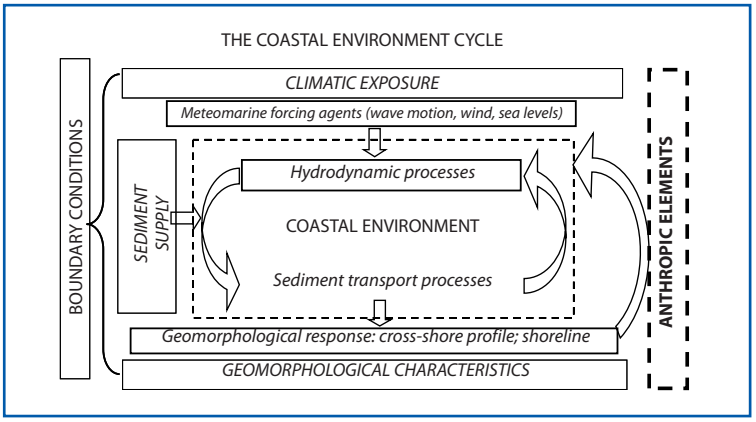
CHAPTER 9

COASTAL AREAS

Introduction

The coast is a continuously evolving area. Its changes are more clearly visible near low and sandy shores, where there are adjustments of the seashore and land surfaces that emerge and are submerged by the sea. Coastline dynamics mainly depend on the sea's action (wave motion, tides, currents and storms), but they are also influenced by all those direct and indirect natural and human activities that intervene on the coastal balance changing its morphological characteristics. The extraction of inert material from riverbeds and the stabilisation of banks and mountain slopes reduce the flow of sediments at the river mouths when they should be naturally distributed along the coast. Urban and productive settlements in coastal areas as well as land and sea transport infrastructures and protection works invade the sea and the coastal areas interacting with their natural evolution.



The situation

Europe is affected by erosion phenomena.

All European coastal states are in some way affected by littoral erosion phenomena (Table 9.1). About 20,000 km of coasts (20% of European coasts) have suffered serious impacts. In most affected areas (15,000 km) erosion phenomena are in course partly due to the realization of protection works (2,900 km). Furthermore, other 4,700 km have been artificially stabilized (Table 9.2).

European coast situation.

Table 9.1: Types of coast by nation[1]

Nation	Total shoreline length	Non erodibile rocky coast	Erodible rocky coast	Beach	Muddy coast	Artificial coast	Other**
	km	%					
Belgium	98	0	0	66	0	34	0
Cyprus*	66	9	0	67	0	20	4
Denmark	4,605	1	8	65	13	12	1
Estonia	2,548	0	6	90	4	1	0
Finland	14,018	57	0	38	4	1	0
France	8,245	25	15	31	13	15	1
Germany	3,524	0	5	64	13	18	0
Greece	13,780	39	11	47	0	4	0
Ireland	4,578	56	1	39	1	3	1
Italy	**7,468**	**15**	**28**	**50**	**0**	**8**	**0**
Latvia	534	0	0	95	2	3	1
Lithuania	263	0	3	65	19	12	0
Malta	173	78	10	5	0	7	1
Poland	634	0	0	83	14	3	0
Portugal	1,187	29	22	44	0	5	1
Slovenia	46	0	53	30	0	18	0
Spain	6,584	18	43	28	2	10	0
Sweden	13,537	56	0	38	5	1	0
Holland	1,276	0	0	35	4	60	1
United Kingdom	17,381	42	18	25	9	5	1
Others (Bulgaria, Romania)	350	-	-	-	-	-	-
TOTAL	**100,925**	**34**	**11.7**	**40.7**	**5.3**	**6.4**	**0.5**

* only 20% reported
** other assesments (virtual lines)

[1] Source: Eurosion Project, 2004

Erosion phenomena are in course along 15,000 km of coast.

Table 9.2: Extension of coastal erosion by nation[2]

Nation	Total shoreline length	Eroding shoreline (2001)	Artificial protected shoreline (2001)	Eroding shoreline next to protected stretches (2001)	Total shoreline affected by coastal erosion
	km				
Belgium	98	25	46	18	53
Cyprus	66	25	0	0	25
Denmark	4,605	607	201	92	716
Estonia	2,548	51	9	0	60
Finland	14,018	5	7	0	12
France	8,245	2,055	1,360	612	2,803
Germany	3,524	452	772	147	1,077
Greece	13,780	3,945	579	156	4,368
Ireland	4,578	912	349	273	988
Italy	**7,468**	**1,704**	**1,083**	**438**	**2,349**
Latvia	534	175	30	4	201
Lithuania	263	64	0	0	64
Malta	173	7	0	0	7
Poland	634	349	138	134	353
Portugal	1,187	338	72	61	349
Slovenia	46	14	38	14	38
Spain	6,584	757	214	147	824
Sweden	13,567	327	85	80	332
Holland	1,276	134	146	50	230
United Kingdom	17,381	3,009	2,373	677	4,705
Others (Bulgaria, Romania)	350	156	44	22	178
TOTAL	**100,925**	**15,111**	**7,546**	**2,925**	**19,732**

It is estimated that 15 km²/year of surface area is lost or compromised.

It is estimated that 15 km²/year of surface area is lost or seriously compromised. Between 1999 and 2002, from 250 to 300 buildings were abandoned due to the imminent risk of coastal erosion and other 3,000 have lost at least 10% of their market value.

These losses are even insignificant if compared to the coastal flood risk caused by the destruction of dunes and collapse of barriers against the sea.

[2] Source: Eurosion Project, 2004

In 2001, 70 million inhabitants lived in coastal areas.

This problem involves several thousands of km^2 and millions of people. Over the last 50 years, the population living in European coastal communities has more than doubled, reaching 70 million inhabitants in 2001.

The total value of economic activities located within 500 m of the shoreline has multiplied reaching an amount of 500-1,000 billion Euros.

Considering climate change forecasts, we can say that erosion and flood risks for urban, tourism and industrial settlements, agricultural land and recreational areas are growing every year.

Due to the difficulty of combining population safety and business activities with the benefits offered by natural coast processes, there has been a substantial increase in coastal protection investments over the last 15 years.

The length of new coastal stretches safeguarded by engineering works has grown by more than 900 km and, since the 1990s, 63% of eroding coasts have within 30 km of artificially stiffened coast sections.

It is estimated that by 2020 the cost of coastal erosion will reach an average of 5,400 million euros/year.

Protective action costs are growing. In 2001, public funds allocated for the protection of coasts against erosion and flood risks reached an amount of 3,200 million euros, while recent studies for UN IPCC estimated that by 2020 the cost of coastal erosion will reach an average of 5,400 million euros/year.

