CHAPTER 7


# ENVIRONMENTAL RISK

## Risk of Natural Origin
## Anthropogenic Risk

## Introduction

*Evaluating environmental risk means estimating the detrimental effects produced by natural events or human activities on the environment as well as on man and human activities.*

Evaluating environmental risk means estimating the detrimental effects produced by natural events or human activities (especially industrial ones) on the environment itself, as well as on humans and their activities.

As a rule, risk is defined 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. When environmental risk is involved, the level of hazard is the probability that a given natural event or an industrial accident will occur at a certain intensity in a given area and within a certain interval of time. Vulnerability expresses the capacity 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.

*Problems tied to environmental risk are analysed according to their connection with risk of natural origin or anthropogenic risk.*

In the present analysis of the problems tied to risk, it has been decided to subdivide the topic into two parts: risk of natural origin 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.

## Risk of natural origin

*Natural events may be of exogenous or endogenous origin.*

Natural events that are likely to give rise to conditions of risk can be subdivided into two main categories of underlying causes: events of endogenous origin (including for instance volcanic eruptions, earthquakes, etc.), set off by forces within the earth, and those of exogenous origin (including floods, landslides, avalanches, etc.), occurring on the terrestrial surface. The intensity and frequency of such events may range within a wide scale. Certain phenomena tend to occur in a sudden and extreme way, while others operate more slowly and continuously (subsidence is a typical example).

Both types of events are likely to cause serious damages on man and human activities.
The concept of natural risk should, therefore, be understood as an interaction between the processes of instability that "naturally" occur in the territory, remodelling its shape, and human assets, whether physical or economic, social or environmental. The interaction between the natural events referred to above and anthropogenic activities is reciprocal, with the consequence that inappropriate modes of use and management of the territory frequently result in an amplification of disturbances underway or in the triggering of new ones.

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

## 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) makes Italy one of the countries facing the greatest seismic and volcanic danger in the area. A similar level of hazard, combined with the widespread presence of exposed elements (population centres, infrastructures, elements of 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 Apennine range and especially in the sectors of the inter-Apennine basin, along the Calabrian edge of the Tyrrhenian and in Southeast Sicily (Figure 7.1).

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

*The areas facing the greatest seismic risk are found in the Friuli area, along the central-southern spine of the Apennine range, along the Calabrian edge of the Tyrrhenian and in Southeast Sicily.*

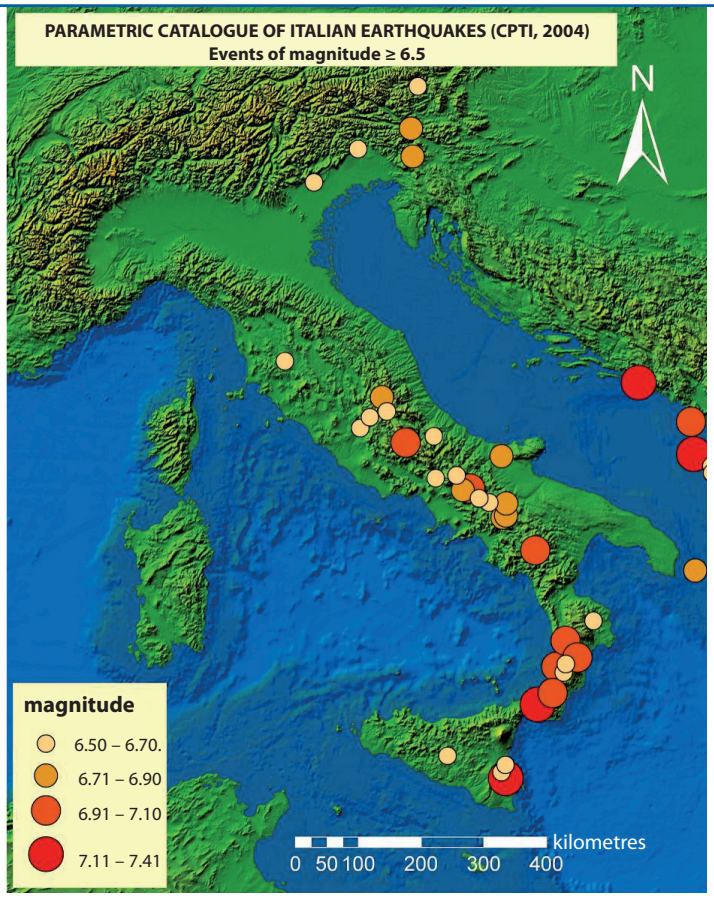


**Figure 7.1: Distribution throughout the national territory of the major seismic events of the past (magnitude ≥ 6.5)[1]**

*The conditions of greatest volcanic risk are naturally related to the proximity of Italy's active volcanoes.*

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 part, the Alban Hills (Figure 7.2). A decidedly lower level of risk, though not one entirely to be ignored, is connected

[1] Source: Parametric Catalogue of Italian Earthquakes (INGV) data processed by ISPRA

with the underwater volcanoes found in both the Tyrrhenian Sea and the Straits of Sicily. In the Tyrrhenian basin the Marsili would appear to be confirmed as 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. The danger of such volcanoes is tied not only to their endogenous activity, but also to the probable activation of gravity slides along the slopes, resulting in tidal waves.

*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.*

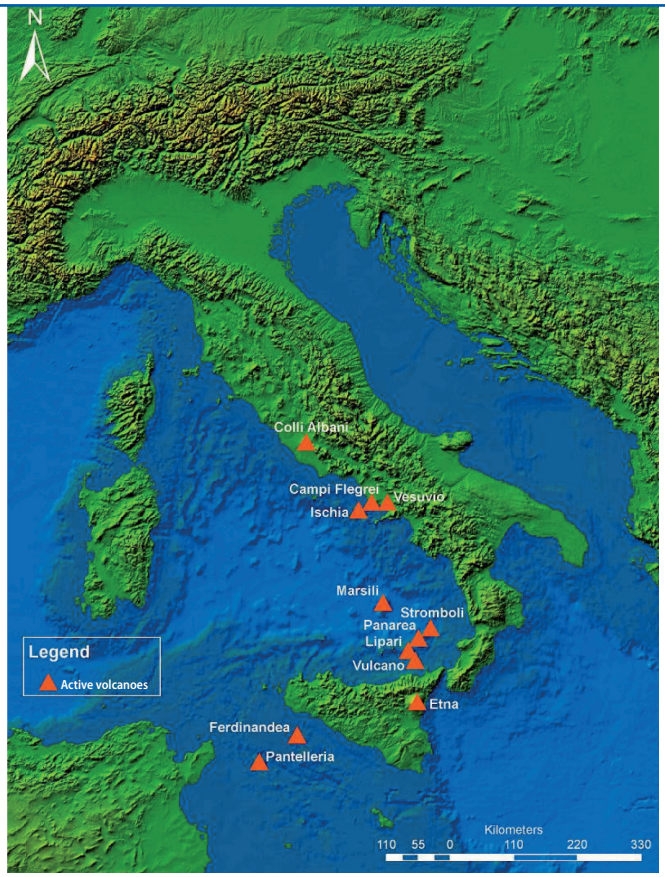


**Figure 7.2: Distribution of the main active volcanoes in Italian territory[2]**

[2] Source: Parametric Catalogue of Italian Earthquakes (INGV) data processed by ISPRA

*Seismic and volcanic events can often manifest themselves in tandem, as frequently occurs in the Etna area.*

Seismic and volcanic events can often manifest themselves in tandem, as frequently occurs in the Etna area. Furthermore, in addition to the damage tied to the seismic quake alone, further harm is done by natural events brought about by or related to the earthquake, such as landslides and falling rocks, liquefaction, consolidation, tsunami and surface faulting. Quite frequently volcanic events also present related phenomena, such as: activation of mud and/or debris flows (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

*Though there were no massive manifestations during 2007, seismic and volcanic activities remained sources of elevated risk in Italy.*
*In 2007, only one seismic event exceeded the threshold magnitude of 4.5. This event occurred in the Aeolian Islands on 4 July, at a magnitude of 4.9.*

