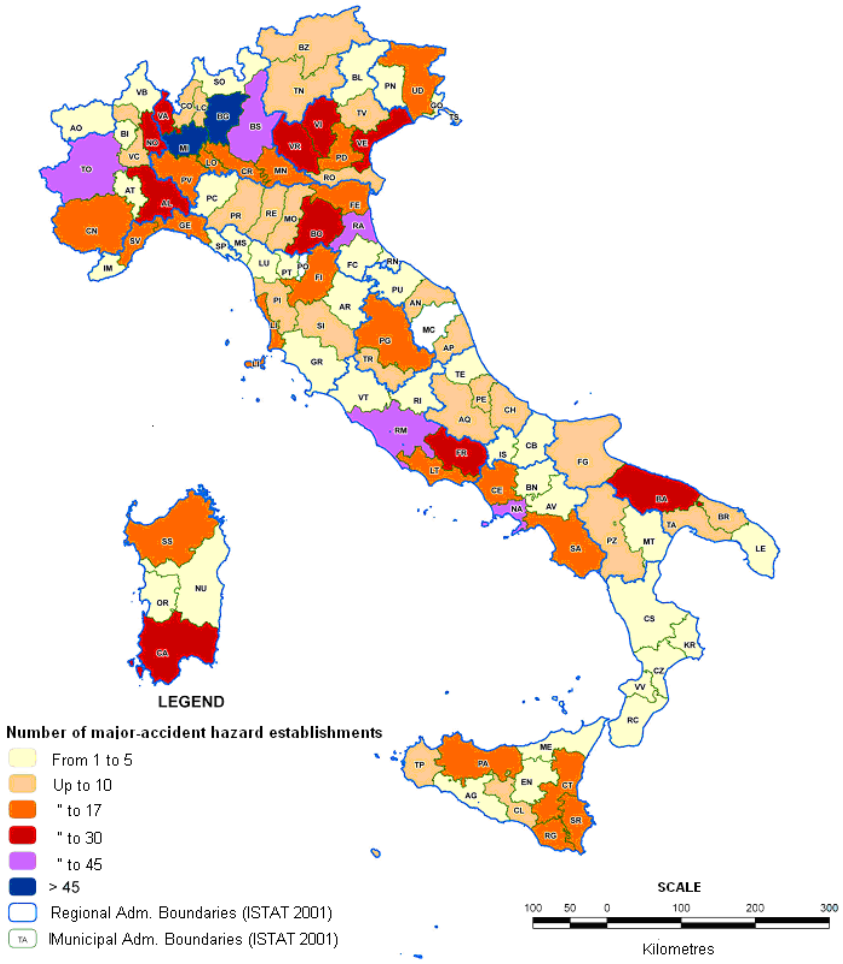
Knowledge of the number and the distribution throughout the territory of the Major Accident Hazard establishments makes it possible to draw up risk maps.



The regions with the greatest concentration of facilities at risk of serious accidents are: Lombardy, Emilia Romagna, Venetia and Piedmont. Next come Latium, Campania and Sicily.

Figure 5.12: Regional distribution of the establishments subject to Legislative Decree 334/99, plus subsequent modifications and additions[1]

[1] Source: APAT analysis of data from the Ministry of the Environment, Land and Sea



The largest number of Major Accident Hazard establishments are concentrated in the central-northern provinces, and especially in Turin, Milan, Bergamo, Brescia and Ravenna, in the north, plus Rome and Naples in the central-southern zone.

Figure 5.13: Number of Major-Accident Hazard establishments – provincial distribution[2]

[2] Source: APAT analysis of data from the Ministry of the Environment, Land and Sea

Of particular note among municipalities with 4 or more Major Accident Hazard establishments are Venice, Ravenna, Rome and Naples.