There are three different types of impact.

Coastal erosion has three different types of impact:

- loss of land having a certain economic value;
- destruction of natural sea defences (dune systems) as a result of even one single event causing hinterland flooding;
- failure of artificial protection systems that can potentially generate hinterland flooding.

The process of erosion and accretion of coastal areas has always existed and has contributed to moulding landscapes, creating a wide range of morphologies.

In some areas, the erosion of the hinterland caused by rain and landslides along rivers has created a considerable accumulation of sediments that are useful to coast dynamics.

These sediments, together with those deriving from coastal morphological structures (cliffs and marine sand banks), provide availability of material that is essential for the formation of

beaches and sandy dunes. Moreover, these *habitats* create a large number of benefits such as: the possibility of installing economic and recreational activities; protecting depressed areas from floods; absorbing wave energy during storms; reducing eutrophization of coastal waters, increasing biodiversity, etc.
Climate change has a significant influence on the progress of the coastal erosion phenomenon and on the evolution of marine flood risk levels of coastal areas.

Climate change influences the progress of coastal erosion and the increase of flood risk.

The Italian coast has a length of 8,353 km, of which 4,863 km are low sandy or delta coastlines (Tables 9.3 and 9.4). From a physical point of view, the latter are more vulnerable to sea action and subject to intense geomorphological dynamics.
Indeed, in Italy coastal zone risks are mainly related to erosion phenomena and to storms or floods, which are mostly relevant for low and sandy coasts and for coastal alluvial plains.

On the Italian coast, 4,863 km of low, sandy or delta coastlines are more vulnerable to sea action.

Table 9.3: Distribution of Italian coast by type[3]

Type of coast	km	%
Natural	7,687	92
Artificial	314	3.80
Fictitious	352	4.20
TOTAL	**8,353**	**100**

Table 9.4: Distribution of natural coast by type[4]

Type of coast	km	%
High	2,824	36.7
Low	4,863	63.3
Natural	**7,687**	**100**

[3] Source: ISPRA
[4] Source: ISPRA

In the last century, the coastal system suffered a very strong anthropisation process that, in some areas, has considerably changed and altered the natural and environmental features of the territory.

The coastal system suffered a very strong anthropisation process.

Due to their accessibility, low coastal areas are more densely occupied by residential settlements and considerable business activities (even for tourism) as well as road and sea transport infrastructures. Indeed, in Italy more than 300 km of coasts host commercial and leisure port facilities.

In Italy, over 300 km of coasts host commercial or leisure port facilities.

According to surveys carried out by the National Statistics Institute (ISTAT), 16.8 million inhabitants permanently live in the 642 coastal municipalities, which represent about 30% of the total population. This gives an idea of how populated coastal areas actually are in Italy, given that both seasonal and tourism flows are not included.

About 30% of the total population lives in the 642 coastal municipalities.

Coast urbanization has transformed the evolution of littorals and has turned the natural phenomenon of coastal erosion into a serious problem, particularly near urban centres where homes, infrastructures and economic activities are at risk.

There are many human activities in coastal zones (industries, tourism, fishing, aquaculture, etc.). Problems arise when these activities tend to develop together on the narrow coastal strip and come into conflict both with each other and with the interest of protecting natural environments and landscape.

Data on land use collected by the Corine Land Cover 2000, covering an area of 10 km from the coast towards the hinterland (Figure 9.1), shows that 58.7% of land is used for agriculture and 6.6% is occupied by urban centres, industries and road, air and sea transport infrastructures. In other words, in Italy two thirds (over 65%) of land included within the 10 km strip from the shore, is used for human activities and is moulded even by invasive and irreversible human intervention on the environment (Figure 9.2).

58.7% of land included within the 10 km strip from the shore is used for agriculture while 6.6% is occupied by urban centres, industries and road, air and sea transport infrastructures.

Artificially moulded land in the area within the 10 km strip. The red areas show where the land is more densely occupied by artificial structures. These are located near the most important coastal cities (by number of inhabitants and commercial, industrial and maritime activities).

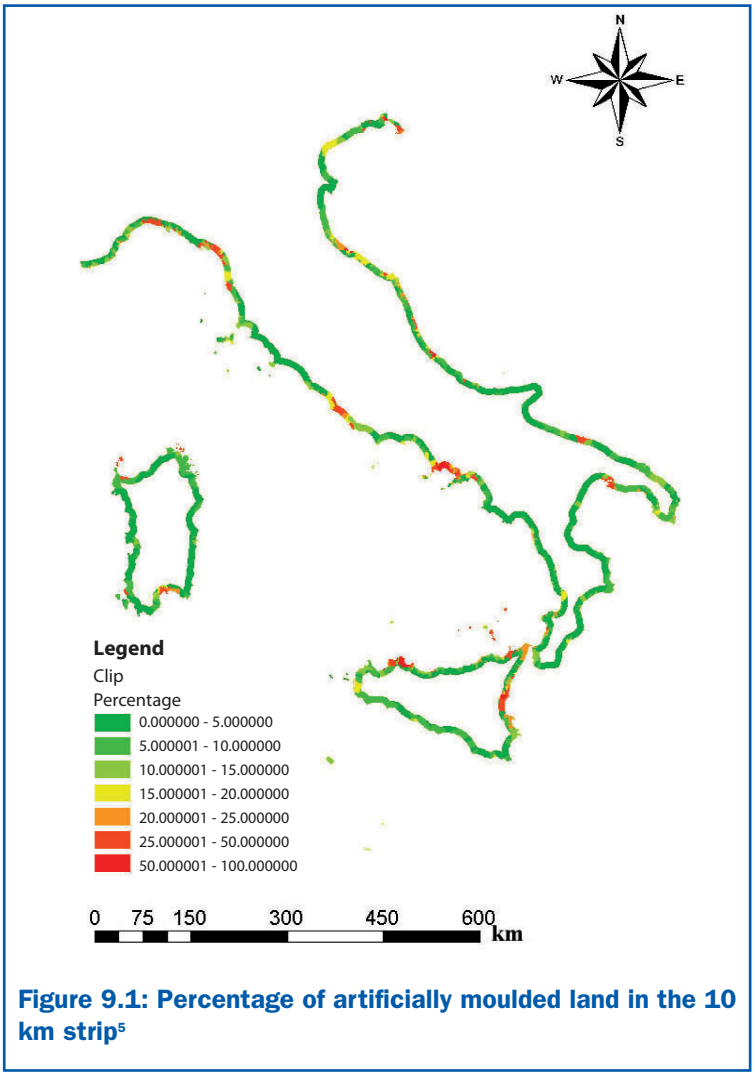


Figure 9.1: Percentage of artificially moulded land in the 10 km strip[5]