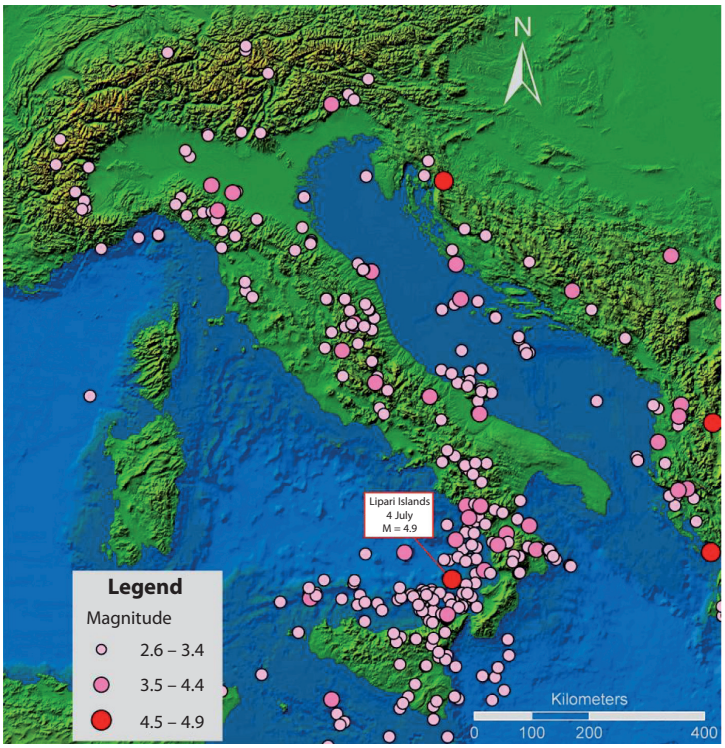


**Figure 7.3: Main seismic events registered during 2007[3]**

[3] Source: INGV data processed by ISPRA

directly on the sea bottom, as occurred at Stromboli in 2002); secondary quakes (typical of the Phlegraean fields).
There were no extreme examples of seismic or volcanic activity during the year 2007. Only one seismic event exceeded the threshold magnitude of 4.5 (Figure 7.3). Such event occurred in the Aeolian Islands on 4 July, with a magnitude of 4.9 and depth of the epicentre of 280 km. On account of the noteworthy depth of the epicentre, no significant damage occurred.

*In 2007, only one event, which occurred in the Aeolian Islands on 4 July, exceeded the threshold magnitude of 4.5.*

Landslides and flooding are among the most frequent natural disasters in Italian territory and one of the primary causes of risk for the country's socio-economic structure. In terms of the level of hazard of the events, whether they involve flooding or sliding, Italian territory presents a great variety of geological, climatic, morphological and tectonic situations. Large alluvial plains facilitate the occurrence of extensive flooding, while the dynamics of hydraulic disturbances in mountain areas are characterised by high flow speed due to the steep gradients of river and stream beds. Landslide events present an even more complex scenario, due to multiple combinations of geological, morphological and climatic factors that give rise to phenomena which vary greatly in terms of type, kinematic properties, ongoing development and extension of the areas involved.

*Landslides and flooding are among the most frequent natural disasters in the Italian territory, and one of the primary causes of risk for the country's socio-economic structure.*

Since 2002, APAT (now ISPRA, the Institute for Environmental Protection and Research) has carried out a systematic study on the main meteorological events that have occurred in Italy from the post-war period (1951) to the present, publishing pluviometric data, plus information on the types of flooding, the numbers of individuals involved and the urgent measures adopted to face the disturbances. Information on the principal floods that occurred in Italy in 2007, indicating the dates and locations of the events, the number of human deaths and the total estimated damage, is shown in Table 7.1. The information listed (indicating the period and location of flooding events) is taken from the reports published on the web by the main Italian media, while the figures on the number of victims and the total estimated damage have been taken from official sources (ISTAT, CNR, Civil Defence Department, ARPA and local government bodies).

*Since 2002, APAT (now ISPRA) has carried out a systematic study of the main meteorological events that have occurred in Italy from the post-war period (1951) to the present.*

**Table 7.1: List of the main floods in Italy (2007)[4]**

| Period of the event | Region | Deaths | Total estimated damage | Total estimated damage/GDP |
|---|---|---|---|---|
| | | n. | milioni di € | ‰ |
| 1- 4 May 2007 | Piedmont | 0 | 7 | 0.00521 |
| 4 May 2007 | Liguria | 0 | 5.75* | 0.00428 |
| 26-28 May 2007 | Veneto, Friuli Venezia Giulia, Lombardy, Piedmont | 1 | 2 | 0.00149 |
| 1 June 2007 | Liguria | 0 | | 0 |
| From 13 to 15 June 2007 | Veneto | 0 | | 0 |
| 20 June 2007 | Piedmont | 0 | 1* | 0.00074 |
| 8-9 August 2007 | Aosta Valley, Piedmont, Lombardy, Liguria, Tuscany | 0 | | 0 |
| 19-20 August 2007 | Liguria | 0 | | 0 |
| 30-31 August 2007 | Piedmont, Lombardy | 0 | 2.2* | 0.00163 |
| 26-27 September 2007 | Veneto | 0 | 100 | 0.07451 |
| 6-7 October 2007 | Abruzzo, Molise, Campania, Lazio, Marche | 1 | 50 | 0.03725 |
| 18-21 October 2007 | Sicily, Calabria | 0 | 150* | 0,11177 |
| 25 October 2007 | Sicily, Calabria | 0 | 150* | 0,11177 |
| 2-3 November 2007 | Sicily | 0 | 150* | 0,11177 |
| 22-24 November 2007 | Friuli Venezia Giulia, Liguria, Tuscany | 0 | | |

(*) Data based on funds appropriated

[4] Source: ISPRA processing of ISTAT data; Coldiretti data; CIA data; www.corriere.it; www.repubblica.it; www.rainews24.it; www.gazzettadelsud.it; www.sambenedettoggi.it; www.ilgrecale.it; www.ilmeridiano.info; http://laprovinciapavese.repubblica.it; http://www.commissarioallagamenti.veneto.it; www.meteoweb.it; www.meteoitalia.it; www.meteo4.com; www.meteolive.it; www.meteoveneto.com; www.meteotriveneto.it; http://www.protezionecivile.it; CNR-GNDCI Progetto AVI; ARPA Piedmont; Benedini & Gisotti Il dissesto idrogeologico

Data presented during the National Conference on Climate Change (organised in 2007 by the Ministry of the Environment, Land and Sea and the APAT) show a general downward trend of scarce seasonal and annual precipitation. This drop is particularly evident on the national level (-5% per century), with a sharper decrease for the regions of Central Italy, showing a negative trend of –10% per century. Furthermore, it has been noted that, during the last 120 years, in addition to a slight decrease in global precipitation, there has been a sharp reduction in the number of rainy days, combined with a significant increase in intensity. There has been an especially noticeable increase in the contribution of heavy precipitation events to total precipitation, combined with a significant decrease in the number of weak rainfall days.

Figures 7.4 and 7.5 show, respectively, data on victims and on total damage compared to GDP produced by flooding between 1951 and 2007.

Nevertheless, despite some sporadic events that occurred around the 90's [Valtellina, in Lombardy (1987), Piedmont (1994), Sarno, in Campania (1998), Soverato, in Calabria and Piedmont/Aosta Valley (2000)], there has been a downward trend in damage and victims, as compared to GDP. This can mostly be attributed to improvements in structural and non-structural systems for safeguarding the territory and mitigating risk.

The estimated economic damage amounts to no less than 5 billion euros for the last seven years. This parameter is also influenced by the course of socio-economic and demographic development whose demands have resulted in a use of the territory that does not always respect its natural role.