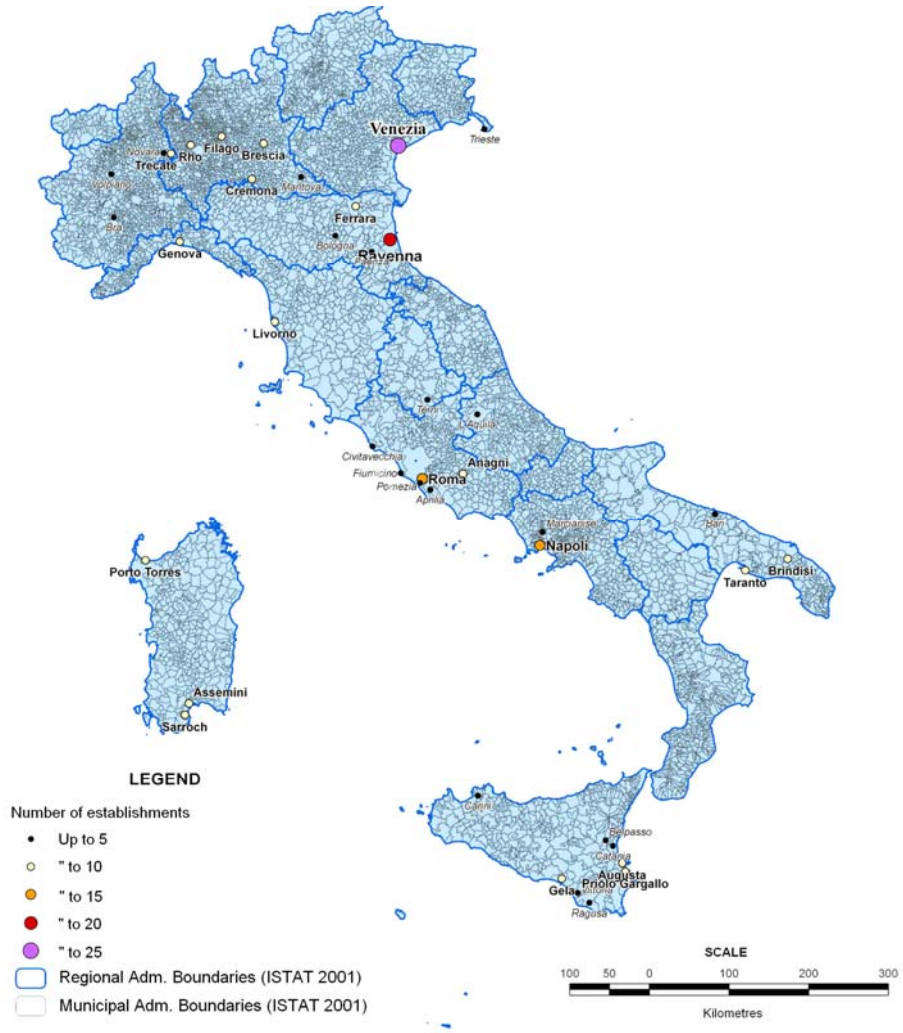


Figure 5.14: Municipalities with 4 or more Major-Accident Hazard establishments[3]

An analysis of the types of establishments involved (Figure 5.15) makes it possible to formulate further considerations regarding the map of industrial risk in our country. Using this information, the types of industrial activities most widespread among the Major-Accident Hazard establishments can be identified, together with their distribution throughout the national territory.

Knowledge of the activities of a plant makes it possible to identify the associated hazard.

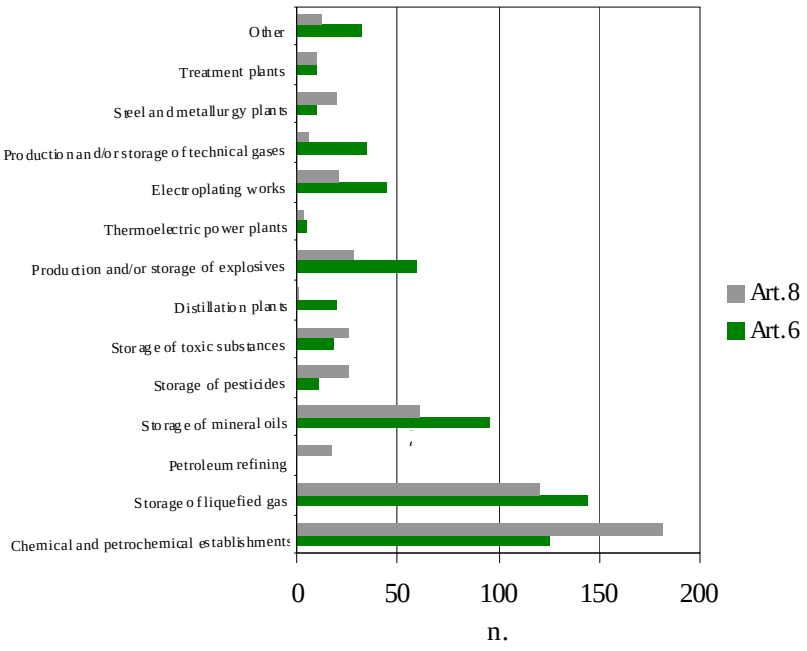
Knowledge of the activities of a given establishment makes it possible to determine in advance, albeit in general terms, the potential associated hazards. For example, storage depots of LPG and explosives, as well as distilleries and plants for the production and/or deposit of technical gases, present a predominant hazard of fire and/or explosion, with effects attributable, in the case of an accident, to irradiation or overpressure of varying extents, with the possibility of structural damage to the plants and buildings, as well as damage to man. Chemical factories, refineries, depots of toxic materials and pesticide products

[3]Source: APAT analysis supplied by the Ministry of the Environment, Land and Sea

entail, in addition to the risk of fire and/or explosion, as in the above cases, the risk of the spread of toxic or eco-toxic substances, eventually over significant distances, and thus the possibility of immediate and/or delayed threat to both man and the environment.