[5] Source: ISPRA

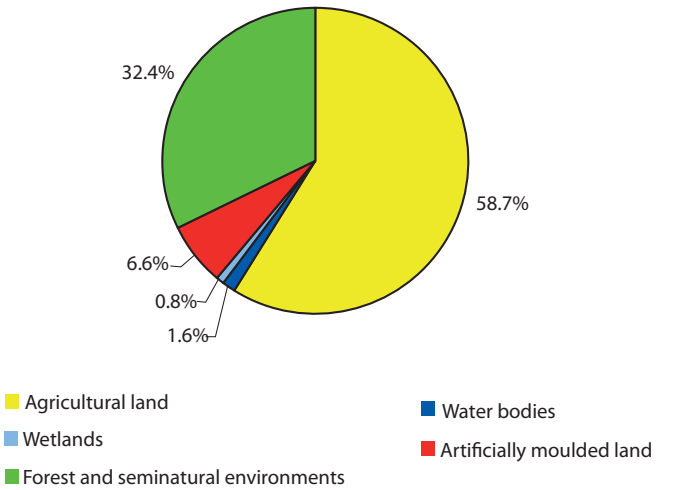


Figure 9.2: Land use in Italy in the area within 10 km from the shore towards the hinterland[6]

Over 65% of land included within the 10 km strip from the shore is used for human activities and moulded by invasive and irreversible intervention on the environment.

The concentration of activities in a reduced space has a considerable influence on the natural dynamics of coastal zones, with specific reference to sandy shores. These are further complicated by strong variations induced by tourist activities and by environmental pressure over the years. Indeed, with effect from the 1950s, the coast is not only considered an area for trading of goods and construction of ports facilities. In general it is not only used for maritime activities. It is also an area used for living, leisure and profit-making through tourist activities. This has caused an additional occupation of land, due to urbanization, and a further irreversible invasion of the coastal environment.

The coastal risk was identified as a serious national problem as early as the 1970s. Over the years, coastal erosion has become a very important social and economic issue for the country and has often been the theme of assessment studies and impact estimates.

The coastal risk is considered a serious national problem since the 1970s.

[6] Source: ISPRA

According to a study carried out by the "De Marchi Commission", erosion processes have involved the main river mouths and large sections of coast since the 1950s.

The national situation (1968-1969) of the erosion phenomenon (Figure 9.3) was analysed within the framework of activities carried out by the *Commissione Interministeriale per lo Studio della Sistemazione Idraulica e della Difesa del Suolo* (Interministerial Commission for the Study of the Hydraulic Arrangement and Land Protection known as the "De Marchi Commission"). Results highlighted that since the 1950s erosion processes have involved all of Italy's main river mouths as well as large sections of the coastal strip.

The Atlas of the Italian Beaches (1985-1997) confirms the persisting erosion of main river mouths and worsening of coast erosion phenomena.

Subsequent studies, conducted at national scale in the period 1985-1997, were published on the well-known Atlas of the Italian Beaches (CNR, MURST, 1997) (Figure 9.4). They confirmed that main river mouths are continuing to erode and that coast erosion phenomena are generally worsening. Mitigation cases were found almost exclusively near stretches of coast where local protection interventions had been planned.

Studies conducted in different periods show that erosion phenomena persist and worsen with time.

Figure 9.3: Map summarizing eroding coast sections[7]

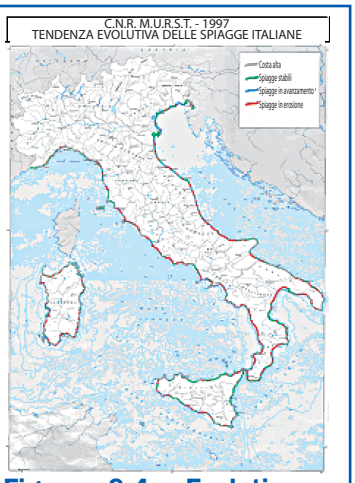


Figure 9.4: Evolutionary trend of Italian beaches[8]

[7] Source: De Marchi Commission
[8] Source: Atlas of the Italian Beaches, CNR-MURST, 1997

Italy is among the countries having the highest risk of coastal erosion.

A study conducted by ISPRA in 2005 identified the geomorphological features of Italian littorals and assessed shoreline variations over the last 40-50 years.
Based on uniform methodology and information at national scale, the outline of the coastline was traced and developed from colour zenital orthophotos obtained from flight IT2000 and compared to the coast-line obtained from mosaics IGM 1:25,000.
As a result, Italy is among the countries having the highest risk of coastal erosion in Europe.
Table 9.5 summarizes the analysis of variations in the Italian coasts over the last 50 years. It shows that 30% of the littoral is subject to an intense geomorphological evolution.
Moreover, the study showed that only in the low coasts (Table 9.6) out of the 4,863 km of low and delta coasts in Italy, 1,170 km are definitely eroding. In other words, over the last 50 years 24% of sandy coasts suffered an average erosion of over 25m.

Table 9.5: Stable and amended coast, both decreasing and increasing[9]

COAST	km	%
TOTAL	**8,353**	**100.0**
Stable	5,385	64.5
Amended	2,448	29.3
Unclassified	520	6.2
Amended	**2,448**	**29.3**
Decreasing	1,285	15.4
Increasing	1,163	13.9

Table 9.6: Stable and amended low coast both decreasing and increasing[10]

COAST	km	%
TOTAL	**4,863**	**100.0**
Stable	2,387	49.1
Amended	2,227	45.8
Unclassified	248	5.1
Amended	**2,227**	**45.8**
Decreasing	1,170	24.1
Increasing	1,058	21.7

30% of the coast is subject to an intense geomorphological evolution. Furthermore, over the last 50 years, 24% of sandy coast has decreased by an average of over 25 m.

Table 9.7 shows that the most affected regions are: Sicily (with as many as 313 km of strongly eroded coast); Calabria (208 km), Apulia (127 km), Sardinia (107 km), Lazio (63 km) and Tuscany (60 km). With regard to coast length, most decreasing beaches are found in Marche (38.6%), followed by Basilicata (38.1%), Molise (34.7%) and Calabria (32%).

The regions that are mostly affected by coast erosion are: Sicily (313 km), Calabria (208 km), Apulia (127 km) and Sardinia (107 km).