*Hydro-geological disruptions: in recent years there has been a downward trend in victims and damage produced by extreme events, probably due to improvements in the systems for safeguarding the territory.*

*In recent years there has been a downward trend in victims and damage produced by extreme events.*
*Only 4 events exceeded the threshold of a hundred victims. These occurred in 1998, 1966, 1954, 1951.*

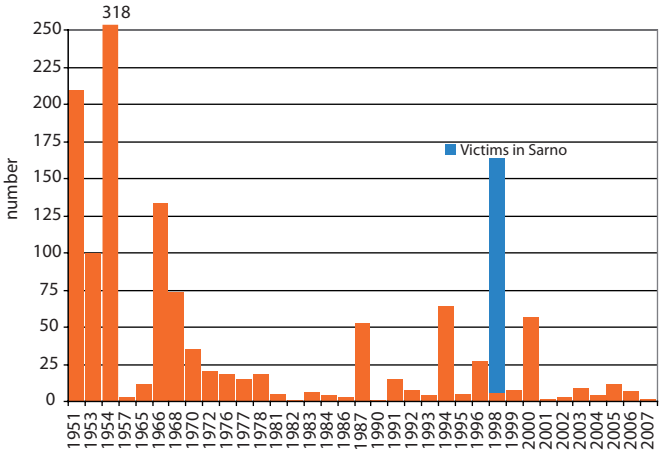


**Figure 7.4: Victims of the main floods in Italy from 1951 to 2007[5]**

*The estimated economic damage amounts to no less than 5 billion euros for the last seven years.*

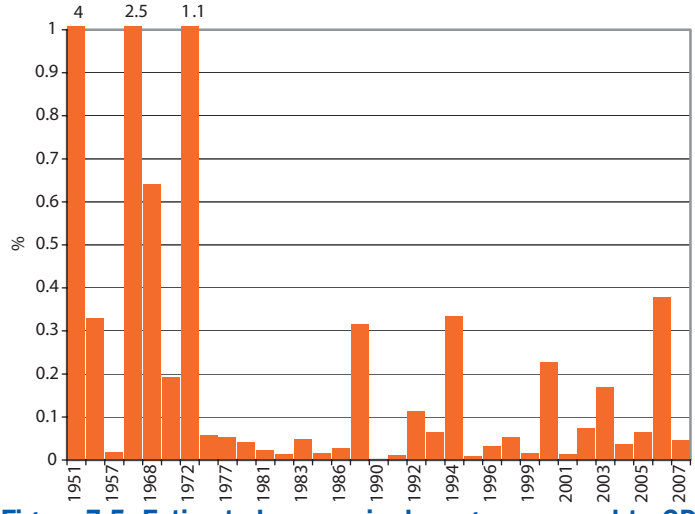


**Figure 7.5: Estimated economic damage compared to GDP, for flood events occurred from 1951 to 2007[6]**

[5] Source: ISPRA
[6] Source: ISPRA

In terms of landslide disturbances, Italy presents an especially high risk 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 Venezia Giulia (2003). A census carried out under the IFFI Project (Inventory of Landslide Events in Italy) has identified 483,272 landslides involving an area of 20,573 km$^2$, equal to 6.8% of the national territory. This census has been carried out since 1999 by the Italian Geological Service (since 2002 part of the APAT, now the ISPRA), in cooperation with 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 7.6). The data on Basilicata, Calabria and Sicily tend to underestimate the actual situation of disruption, because surveys of landslide events carried out to date have focused on areas where urban centres or major transport infrastructures are located. The data gathered by the 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 32.5%, slow earth flow, at 15.3%, rapid debris flow, at 14.6%, and complex landslides, at 11.3%. A large portion of landslide events present renewed activity over time; quite often, dormant periods of 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

*Landslides are the natural disasters that occur with the greatest frequency and, after earthquakes, cause the greatest number of victims.*
*In Italy, more than 480,000 landslides have been identified, involving an area of over 20,500 km$^2$.*

*The data gathered by the IFFI show that the most frequent types of movement (classified on the basis of the prevalent component of the movement) are rotational/translational slides.*

mud/debris flows. Not all landslides present the same level of hazard, with those involving high-speed movement and noteworthy volumes of rock or soil causing the greatest damage and number of victims.
In order to obtain a preliminary landslide risk assessment of Italian territory, landslides (recorded in the IFFI database) have been

*Italy presents an especially high risk of landslide, on account of its geological and morphological characteristics (75% of the territory is mountainous-hilly). As of December 2007, the landslides recorded covered 6.8% of the national territory.*

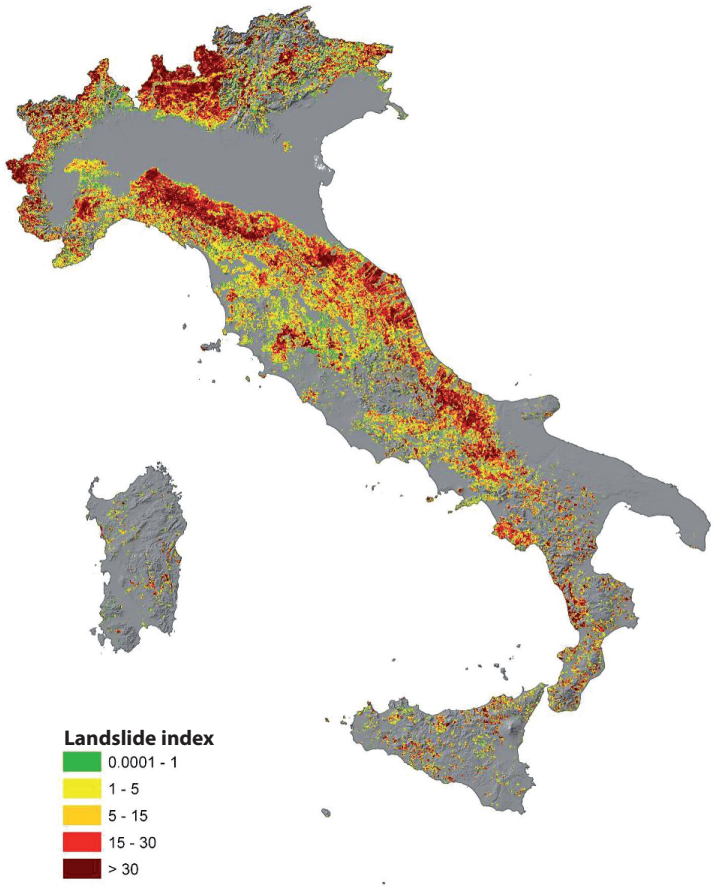


**Figura 7.6: Landslide index (%)**[7]

[7] Source: ISPRA

cross-analysed with the exposed elements (infrastructures, urban centres, etc.), taken from the Corine Land Cover 2000 (Figure 7.7).

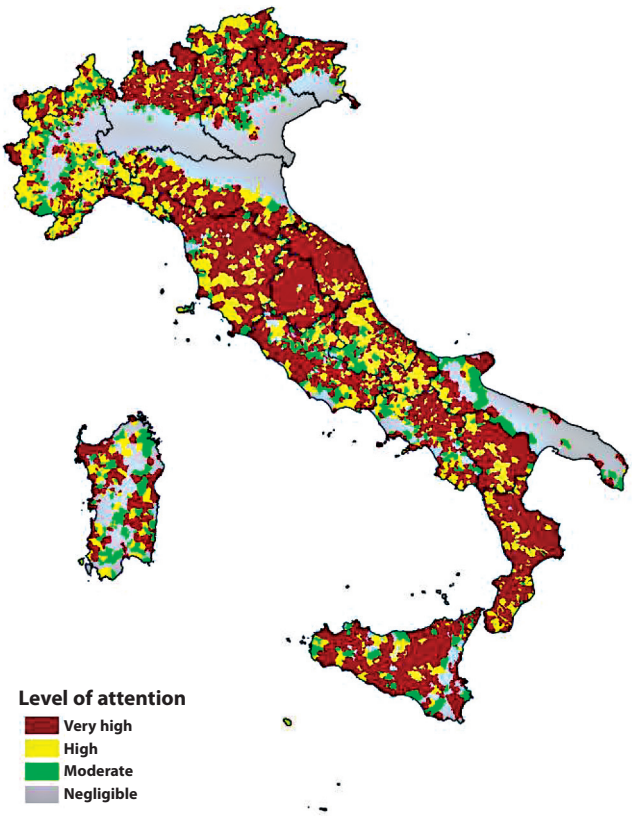


**Figure 7.7: Level of attention for landslide risk, on municipality basis [8]**

*In Italy, a total of 2,940 municipalities were classified at very high levels of attention, 1,732 municipalities require high levels of attention, 1,036 municipalities warrant a moderate level, and 2,393 call for negligible levels of attention.*

The Italian municipalities affected by landslides currently number 5,708, or 70.5% of the total, while 2,393 present negligible levels of attention (municipalities in which no landslides have been registered). A total of 2,940 municipalities have been classified at very high levels of attention (intersections between landslides and the continuous and discontinuous urban texture, as well as industrial or commercial areas),

*Italian municipalities affected by landslides currently number 5,708, equal to 70.5% of the total.*

[8] Source: ISPRA

1,732 municipalities call for high levels of attention (intersections between landslides and the highway, railway and road networks, areas used for mining, dumping and worksites), and 1,036 rate a moderate level of attention (intersection between landslides and arable lands, wooded territories, and semi-natural environments, green urban areas and sports and recreation areas), and 2,393 call for negligible levels of attention (municipalities in which no landslides have been registered). The estimated population exposed to landslide risk, on the basis of landslides recorded in the IFFI inventory and the data gathered during the ISTAT 2001 census, totals 992,403 inhabitants, equal to 1.74% of Italy's resident population. The data, grouped by municipality, show that the greatest number of individuals at risk are found in the regions of Calabria, Marche and Sicily (Figure 7.8).