In terms of the types of activities located throughout the national territory, a predominance of chemical and/or petrochemical establishments was observed, together with depots of liquefied gas (essentially LPG), which, taken together, account for approximately 50% of all the establishments. Chemical and petrochemical establishments were found to be concentrated in Lombardy, Piedmont, Emilia Romagna and Venetia. The refining industry (17 plants in Italy), on the other hand, is spread more or less throughout the national territory, with especially high concentrations in Sicily and Lombardy, where the respective numbers of plants are 5 and 3. A similar observation can be made for storage depots of mineral oils, which are concentrated in the vicinity of the country's major urban areas. As for depots of LPG, they are widespread in the southern regions, and especially Campania and Sicily, in addition to Lombardy, Tuscany, Venetia and Emilia Romagna. These establishments are often found in urban areas with noteworthy concentrations in the provinces of Naples, Salerno, Brescia, Venice and Catania.

In Italy, the prevalent types of MAH establishments are chemical and/or petrochemical factories and LPG depots (approximately 50%). The first category is essentially concentrated in the northern regions, while the second is also widespread in the south.



The main types of establishments are chemical and/or petrochemical plants, plus depots of liquefied gas (mainly LPG), which, taken altogether, account for approximately 50% of all the facilities.

Figure 5.15: National distribution of establishments subject to Legislative Decree 334/99, plus subsequent modifications and additions, by type of activity[4]

[4] Source: APAT analysis of data from the Ministry of the Environment, Land and Sea

5.2.2 The causes

Distinguishing characteristics of Italy include the extensive network of LPG depots, designed to supply zones not reached by the methane network …

The pressure from Major-Accident Hazard establishments in Italy is comparable to that of Europe's other leading industrial countries, though there are undoubtedly distinguishing characteristics tied to the history and development of Italian industry, as well as to the choices made in the past, as in the case of energy supplies.

Examples are the high concentration of refineries found in Sicily and Lombardy, the major petrochemical complexes developed in the post-war years in the Po River valley (Ravenna, Ferrara) and in the Venice Lagoon (Marghera), as well as in Southern Italy (Brindisi, Priolo, Gela, Porto Torres etc.), starting in the 60's and 70's. A distinguishing characteristic of Italy, within the European framework of facilities at risk, is the noteworthy growth of the network of LPG depots, meant to supply areas of the country not reached by the methane distribution network.

…plus the presence of industrial districts with high concentrations of small and medium-size industries whose production activities are similar to, or connected with, a single production sector.

A further national characteristic is the presence of industrial districts containing a concentration of small and medium-size industries whose production activities are similar to or connected with a single sector, such as chemicals and pharmaceuticals in certain areas of Lombardy (25% of the Major-Accident Hazard establishments are found in Lombardy) and in the Pontine area, or electroplating works in Venetia, Piedmont and Lombardy. These operations are often found in congested territorial contexts, closely connected with urban settings or in densely inhabited areas characterised by the presence of population centres highly sensitive to potential accidents.

5.2.3 The solutions

The activities of response implemented in Italy are in line with those implemented in the other EU countries.

The regulatory framework for the control of the Major-Accident Hazard establishments on the European and national levels is well defined and fully developed, thanks to the three successive Community directives, together with the national legislation transposing their contents. The actions of response implemented in Italy are in line with those undertaken in other EU countries, demonstrating an essential compliance with European standards, though there is room for improvement through:

- a streamlining and acceleration of the procedure for assessing safety reports and increasing inspection controls;
- heightened awareness on the part of municipal administrations regarding problems of industrial risk, with a resulting increase in activities of control within the territory and in the supply of information to the population;
- improvement in both the quality and quantity of the activities connected with the planning of external emergencies in the event of an accident.

The improvements indicated above can be achieved when the following are present:

- definite allocations of resources for the branches of the Public Administration and the technical bodies involved, eventually through the introduction, under the Seveso regulations, of a system of fees charged to the operators of Major-Accident Hazard establishments, based on the controls performed by the P.A.;
- gradual decentralisation of the controls on the regional level, in keeping with the provisions of the Bassanini Act, following confirmation of the presence of local capacities and/or guarantees that the controls will be increased, especially in the southern regions, plus the formulation and maintenance of monitoring procedures by the Ministry of the Environment, Land and Sea;
- precise and timely definition, on the central government level, of detailed criteria and technical references meant serve as guidelines for the authorities and the local technical bodies responsible for the controls.

The agency system can make a valuable contribution to the problems connected with anthropogenic risk.

Within the above scenario, an element of key importance would appear to be reinforcement of the System of Environmental Agencies, which, given their role, as well as the know-how and experiences matured, can make a significant contribution, together with other subjects, to solving the problems highlighted.