[9] Source: ISPRA
[10] Source: ISPRA

Table 9.7: Variation of Italian coast shorelines and surface areas[11]

Region	Total coast	Natural coast			Analysis of low coast modifications (variation > +/- 25m)											
					Shoreline										Surface area	
		Total	Low coast		Stable		Unclassified		Modified							
									Total		Erosion		Progress			
	km	km	km	%	km	%	km	%	km	%	km	%	km	%	Erosion km²	Progress km²
ITALY	**8,353**	**7,687**	**4,863**	**63.3**	**2,387**	**49.1**	**248**	**5.1**	**2,227**	**45.8**	**1,170**	**24.1**	**1,058**	**21.7**	**54.2**	**49.1**
Liguria	381	302	140	46.5	59	41.9	8	5.9	73	52.2	28	19.9	45	32.4	1.3	1.9
Tuscany	651	614	280	45.5	138	49.5	10	3.4	132	47.1	60	21.3	72	25.8	4.3	4.4
Lazio	384	356	273	76.8	117	42.9	13	4.6	144	52.5	63	23.1	81	29.5	2.2	3.1
Campania	509	450	224	49.8	116	51.9	6	2.7	102	45.5	55	24.7	47	20.8	2.4	1.6
Basilicata	65	64	40	62.3	7	16.3	0	0	34	83.7	15	38.1	18	45.6	1.4	1.4
Calabria	737	691	636	92.1	252	39.7	4	0.6	380	59.7	208	32.7	172	27	8.7	6.7
Apulia	965	893	689	77.1	431	62.6	33	4.8	225	32.6	127	18.5	98	14.2	3.6	2.9
Molise	37	33	33	100	10	30.8	0	0	23	69.2	12	34.7	12	34.5	1.2	0.5
Abruzzo	129	115	113	98.3	42	36.9	0	0.1	71	63.1	32	28.3	39	34.8	1.7	1.4
Marche	177	156	140	89.7	39	28.3	9	6.4	91	65.3	54	38.6	37	26.7	3.1	1.2
Emilia Romagna	181	162	162	100	11	6.5	58	35.5	94	57.9	41	25.3	53	32.6	4.7	5.0
Veneto	218	166	166	100	13	7.8	56	33.8	97	58.3	35	21	62	37.3	2.5	4.5
Friuli Venezia Giulia	120	74	74	100	29	40.1	1	1.2	43	58.7	20	26.6	24	32.1	0.8	2.9
Sardinia	2,180	2,106	785	37.3	580	74	29	3.7	175	22.3	107	13.6	68	8.7	2.8	4.6
Sicily	1,619	1,505	1,108	73.7	542	48.9	22	2	544	49.1	313	28.3	231	20.8	13.5	7.0

In Italy, over the last 50 years, 54 km² of coastline was subject to significant erosion.

According to findings of Eurosion (project commissioned by the General Directorate Environment of the European Commission) every year Europe looses about 15 km² of beaches. Only in Italy, over the last 50 years, as many as 54 km² of coastline were subject to significant erosion. The total balance between decreasing and increasing areas is, in any case, negative with a final coastal land loss of about 5 km². Entire beaches have disappeared or have been considerably reduced, with a land value loss both from an environmental and economic point of view. In many cases, the reduction of shorelines has created serious concern for the security of roads and railways, especially in the event of rough seas.

Considering the evolutionary trend of Italian littorals and the concentration of activities and urban settlements along the coast, it can be assessed that the area subject to potential flood risk

[11] Source: ISPRA

(RICE - Radium of Influence of Coastal Erosion[12]) (Figure 9.5) in coastal areas covers 954,379 ha. This is equivalent to 3.17% of the national surface and involves 5,276,535 people (9.12% of the whole population). It is also estimated that 336,746 ha of land (1.12% of the national surface) and 2,133,041 people (3.69% of the total population) are exposed to a medium-high and high risk.

The area subject to potential flood risk (RICE), in coastal areas, is equivalent to 3.17% of the national surface and involves 9.12% of the whole population.

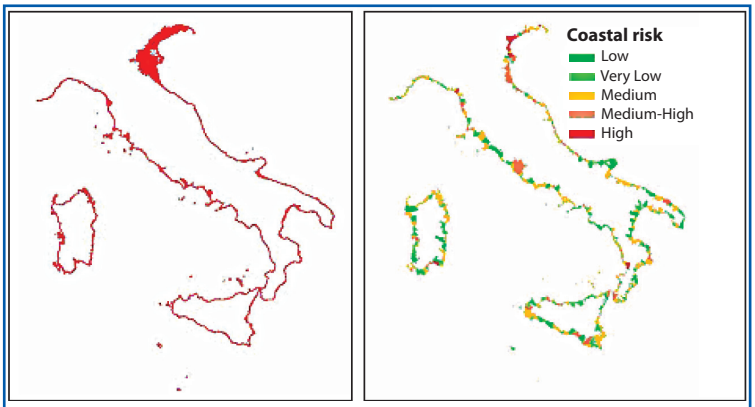


Figure 9.5: RICE area in Italy and map of coastal risk by municipality[13]

It is estimated that 336,746 ha of land (1.12% of the national surface) and 2,133,041 people (3.69% of the total population) are exposed to a medium-high and high risk.

Erosion is growing and is destined to worsen. Over the years, the expansion of areas subject to flood risk has motivated interventions aimed at controlling this phenomenon with the realization of works to protect the coastline. However, hard structures have not resolved the erosion problem, especially in the medium and long term. Indeed, in many cases they have contributed to

Protection interventions with hard structures have not resolved the erosion problem.

[12] The RICE area is defined as all terrestrial areas located: within 500 m from the coastline and extended to areas lying under 5 m* above sea level. (*) Taking into account that errors can be made when defining the DTM (Digital Terrain Model). To avoid underestimation of areas below 5m, 10m was considered the limit contour line.

[13] Source: ISPRA

increasing the process of artificialisation and marine/coastal habitat degradation. Only in the last decade have beach replenishing interventions taken place using sands from land and sea quarries, either soft or protected by hard structures.
Figure 9.6 shows the distribution of protection and harbour works over the whole national territory.

Distribution of protection and harbour works over the national territory. Sicily, where about three quarters of the coasts are low, has realised three times as many protection works as Sardinia. Two thirds of Sardinian coasts, instead, are high and rocky. For this reason it requires fewer protection works with respect to other regions on the Adriatic coast.