*The population exposed to landslide risk totals 992,403 inhabitants, equal to 1.74% of Italy's resident populationy.*

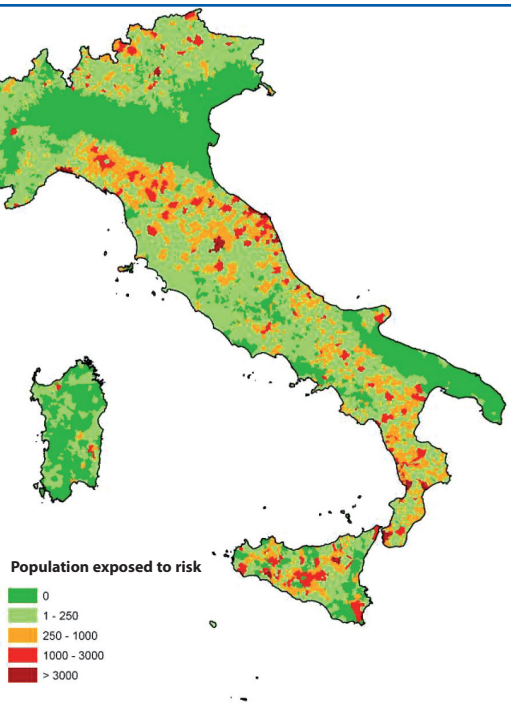


**Figure 7.8: Population exposed to landslide risk[9]**

[9] Source: ISPRA

All of Europe's coastal states are in some way affected by coastal erosion. About 20,000 km of coastline (equal to 20% of the European total) have been severely impacted. Most of the areas involved (15,000 km) are currently affected by coastal erosion, partly due to the realisation of defence works (2,900 km). Moreover, 4,700 km of coastline has been artificially stabilised.

*About 20,000 km of coastline (20% of the European total) have been severely impacted.*

The total surface area lost or severely affected by erosion is estimated at 15 km$^2$/year. In the period between 1999 and 2002, more than 250 buildings were abandoned owing to imminent threats posed by coastal erosion, while 3,000 buildings lost at least 10% of their market value. Such losses are negligible, however, when compared to the risk of coastal flooding due to the destruction of dunes or the collapse of protective works due to the action of the waves.

*The estimated total surface area that has been lost or severely affected by erosion is 15 km$^2$/year.*

Thousands of square kilometres and millions of people are exposed to this kind of risk. In the last 50 years, the population of Europe's coastal communities has more than doubled, reaching 70 million inhabitants in 2001, and the overall value of economic activities located within 500 metres of the seashore has continued to grow, reaching 500 billion-1 trillion euros. In light of estimates of climate change, the risk of erosion and flooding for urban centres, tourist resorts and industrial areas, as well as for agricultural territories, recreation centres and natural habitats, grows year after year.

*A general retreat of Italy's sandy coastlines was registered from the '70s to the present.*

Data on the erosion and flooding of coastal areas in Italy, 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 1,170 km of Italy's roughly 4,863 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 Italy's total of approximately 8,350 km of coastline.

*20% of the total Italian coastline (8,350 km) suffers from an evident state of erosion and is at risk of flooding.*

*The effect on our territory of the erosion and flooding of coastal areas is significant.*

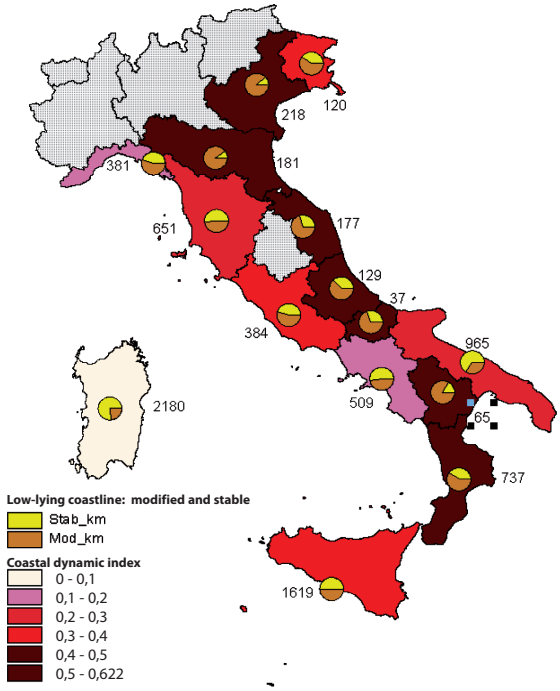


**Figure 7.9: Variation > 25m of the low-lying coastline and the index of coastal dynamic[10]**

*The integrated management of coastal areas calls for the formulation of numerical indexes to assess risk conditions.*

The need for wide-scale, integrated management of coastal areas, with appropriate steps taken 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 falling in the RICE[11] category, meaning a zone potentially subject to erosion and flooding within the next 100

[10] Source: ISPRA

[11] 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, a value of 10 m was used for the limit curve.

years (Figure 7.10a) was identified. Of note is the fact that the area potentially at risk occupies approximately 1 million hectares, equal to 3.17% of the entire national surface area, and houses more than 5 million inhabitants, or 9.12% of the entire population. Within this zone, it is estimated that a surface area of about 340,000 ha (1.12 of the national surface area) and a population exceeding 2 million inhabitants (3.69% of the total population) are exposed to a moderate-high or high risk (Figure 7.10b).

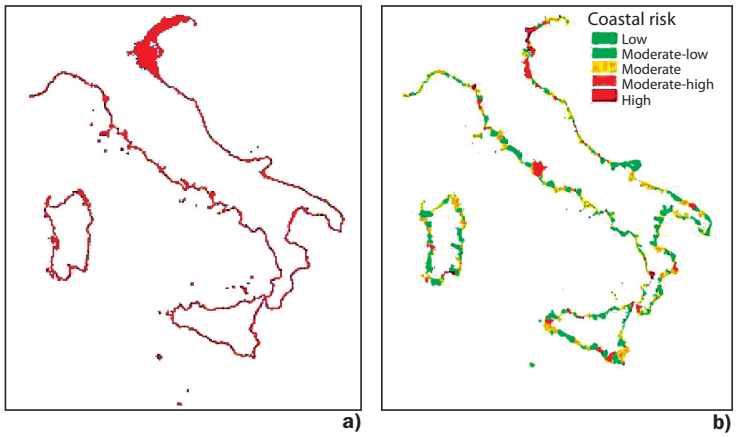


**Figure 7.10: a) RICE Area in Italy and b) Map of the coastal risk by municipality[12]**

*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 houses roughly 5.3 million 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.*

## The causes

Events such as earthquakes, volcanic eruptions, landslides and flooding occur with great frequency in Italy, owing to the geodynamic context of our country and to the morphological characteristics of its territory. These events often give rise to conditions of elevated risk, given the presence of human activities even in areas at high risk. Such activities can even contribute to the danger, modifying areas whose natural balances are already precarious (through either direct actions, such as roadway construction, excavation or overloads, or indirect actions, including negligent maintenance of defence works).