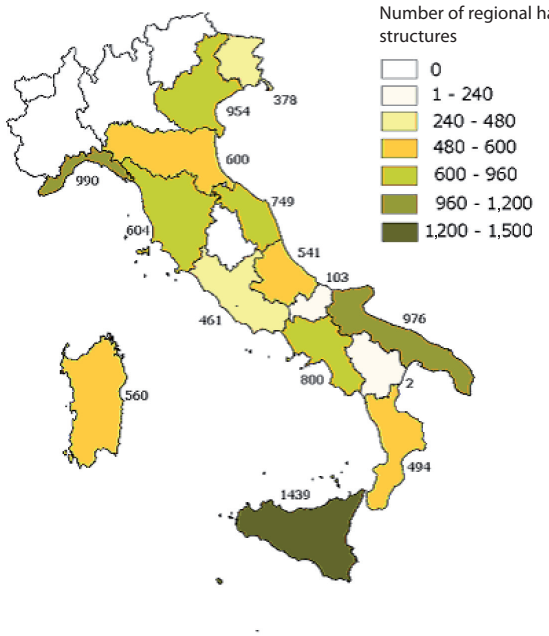


Figure 9.6: Distribution of harbour and protection works by region[14]

Decisions on the type of works to undertake and resources needed have been influenced by elements such as the geomorphological characteristics of littorals, exposure to meteo-marine events and the intensity of sea storms.

[14] Source: ISPRA

Adriatic regions such as Emilia Romagna, where the shores are mainly sandy, have an intense concentration of hard structures detached from the shore (submerged or emerged breakwaters). The Northern Adriatic coast is essentially protected by groins and natral rock revetments, built directly on the coastline or mixed solutions.

Adriatic regions, which have sandy littorals, have a high concentration of hard structures detached from the shore.

Thyrrhenian coasts are protected by breakwaters and mixed protection works. These marine protection works combine several types of protection structures or works which, after the initial design (following interventions of completion or lengthening) are currently considered unclassified.

Thyrrhenian coasts are protected by reefs and a combination of protection works.

The distribution of works carried out in Italy's two main islands, Sicily and Sardinia, is the clearest example of the direct relationship between the geomorphological nature of coasts and the use of economic and administrative resources required to control coast erosion phenomena.

Sicily, where three quarters of the coasts are low, has realised three times as many protection works as Sardinia. Two thirds of Sardinian coasts, instead, are high and rocky. For this reason it has fewer protection works than other regions on the Adriatic coast.

Sicily, where three quarters of the coasts are low, has realised three times as many protection works as Sardinia.

Unfortunately, on all sections of Italian coasts, the planning and execution of protection works mainly occurred without taking into account the dynamics of physiographic units and considering only the administrative limits of the executing body.

This approach, as well as the urgency of carrying out the works, has often affected results. Indeed, protection works limited to a short stretch of eroding coast can worsen the situation or even cause new erosion phenomena on adjacent non-protected shores.

Causes

In brief, the phenomenon of erosion on Italian coasts is constantly increasing due to:

The phenomenon of erosion in our country is constantly increasing.

- the reduction in the contribution of solid river sediments flowing towards beaches, either collected from riverbeds or caught up by slope stabilization, river control and dam works (due primarily to human activity, as opposed to natural action);

- sea storms occurring in concomitance with floods causing paroxysmal erosion phenomena at river mouths;
- the relative increase in sea level and concomitant lowering of land level due to natural and human-induced subsidence processes.

In ancient times, the large expanse of the Italian coast was due to deforestation caused by the intensification of trading and agricultural activities, first by the Italic and then by the Roman people. This activity increased the speed of land erosion processes in the countryside and in the hilly area, favouring the flow of large quantities of sediment through rivers to the sea. Many river mouths therefore benefited, receiving a great availability of sediment. This enabled the development of wide and branched deltas and favoured the structuring of coastal plains as well as the progradation of beaches. In recent times, this availability of sediment has lacked due to: control of water flows, urbanization of coasts (with the dismantling and hardening of dunal structures), cautious use of soil (to reduce loss of fertile soil) and stabilization of slopes. This has favoured beach regression and triggered off erosion phenomena in the whole peninsula. The blockage of sediment and the drainage of water for irrigation and reclamation works (which have created healthy soils in many coastal strips) have contributed to creating vast depressed areas subject to floods, which today are below sea level.

Coastal erosion and floods caused by average sea level variations and violent sea storms have a serious impact on the loss of biodiversity, of landscape and environmental heritage (coastal pine woods, dunes, beaches, etc.) and of areas where very valuable economic activities can be developed.

In coastal management, there is clearly a need to collect adequate information on: sea storm intensity; wave height, sea level, river and coastal sediment flow.

Response

Regulations

In the last decades, following the growing occupation of coasts, the widespread practice of unlawful building and lack of land and coastal management criteria, there is a greater awareness of the

There is a greater awareness of improving coastal management.

need to improve land management. Over the years, this has generated specific regulations at European level as well as national strategies, regional plans, studies, inventories and researches. Indeed, today many regulations and tools are applied, which contribute to protecting the coastal environment. In Italy the main regulations on coastal areas are indicated below.

The main regulations.

- The Marine Navigation Code, which regulates action on state maritime property.
- Law 431/85 (Galasso law) which establishes landscape obligations in the coastal strip within 300 m from the water's edge. However, these are very general, passive and insufficient in contrasting the growing coast transformation initiatives.
- Law 183/89 on land protection, since replaced by Legislative Decree 152/06, which gives the State the function of defining general approaches, criteria and administrative functions on the protection of coast in basins and areas of national relevance for the security of the State and maritime navigation. In other areas, administrative functions are carried out by the regional authorities.
- Legislative Decree 112/98 gives the state the function of defining general approaches and criteria for protecting coasts. Administrative functions related to planning and integrated management of interventions for the protection of coasts and inhabited areas are given to regional authorities. The subsequent Legislative Decree 96/99 also involves provincial authorities in the administrative part. Land protection and specifically coast erosion problems have contributed to increasing the awareness on the need to allocate resources and plan interventions aimed at preventing risks and taking emergency action.

In carrying out the functions conferred to them by Legislative Decree 112/98, regional authorities have issued regional laws for the preparation of action plans to protect the coastal strip. Some of them (i.e. Liguria, Emilia Romagna and Marche) have also adopted integrated coast management programmes to enforce European Parliament Recommendation of 30/05/02.

Regional laws have been issued for the preparation of action plans. Liguria, Emilia Romagna and Marche have adopted integrated coast management programmes.

Coastal environment planning and management activities are still weak and extremely fragmented due to the different duties conferred to a considerable number of different players.

Plans for managing coastal zones have been defined. Systematic activities that monitor and analyse vulnerable areas are being carried out.

Knowledge

Over the last few years, assessment of coastal risk and coastal management has acquired fundamental importance in defining environmental and civil protection policies.

Plans for managing coastal zones can only be based on systematic activities that monitor and analyse vulnerable areas in order to identify the most adequate provisions to protect sensitive and intensely exploited areas.