*The evolution of the main disruptive events occurring on the Italian peninsula is influenced by both natural and anthropogenic factors.*

[12] Source: ISPRA

*Physical mechanisms governing the onset and the evolution of natural hazard events are very complex and not linear.*

*Anthropogenic causes include, among others, a use of the territory that does not pay sufficient attention to the characteristics and the delicate natural balances of Italian terrain.*

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

Disruptive events are influenced by a multiplicity of "natural" factors that are mainly tied to the special geo-morphological conformation of the Italian territory, as well as to the type and extension of the vegetative coverage and conditions of weather and climate. Physical mechanisms ruling the onset and the evolution of natural hazard events are very complex and not linear, and can set off different effects from one place to the next, even in situations that would appear to be similar.

Anthropogenic causes include, among others, a use of the territory that does not pay sufficient attention to the characteristics and the delicate natural balances of Italian terrain. The management of the environment does not always respects the "environmental" traits of the territory, allowing planning and implementation of increasingly invasive works (such as embankments, dikes, canals, reclamation works and retaining walls) that prevent 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.

Coastal environments and the watersheds underneath them (subdivided into physiographic units) also present a conformation that is the end result of a complex interaction among numerous factors, the majority of which are anthropogenic. 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 slopes.

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

- reduced flow of solid river materials to beaches, due to works for the stabilisation of slopes, the control of rivers and the building of dams (primarily anthropogenic, as opposed to natural);
- the combined effects of tides and flood events, which cause heightened erosion at river mouths, where large volumes of river water reach the sea;
- a rise in the sea level due to a lowering of the terrain caused by the combined effect of natural and anthropogenic subsidence, plus eustatic movements.

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

## 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 planet's natural dynamics, meaning that there is little that man can do to control them. Nevertheless, conditions of risk 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 set 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 the zones subject to risk. Prevention consists of selecting and applying technical procedures designed on the basis of the knowledge obtained. Unfortunately, the choices 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, while prevention mostly consists of making appropriate planning choices, as well as selecting and applying technical procedures designed on the basis of the knowledge obtained. An urban planning approach that takes into consideration natural hazards (including the effects of seismic phenomena and those produced by intense meteorological events) needs to become an essential component in the decision-making process, on both the political and administrative levels.

In terms of seismic risk, for example, although it is not possible to reduce the hazard component, less vulnerable buildings should be constructed in areas exposed to this risk. The seismic classification of the national territory can be a precious tool. Having been significantly reinforced following the 1980 earthquake in Irpinia and, more recently, after the earthquake of 2002 in the Molise, by the issue of Ordinance no. 3274 of 20 March 2003 and no. 3519 of 28 April 2006 by the Prime Minister, the classification reflects the state of the art as far as knowledge of seismic risk in Italy is concerned (Figure 7.11). The Map of seismic classification provides an updated overview of the various areas of Italian territory characterised by different levels of seismic

*This map presents seismic hazard in terms of maximum ground acceleration, with a 10% probability of exceedance over 50 years on rigid terrain.*

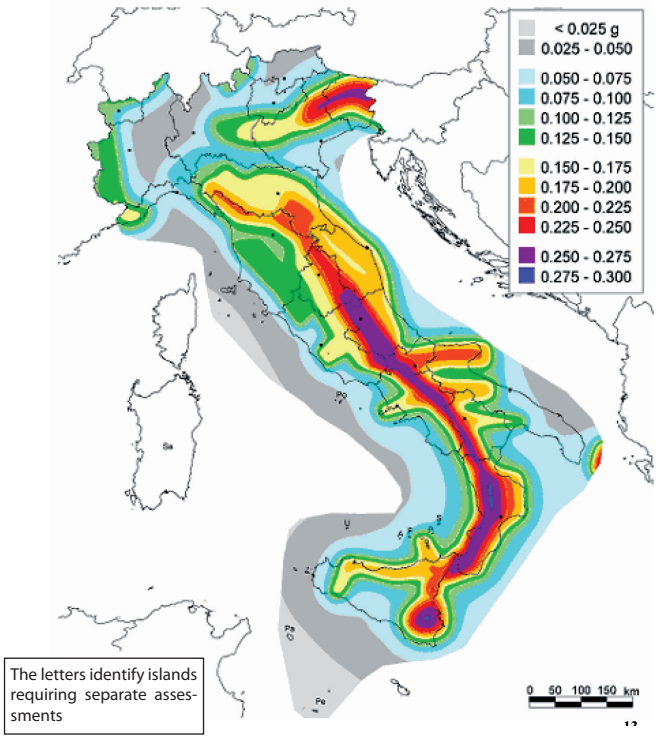


**Figure 7.11: Seismic hazard map of the national territory[13]**

*The seismic classification map provides an updated overview of the various areas of Italian territory characterised by different levels of seismic hazard, together with appropriate anti-seismic regulations for the construction of buildings and other public works.*

hazard (Figure 7.12), together with appropriate anti-seismic regulations for the construction of buildings and other public works. Unfortunately, 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 regulations 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 construction codes.

[13] Sources: INGV

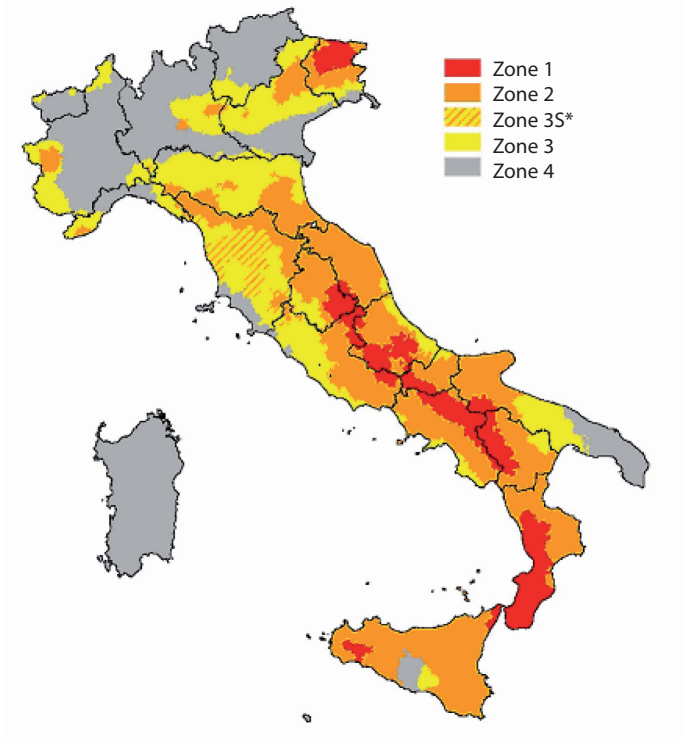


**Figure 7.12: Seismic classification map[14]**

*The seismic classification map shows Italian municipalities subdivided into four seismic areas of decreasing seismic hazard, from area 1 to area 4; these areas correspond to four classes of maximum ground acceleration presenting a 10% probability of occurrence over 50 years.*

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 review, for the purpose of managing the emergency phases of any eruptions, eventually through the evacuation of the areas held to be at risk, based

*In the case of Vesuvius and the Phlegraean Fields, the Italian Civil Defence Department has drawn up specific emergency plans for handling the critical phases of any eruptions.*

[14] Source: ISPRA
Note: The 3S* area (created for the Tuscany Region by Regional Decree no. 431/06) is based on a precautionary principle, under which the municipalities in the area, classified as facing "low seismic hazard", nevertheless follow the anti-seismic planning criteria indicated for medium seismic hazard areas (S2)

*In many sectors of Italian territory, there has been urban development on active tectonic structures capable of producing significant dislocations/deformations of the topographic surface (capable faults). In such cases, assessment of seismic risk is underestimated.*

*Policies protecting the land are governed in Italy by Legislative Decree no. 152/06, whose provisions are mant to ensure protection and reclamation of ground and subsoil, the hydrogeological reclamation of the territory and precautionary measures against hazardous situations.*

on the reference eruption scenarios. What is necessary, and should be aimed at, is a combination of planning and initiatives geared towards the decongestion of an urban situation that is simply unfeasible in an area containing active volcanic structures, together with 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 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 governed in Italy by Legislative Decree no. 152/06 on "Environment Regulation", plus subsequent modifications and updating containing provisions aiming at ensuring protection and reclamation of the ground and subsoil, the hydrogeological reclamation of the territory and precautionary measures against hazard situations. Some contents of this measure were already found in Law 183/89, which "Regulated the organisational and functional framework for land protection". This is the first law that, following a 30-year debate on assessments of land protection, has promoted an exhaustive national policy on the question. In particular, this law introduced the concept 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. A subsequent contribution to application of the regulation on the preservation of the territory from "hydrogeological disarray" 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), 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 decree has promoted research on risk conditions throughout the national territory, for the purpose of mitigating them through a policy combining forecasting and prevention. 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", implemented through later regulations. Data updated to March 2008, taken from the National Repertory of Measures and Works for Mitigation of Hydrogeological Risk (ReNDiS) drawn up by the ISPRA, show that, from 1998 to the present, the Ministry of the Environment, Land and Sea has financed, in accordance with Legislative Decree 180/98, plus subsequent modifications and updates, 2,671 urgent initiatives for the reduction of hydro-geological risk, at a total cost of roughly 2 billion euros (Figure 7.13).

*Starting from 1998, the Ministry of the Environment, Land and Sea has financed 2,671 urgent initiatives for the reduction of hydro-geological risk, at a cost of about 2 billion euros.*

*Starting from 1998, and in accordance with Legislative Decree 180/98, the Ministry of the Environment, Land and Sea has financed 2,671 urgent initiatives for the reduction of hydro-geological risk, at a total cost of roughly 2 billion euros.*

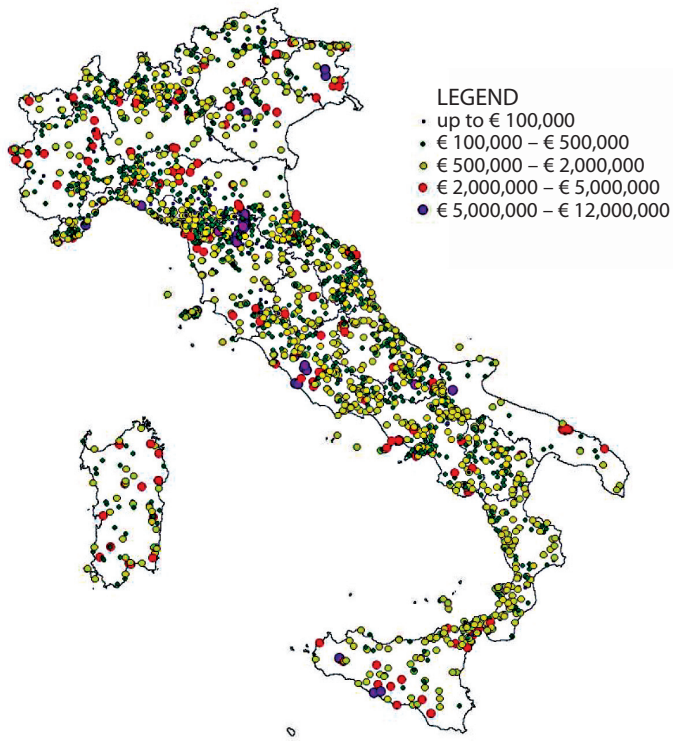


**Figure 7.13: Distribution throughout the national territory of the initiatives financed in accordance with Legislative Decree 180/98 plus subsequent modifications and updating[15]**

[15] Source: ISPRA

*The majority of urgent interventions financed in accordance with Legislative Decree 180/98 concern landslides (40%) and flood events (18%).*

The majority of the urgent initiatives concern gravity slides (40%) and flood events (18%), followed by mixed (2%) and avalanche events (1%), as well as disturbances affecting fire-damaged areas (1%). In the case of about 40% of the initiatives, the main type of disturbance is not indicated in the financing decree.

A further regulatory tool for the assessment and management of flood risk is the Directive 2007/60/EC of 23 October 2007. The "Floods Directive" aims to minimise the adverse consequences of floods – which occur with increasing frequency, due to climate change – by adopting joint cross-border policies for protection against flood risk. The Directive provides an articulated strategy consisting of a preliminary phase of flood risk assessment, followed by the establishment of flood risk maps and the development of risk management plans for areas at risk. Management plans should focus on prevention and protection.

The dissemination of information on hydro-geological instability (landslides, floods, avalanches) among the central and local bodies of the Public Administration, as well as the general population, also plays a very important role in risk prevention. Projects carried out by the ISPRA, such as the National Repertory of Measures and Works for Mitigation of Hydrogeological Risk (ReNDiS), and the Inventory of Landslide Events in Italy (IFFI), are important tools for gathering the basic knowledge required to develop proper territorial planning.

*The dissemination of information on hydro-geological instability (landslides, floods, avalanches) among the central and local bodies of the Public Administration, as well as the general population, plays a very important role in risk prevention.*
*Projects carried out by the ISPRA, such as ReNDiS and IFFI, are important tools for gathering the basic knowledge required to develop proper 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. To this end, in 2005, the APAT (now the ISPRA) 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. Since 2008, thanks to a newly-created function, WebGIS, landslides can be visualised with *Google Earth*.The dissemination of data is also a factor of noteworthy importance when it comes to analysing coastal erosion. A step held to be extremely important is making the best possible use of existing national databases (which are extremely accurate and, in theory, provide more cartographic information than do the databases of other countries), in order to offset the major shortcoming represented by

the lack of uniform, readily available knowledge. 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 fundamentals and "strategic" thematic write-ups between the various bodies and branches of the central, regional and local governments.

*The dissemination of data is also a factor of noteworthy importance when it comes to analysing coastal erosion. Existing national databases can offset the major shortcoming represented by the lack of uniform, readily available knowledge.*

Possible approaches for protecting human life and property can be classified in three main categories:

- Retreat: no action is taken to protect land from the sea. Motives for choosing this option are the huge economic and environmental impact of protective measures;
- Protection: involving operations such as as the construction of permanent protection structures, dune reconstruction, the introduction of vegetation and replenishment of beaches;
- Accommodation: meaning people going on living in the territory at risk, without attempting to prevent erosion or flood events.

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 for all of the more than 4,863 km of Italy's low sandy coasts. Even limiting efforts to the approximately 1,170 km where erosion, as of today, has already occurred would call for enormous initial investments (on the order of 2 billion euros) needing to be repeated over time, plus the use of quantities of sediment for replenishing on the order of 150-200 million cubic metres, and this only at the start, to say nothing of 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 further need to comply with current regulations in the sector.

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

Possible solutions for enacting strategies of adaptation include:

- abandoning areas to their natural course of evolution;
- preserving and/or reconstructing nature zones that serve as "soft" interfaces between the land and the sea;
- preserving and/or reconstructing coastal dunes;
- implementing strategies of territorial planning, in order to avoid further deterioration, in terms of vulnerability, with one option being planning constraints;

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

- 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 overlay the Municipal Regulatory Plans (MRP) with the recommendations of the Coastal Management Plans while making the Strategic Environmental Assessment (SEA) part of the process for assessing coastal plains. It should also be ensured that the system of assessment is independent of the subject that formulates the plan.

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

*At present 9 out of 15 coastal regions possess tools that cover their entire regional territory, in the form of coastal protection plans or integrated management plans for coastal zones.*

The first and second strategies are based on the principle of abandoning the struggle for territorial advantage 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 a project 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".

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

In terms of coastal planning, 9 out of 15 coastal regions currently possess tools that cover their entire regional territory, in the form of coastal protection plans or integrated management plans for coastal zones (see chapter 9).

The remaining regions generally adopt programmes of intervention and Regional Operating Plans (ROP) whose aim is limited to the identification of a series of protective works to be realised along short coastal segments.

The lack of general guidelines and approaches on a national level has led to the development of different regulatory plans (individual plans, as provided for by Law 183/89 and Legislative Decree 180/98, landscape plans, as provided for by Law 431/89 and Legislative Decree 94/04), and consequently various approaches in terms of planning, compulsory compliance and protection of the areas involved.

In light of the above, an increasingly urgent priority is the implementation of the EC recommendations on ICZM (Recommendations of the European Parliament and Council concerning the implementation of Integrated Coastal Zone Management in Europe-05/03/2002), through formulation of national guidelines endorsed by the government bodies and the authorities which currently hold responsibility for planning. Equally urgent is the need for a regulatory definition of the concept of "Coastal Plan", 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.

*The implementation of the EC recommendations on ICZM.*

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 interventions that will prove necessary for coastal planning call for synergy between public and private investment, as well as a coordination of local and national initiatives.*

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. A concrete action could be the result of an approach that groups initiatives on a central level, with the participation of representatives of institutions, regional governments and the academic world, for projects and programmes to be undertaken in coastal zones.