The need to face this problem at national, regional and local scale has generated sector studies promoted by the European Commission Environment DG and INTERREG programmes (EUROSION, SANDPIT, BEACHMED, MESSINA, CADSEALAND and BEACHMED-e). These have led many European countries to create increasingly consistent data bases that include essential variables for environmental characterisation focussed on assessing risks associated with coastal areas.

Crucial coast management problems.

Researchers are facing crucial coast management problems such as:

1) Reconstruction of the climate in the Mediterranean. These include trends and variability with different time scales, in which interaction between ocean and atmosphere and currents play a significant role. There is still insufficient in-depth knowledge of these issues;
2) Identification of climate change caused by the increase in human factors (emissions of CO_2 and other greenhouse gases, aerosol, etc.) and their impact on coasts.

To this purpose, it is necessary to continuously observe and document aspects such as: physical and geoenvironmental characteristics; the extent and dynamics of coast transformation; the progress of anthropisation and exposure risks due to natural processes or human activities.

The sea's physical characteristics are based on wave measurement buoys.

With regard to the sea's physical characteristics, in Italy wave observation is based on wave measurement buoys (Figure 9.7) and satellite systems. Both systems do not provide sufficiently long and geographically distributed time scales to identify the variability and trend of wave climatology.

Distribution of wave measurement buoys, which define the sea's physical characteristics.

Figure 9.7: Distribution of wave measurement buoys[15]

Data provided by wave measurement buoys have been generally available since the second half of the 1980s while satellite data have been available since the first half of 1990s. Knowledge of past events is based on simulation models which, however, are imprecise due to the inaccuracy of the "wind" variable. An analysis of available data shows that during the second half of the 20th Century there was a reduction in the average intensity of sea storms during winter months (Figure 9.8) and even a reduction of extreme events, although this is limited to a central strip of the Mediterranean which involves the South of Italy (Figure 9.9).

[15] Source: National wave measurement network (ISPRA)

During the second half of the 20th Century there was a reduction in the average intensity of sea storms in the Winter months and extreme events also reduced.

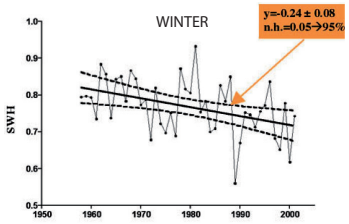


Figure 9.8: Average significant wave height: current trends[16]

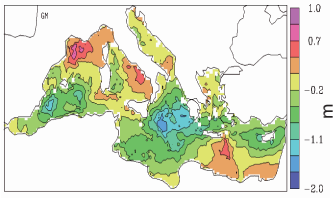


Figure 9.9: Extreme values of significant wave height: current trends, 44-year statistic of extreme winter events, ERA40 simulation[17]

Fewer problems are found with data on average sea level, due to the availability of sufficiently long time series.
However these are related to a limited number of areas (Figure 9.10) which are known for being critical.

Sufficiently long sea level time series are available for critical areas.

Figure 9.10: National Maerographic Network[18]

[16] Source: Lionello e Sanna, 2005
[17] Source: Lionello et al., 2006
[18] Source: ISPRA

The analysis of long-term sea level variability (Figure 9.11) can only be observed in Genova and in the Northern Adriatic, where both Marina di Ravenna and Venice, show behaviour mainly dominated by subsidence phenomena. These are induced by natural gas and water extraction activities in coastal alluvial plains. Trieste is not affected by this undesired influence. Between 1880 and 2000, both Genova and Trieste show a sea level variation trend of 1.2-1.3 mm/year, which is close to current global assessments.

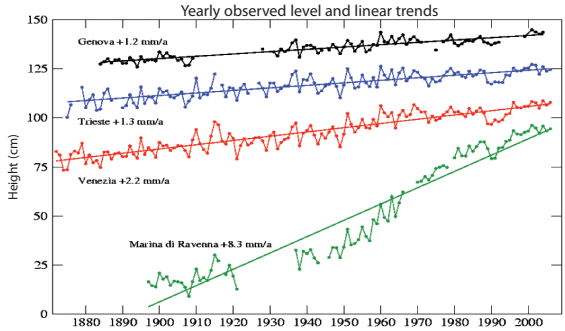


Figure 9.11: Italian historical time series[19]

Subsidence phenomena are found in the Northern Adriatic.

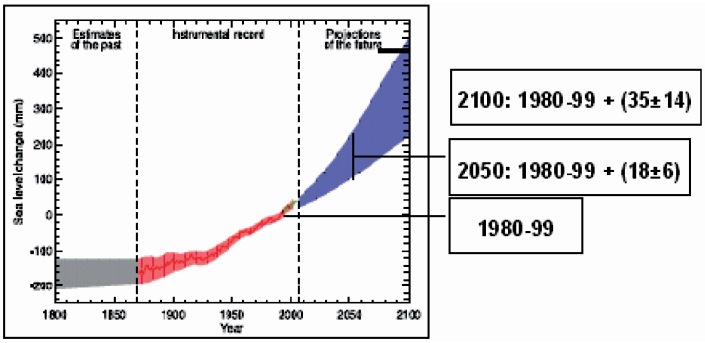


Figure 9.12: Increase in average sea level of the Mediterranean according to IPCC, 2007[20]

The IPCC estimates that the average level of the Mediterranean will increase by about 35 cm in the next 100 years.

[19] Source: F. Raicich, WS CNCC 2007, Palermo
[20] Source: F. Raicich, WS CNCC 2007, Palermo

Mareographic observations enable the interpretation of past sea levels extrapolating future trends, provided that current climate trends are stable.

Considering the current limits in assessing variability of residual tide on a yearly and ten-year scale, mareographic observations provide tools for analysing and interpreting past sea levels and make it possible, in principle, to extrapolate results and compare them with periods for which sufficiently long time series are available. However, these results are only valid if current trends are stable and there are no climate changes, the effects of which can only be considered with the application of specific and adequate simulation models whose performances can be assessed only by comparing mareographic data available.

In order to plan adequate coast management activities on a multi-decadal scale the current uncertainties need to be drastically reduced. This can be done by producing a series of reliable simulations with models that, starting from a global scale and through a regional one focused on the Mediterranean, reproduce characteristics with sufficient details that enable the realistic calculation of wave and sea level climatology, with a sufficiently wide interval of forcing factors and their time and space variability. This is crucial for extreme events which substantially influence the assessment of risks related to erosion and flooding of coastal areas. Indeed, for extreme events considering trends and significant variations is particularly difficult.