## Anthropogenic risk

Anthropogenic risk is defined as the risk (direct or indirect) caused by human activities that are potentially dangerous for both the environment and human life. This broad definition encompasses so-called "industrial risk" arising from activities carried out in industrial establishments.

*Anthropogenic risk is directly or indirectly tied to human activities that are potentially dangerous for human life and the environment.*

A "Major-Accident Hazards Establishment" (MAH establishment)

is defined as an establishment containing dangerous substances (used in the production cycle or simply stored) in quantities that exceed the thresholds established under the Seveso regulations (Directive 82/501/ EEC, plus subsequent modifications).
As a matter of fact, the handling and/or use of huge quantities of substances classified as toxic, flammable, explosive or oxidizing, and therefore dangerous for the environment can eventually lead to the occurrence and uncontrolled development of an accident posing a serious threat to human health and/or the environment, either immediate or delayed, potentially inside or outside the establishment, with fires, explosions or toxic release.
In the Eighties, the European Community took into consideration this type of establishments for the first time, in order to prevent major accidents in industrial plants and limit their consequences for man and the environment as a whole, issuing a special directive (the abovementioned 82/501/EEC, also known as the "Seveso Directive").
Operative application of the directive by the member states of the European Community has made clear the urgent need for updates and modifications, to the point where the Seveso Directive has been updated twice in the last years, under Directives 96/82/EC and 2003/105/EC, transposed into national law with Legislative Decrees 334/99 and 238/05.
These regulations aim at reducing the probability of accidents, as well as their consequences on man and the environment.
To this end, operators of potential major-accident hazards establishments are obliged to fulfil special commitments, such as the production of specific technical and informative documentation, and the implementation of safety management systems. They must also submit to inspections and controls by the competent authorities.

*The Seveso Directive, plus subsequent modifications, aims at reducing major-accident hazards, as well as their impact on man and the environment.*

## The situation

The information on major-accident hazards establishments supplied by operators to the competent authorities (including the Ministry of the Environment, Land and Sea, under the specific obligations indicated in Legislative Decree 334/99, with administrative and penal sanctions handed down in the event of failure to present the declaration, or of incorrect or incomplete declarations)

*The ISPRA, together with Ministry of Environment, Land and Sea, collects the information on major-accident hazards establishments supplied by operators to the competent authorities.*

are collected by the ISPRA, together with the Ministry of the Environment, Land and Sea, through the production and updating of the National Inventory of Major- Accident Hazards Establishments (MAH industries), as stipulated under Legislative Decree 334/99 (Art. 15, fourth paragraph), and validated through a cross-analysis with the data already in the possession of the regional governments and the regional agencies with territorial jurisdiction.

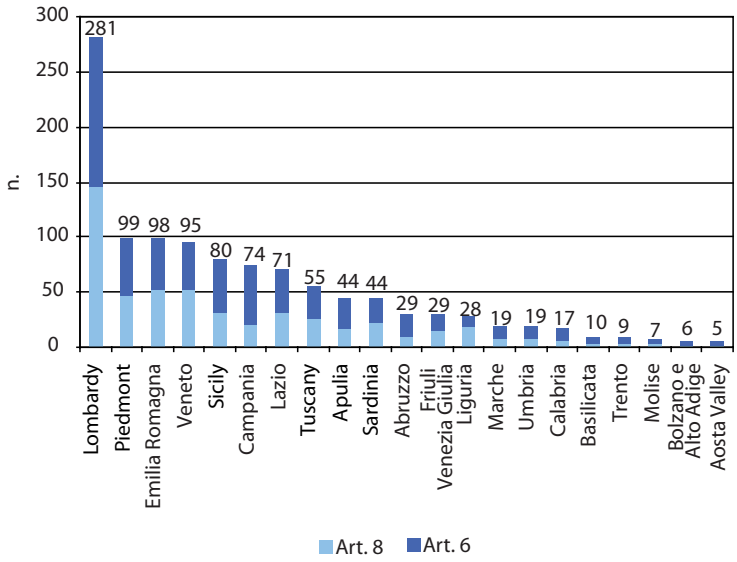


**Figure 7.14: Distribution by region of establishments subject to Legislative Decree 334/99 plus subsequent modifications and updating (30/6/2008)[16]**

*The regions with the greatest concentration of major-accident hazards establishments are: Lombardy, Piedmont, Emilia Romagna and Veneto, followed by Sicily, Campania and Lazio.*

When, for example, the following information is known:

- the number of major-accident hazards establishments, on a regional basis (Figure 7.14);
- the number of major-accident hazards establishments, on a provincial basis (Figure 7.15);

*When the number and distribution within the territory of major-accident hazards establishments is known, risk maps can be drawn.*

[16] Source: Ministry of the Environment, Land and Sea data processed by ISPRA

*The highest concentrations of major accident hazard establishments are found in the provinces of Central and Northern Italy, notably Milan, Bergamo, Brescia and Ravenna in the North, and Naples in Centre-South.*

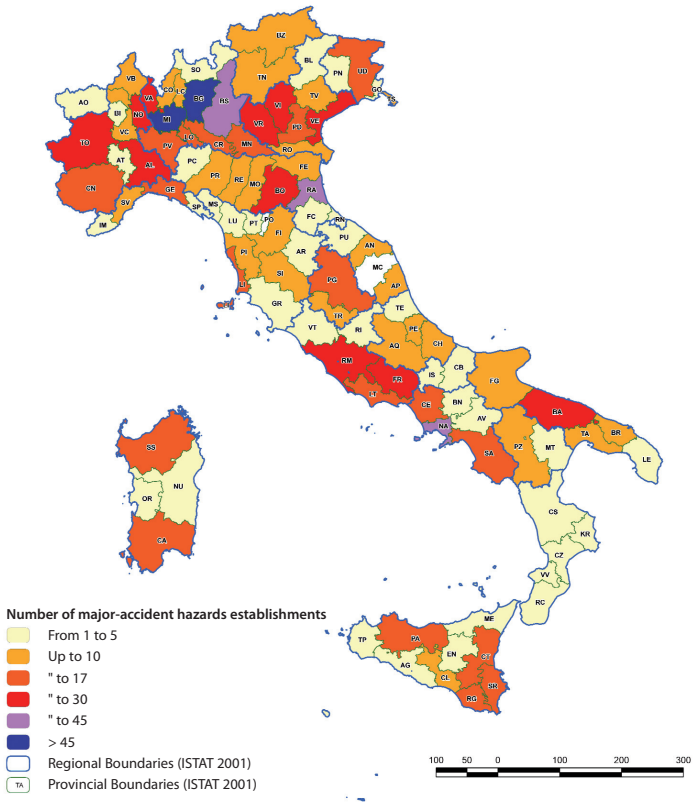


**Figure 7.15: Number of major-accident hazards establishments – Distribution by province (30/6/2008)[17]**

- the number of municipalities with 4 or more major- accident hazards establishments (Figure 7.16), then the areas with the highest concentrations of MAH establishments can be identified, in order to implement controls and precautionary measures adequate to keeping a possible accident in any one of the establishments from involving other plants and causing serious consequences both for man and the environment.

[17] Source: Ministry of the Environment, Land and Sea data processed by ISPRA

*Municipalities with 4 or more major- accident hazards establishments include Venice and Ravenna.*

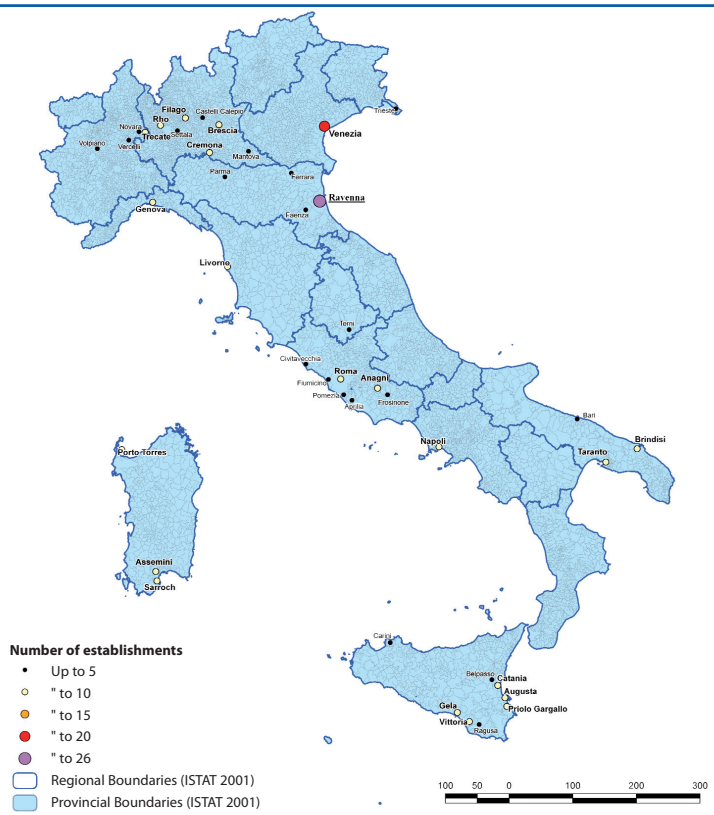


**Figure 7.16: Municipalities with 4 or more major-accident hazards establishments (30/6/2008)[18]**

An analysis of the types of establishments (Figure 7.17) also points to further considerations regarding our country's map of industrial risks. Similar information makes it possible to identify the industrial activities most widespread among the major-accident hazards establishments, as well as their distribution within the national territory.

*When the activities of an establishment are known, its potential risk can be identified.*

When the activities of an establishment are known, then its potential

[18] Source: Ministry of the Environment, Land and Sea data processed by ISPRA

*Chemical and/or petrochemical establishments, as well as liquefied gas storage facilties (mostly LPG), are the most widespread, corresponding to roughly 50% of the total number of establishments.*

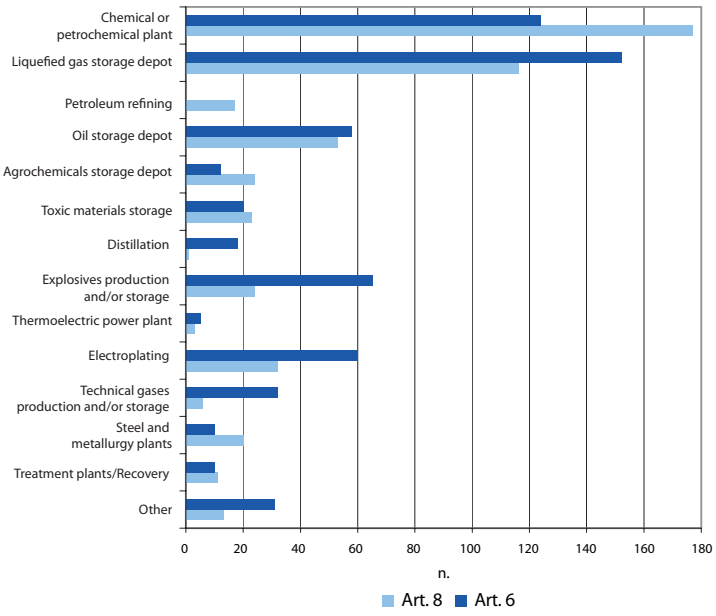


**Figure 7.17: Distribution on a national basis of establishments subject to Legislative Decree 334/99 plus subsequent modifications and updating, by type of activity (30/6/2008)[19]**

risk can be foreseen, at least in general terms. For example, storage sites for LPG or explosives, as well as distilleries and plants for production and/or storage of technical gases, present a shared risk of fire and/or explosion, with effects traceable, in the event of an accident, to radiation or overpressure of varying intensity, with possible structural damage to plants and buildings, as well as damage to human health. Chemical establishments, refineries, toxic gases and agrochemicals storage depots are exposed not only to the risk of fire and/or explosion, as in the case of the facilities referred to earlier, but also to the risk of diffusion of toxic and eco-toxic substances, even at a distance, giving rise to immediate and/or delayed danger for both man and the environment. An analysis of the types of activities that are carried out on the national territory shows a prevalence of chemical

[19] Source: Ministry of the Environment, Land and Sea data processed by ISPRA

and/or petrochemical establishments, as well as liquefied gas facilities (notably LPG), corresponding, when taken as a whole, to 50% of the total number of establishments. Chemical and petrochemical establishments are mainly concentrated in Lombardy, Piedmont, Emilia Romagna and Veneto. Refineries (17 plants in Italy) are distributed more or less throughout the national territory, with especially heavy concentrations in the regions of Sicily and Lombardy, which respectively contain 5 and 3 plants. A similar situation is observable with regard to oil storage depots, which are concentrated near the country's major urban areas. LPG tank storage sites are currently widespread in Campania and Sicily, as well as in Lombardy, Tuscany, Veneto and Emilia Romagna. The sites of these plants are often located near urban areas, and are particularly concentrated in the provinces of Naples, Salerno, Brescia, Venice and Catania.

*In Italy, there is a prevalence of chemical and/or petrochemical plants, as well as LPG facilities (roughly 50%). The former are essentially concentrated in the Northern regions, while the latter are widespread in the South.*

## The causes

The potential danger tied to the presence of major-accident hazards establishments in Italy is comparable to that of the other major European industrial countries, though Italy presents certain peculiarities tied to the development and history of its industry, as well as to choices made in the past, notably in terms of energy supply. A example worth note is the concentration of refineries to be found in Sicily and Lombardy, due to the development of major petrochemical complexes in the post-war period, as well as in the Po Valley (Ravenna, Ferrara), in the Venetian Lagoon (Marghera), and, starting from the '60 and '70 period, in South Italy (Brindisi, Priolo, Gela, Porto Torres, etc.). Within the overall European framework of establishments at risk of accident, one of the Italian peculiarities is the impressive development of the network of LPG tank storage sites, supplying gas to the areas of the country that are not reached by the methane distribution network. Another characteristic of the Italian situation is the presence of industrial districts characterised by a concentration of small and medium-size industries with production activities that are similar or belong to the same production chain, such as the chemical or pharmaceutical sectors in certain areas of the Lombardy Region (where 25% of major accident hazard establishments are located) and in the Pontine area, or the electroplating industry in Veneto, Piedmont and Lombardy. These establishments often operate in congested territories located near urban areas, or in any case densely

*One of the peculiarities of Italy is the impressive development of the network of LPG tank storage sites, supplying gas to the areas of the country that are not reached by the methane distribution network. Another national characteristic is the presence of industrial districts, characterised by a concentration of small and medium-size industries whose operations are similar or belong to the same production chain.*

populated zones, characterised by the presence of population centres that would be highly vulnerable in the event of accidents.

## Solutions

The regulatory framework on the control of major-accident hazards on the European and national levels is now thorough and complete, following the passage of three subsequent directives subsequently transposed into national legislation. Procedures adopted in Italy are in line with those applied in the other EU countries, confirming a substantial alignment with the European standards, though there is room for improvement in terms of:

- streamlining and accelerating procedures for the assessment of safety reports and the intensification of inspections and controls;
- increasing awareness of municipal administrations as regards problems tied to industrial risk, with reinforcement of the activities involved in the control of the territory and the supply of information to the public;
- qualitative improvement of activities related to external emergency planning in the event of accidents.

*Procedures adopted in Italy are in line with those applied in the other EU countries.*

The abovementioned improvements can be introduced, provided that the following requirements are satisfied:

- the certainty of resources being available to the municipal governments and the technical agencies involved, including the introduction, as provided for under the Seveso regulation, of a system of fees to be paid by operators of major-accident hazards establishments, based on the controls carried out by the Public Administration;
- progressive decentralisation of regional controls, in accordance with provisions of the "Bassanini Law", once the presence of the competent local authorities and/or guarantees of their reinforcement have been verified, notably in the Southern regions; organisation and follow-up of monitoring procedures by the Ministry of the Environment, Land and Sea;
- accurate and timely definition, on a national level, of detailed technical references and criteria, to be supplied to local authorities and technical organs responsible for activities of control.

*The Environmental Agencies System can offer a valid contribution to the solution of problems tied to anthropogenic risk.*

Within this framework, a point of vital importance is the enhancement of the Environmental Agencies System, which – given its role, competence and the experience acquired – can offer a valid contribution to the solution of many of the problems at issue.