The potential flow of sediment through rivers strongly depends on how and to what extent the society manages the territory (building speculation, deforestation, hydraulic works, farming practices, etc.). However, it also depends on the impact climate change has on the statistical distribution of rainfall not only with regard to average quantities but also, and especially, with regard to fluctuations which can cause important variations in the erosion potential of precipitation.

In order to make an (at least qualitative) assessment of erosion changes (caused by climate change) in various areas of Italy and therefore evaluate the impact on coast balance it would be advisable to use simulations of 20th Century climate models and 21st Century forecasts/scenarios, after having applied appropriate rainfall space and time downscaling techniques focusing (for example) on potential erosion changes.

This new work would have a great impact and could produce a complete map of Italy. Analysing the performance of the above models would also require the activation of a national programme for the measurement of solid and liquid flows through rivers, which would provide sufficiently uniform and long time series.

Action

Over the last decades, the increase in coast erosion phenomena and the expansion of areas subject to flooding have led to conditions of emergency which required the realization of protection works. Often, these have not resolved the problem in the medium and long-term and in many cases they have contributed to degrading the coastal and marine habitat. In the last ten years, authorities have decided to recover coastlines by means of beach renourishment interventions, using sand from land and marine quarries, either soft or protected by hard structures. However, reducing the vulnerability of Italian coasts with indiscriminate protection interventions along the 4,800 km of low sandy coast is not economically sustainable. Costs of interventions in this area, even limited to soft renourishment works only, are estimated around 1.5 and 2.0 billion Euro and involve a quantity of sediment between 150-200 million cubic metres.

A national plan is required in order to identify potential risk areas.

In view of the above, a national plan is required in order to identify potential risk areas. The plan should include more efficient solutions that can enable each specific region to adapt to climate change. It should also include the principle of giving up the contrast between land and sea and finding different ways in which residential and productive settlements can coexist in coastal areas in harmony with natural values and dynamics.

Responses.

Possible responses aimed at the protection of human life and properties can be generally summarized into three categories:

Retreat.

- Retreat: this does not involve any action to protect land from sea. The coastal area is abandoned and ecosystems either disappear or are transferred. This choice can be motivated

by the excessive economic or environmental impact of protections.

Protection.

- Protection: this provides for the realization of permanent protection structures (such as breakwaters) or softer solutions (such as the reconstruction of dunes, the introduction of stabilizing vegetation, renourishment works, etc.) in order to continue using the territory.

Accommodation.

- Accommodation: this implies that the population continues to use the area at risk without taking action on preventing erosion or flooding. This is done by constructing emergency protection structures, raising buildings, introducing forms of agricultural reconversion or fish farming.

Possible solutions to implement strategies.

Possible solutions to implement these strategies are:

- Withdrawal from areas respecting their natural evolution.
- Conservation and/or reconstruction of natural areas acting as a “soft” interface between land and sea, even by means of recovering the natural capacities of coastal sediment flow.

- Conservation and/or reconstruction of coastal dunes.
- Implementation of land planning strategies to avoid compromising the area further in terms of vulnerability (even by means of planning obligations).
- Continuation of the land-sea contrast favouring soft interventions (renourishment) rather than hard structures.
- Increase in the morphological resilience of emerged beach structures (dunes) and submerged ones (bars etc.).
- Regulations aimed at giving priority to coastal management plans with respect to municipal town plans and introduction of Strategic Environmental Assessment (SEA) when assessing coastal plans. Furthermore, the assessment system must be independent from the entity that is preparing it.

Regional Action Plan.

This implies a Regional Action Plan or even a plan at the sea basin scale. The plan should consider not only the impact of interventions in the area immediately next to it but also its interaction with the whole coastal system. It should be inspired by the principle that "interventions inducing erosion will no longer be funded". A national coordination system on coasts (research, monitoring, methodology, planning criteria, etc.) is also necessary in order that those operating at local level are not isolated from the general system.

Implementation of EC Recommendation on ICZM.

In view of the above, the implementation of the EC Recommendation on ICZM *(Recommendation of the European Parliament and of the Council, concerning the implementation of Integrated Coastal Zone Management in Europe* dated 30 May 2002) is even more urgent. National guidelines shared with local administrations and bodies in charge of planning need to be prepared. Interventions for the establishment of "Coast Plan" regulations are equally urgent in order to define its minimum extension on the basis of coast dynamics and not administrative criteria. The Coast Plan should have priority over municipal town plans and other planning instruments.

Regional initiatives

9 regions have implemented instruments extending to the entire coastline.

Out of 15 coastal regions, 9 of them have implemented instruments extending to the entire regional territory. Among these, 6 regions have a specific coastal protection plan and only Emilia Romagna and Marche have an approved integrated management plan of the coastal

strip. The other regions mainly have coastal protection intervention programmes and Regional Action Plans (POR), which are limited to defining a list of protection works to be carried out on short coastline stretches (Table 9.8, Figure 9.13).
The lack of guidelines and general policies at national level has determined the creation of plans of different legal nature (sectorial plans as per Law 183/89 and Legislative Decree 180/98; Landscape plans, Law 431/85, Legislative Decree 42/04), leading therefore to different methods of planning, compulsoriness and protection of the areas involved. However, a progressive acknowledgement of the principles of coastal integrated management is emerging, according to European Recommendation indications, and planning processes are speeding up.

Table 9.8: Regional coastal plans[21]

Region	Regional plan Type	Coastal protection plan period Status	ICZM Plan period Status	Protection interventions POR
Liguria	Yes Coastal Coordination Territorial Plan	yes 2000 approved		
Tuscany	Yes ICZM Plan for Hydrogeological Readjustment	yes 2004 published	yes	
Lazio			yes experimental	yes
Campania	Yes Erosion Transitional Plans			
Basilicata				
Calabria	Yes Hydrogeological Settlement Transitional Management (=Protection Plan)	yes 2005 approved Plan	yes 2006 editing –	yes Integrated Plan
Molise				yes
Abruzzo	Yes Organic Plan for vulnerable areas at risk	yes 2003 approved		yes
Marche	Yes ICZM Plan	yes 2005 approved	yes 2004 approved	yes
Emilia Romagna	Yes ICZM Plan	yes 1983 approved	yes 2005 approved	yes
Veneto				yes
Friuli Venezia Giulia				yes
Sardinia	Yes Landscape Regional Plan		yes experimental	yes
Sicily	Yes Hydrogeological Settlement Transitional Plan	yes 2004 editing		yes
Plans Total	**9**	**8**	**3**	**12**

[21] Source: Data of the coastal regions processed by ISPRA

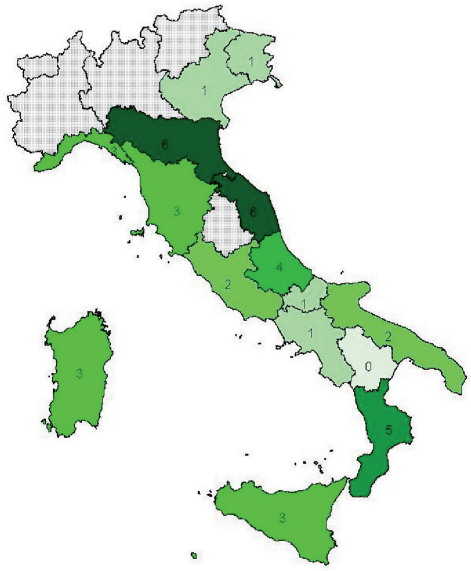


Figure 9.13: Regional planning activities[22]

Map indicating regional planning activities. The number was determined by assigning a weight to existing plans (regional, coastal protection, ICZM, POR). This was doubled if they are approved.

Liguria Region

Liguria Region. The Coastal Technical Plan of Liguria Region, first example in Italy, intends to guarantee a greater stability to the coastline mostly affected by erosion through a set of organic interventions based on:

- arrangement of drainage basins and riverbeds with sea outlet to re-establish a larger supply of sediment to the sea, eliminate any material extraction from watercourses, intervene on the catchment basins reactivating their sediment supply function to the watercourses;
- planning and organization of protection works and renourishment interventions following homogenous methods for single coastline strips, in consideration of the quality of coastline areas, climatic characteristics, landscape and their distinctive naturalistic features;
- intervention on tourist ports; recovery of coastline strips with the presence of Posidonia.

[22] Source: Data of the coastal regions processed by ISPRA

Tuscany Region

Tuscany Region. In 2001, the Region of Tuscany approved the Regional Plan project proposal of Integrated Coastal Zone Management for Hydrogeological Readjustment, enclosing a programme of priority interventions for coastline recovery and readjustment and a regional investment plan. The project refers to contents of European Recommendation dated 30/05/2002, which Tuscany was first in interpreting and turning into action. The proposed plan provides:

- research and analysis of coastal dynamics and conservation of its balance;
- economical development in accordance with principles of sustainable development;
- assurance of balance between natural environment and anthropised areas;
- upgrading of natural systems and safety of residential areas and facilities;
- redevelopment of coastal ecosystem integrity.

The framework of sectorial transition plans was then set up for each regional basin plan.

A Morphodynamic sedimentary plan is currently being prepared by the Arno Basin Authority. The general principle that the region has tried to adopt is to define a "tolerance strip" for coastline variation, beyond which controlled renourishment interventions are activated.

Lazio Region

Lazio Region. The Regional plan for the Protection of Lazio Region Coastline places the attention on:

- coastal dynamics;
- coastal protection systems adopted on Lazio coastline;
- natural resources;
- legal aspects and jurisdiction;
- planning activities programme for 2002/2003/2004.

Regional law 53/1998 has introduced interesting innovations, preliminary to the Coastal Plan project. These establish that coastal protection works should be based on:

- protection of residential areas and relevant coastal facilities;
- limitation of erosion processes and re-establishment of the shores even through artificial renourishment;

- re-naturalization of the coastal strip, protection and re-establishment of coastal dunes.

The Coastal Regional Observatory was established for coastal monitoring, with the task of examining coastal dynamics and monitoring of interventions.
Since 1991, a research for marine sand quarries has been set up. On this issue Lazio region has promoted the project BEACHMED "Environmental recovery and conservation of eroding coastline utilizing marine sand deposits" and BEACHMED-e with the goal of further developing the issues already dealt with in the previous project.

Campania Region

Campania Region. The activities of the four Basin Authorities are coordinated within Campania Region under one specific project, extended also to the underwater relief sector (CARG Project). However, the situation continues to be very fragmented despite the region's attempt to coordinate the initiatives of Basin Authorities (BA) under a joint activity.
The Coastal erosion transitional plan for the Southern strip is already at the implementation stage (BA Left Sele).
A preliminary research on the Central strip of Campania coastline is in due course both for the shores and for the collapse of the ridges (BA Right Sele).
The Northern strip of the coastline (BA Liri GV) is under research and the Erosion Plan is currently being edited.

Calabria Region

Calabria Region. A progressive acknowledgement of the ICZM principles can be seen. As a matter of fact, after having dealt with the coastal erosion problem within the scope of the Hydrogeological Settlement Sectorial Plan (adopting an initial risk analysis methodology), the region is now preparing to draw up an integrated management plan. The plan considers previous action as one of the elements functional to the construction of a broader conceptual plan.

Basilicata Region

Basilicata Region. The region has started a series of studies aimed at coordinating basin planning (with specific regard to the flow of river sediment, the extraction of gravel from riverbeds and the management of dam basin sediments) with coastal planning processes providing safeguard and conservation interventions for

the protection of the coastline, as well as actions directed to the re-establishment of the filling capacity of dams and the reactivation of the downstream sediment flows.
The following priority research activities were identified: erodibility characteristics of drainage basin soils and characteristics of sediment flows through rivers; related changes induced by natural phenomena and by the utilization of water resources; filling of dam basins; marine weather conditions to which shore sections are exposed.
Such activities will be conducted through the activation of monitoring systems of sediment flows, wave motion and evolving coastline trends.

Apulia Region

Apulia Region. Within the framework of the Apulia POR for the 2000-2006 period, the region provided for monitoring activities on the coastal protection interventions already performed and on coastal morphological evolution.
In July 2006, the Regional Council (implementing Regional law no. 17 of 23 June 2006, "Coastal protection and use regulations") took actions to regulate and plan coastal use. The following provisions were decided:

- Short-term provisions: to protect and safeguard the environment and permit accessibility and right for everyone to use maritime State property and territorial sea, simplifying administrative action and integrating the Public Authorities;
- Medium-term provisions: to draw up the Coastal Regional Plan (PRC) in order to regulate coastal activities and interventions. The PRC, in fact, must indicate: the state of Apulia's coastline; the existing facilities; the degree of utilization and anthropisation; the geological and hydrological risks as well as instability and criticality phenomena in general. Moreover, the PRC must be supplied with Technical Implementation Regulations, in order to provide certain rules in the management of the coastal territory and in processes and procedures for issuance of maritime State property authorizations, that have been missing so far;
- "in the long term", constitute the Coastal Regional Observatory, as a permanent structure for the control and integrated management of the coastal territory.

Molise Region

Molise Region. The region has established an agreement for coastal research with Molise University. The Basin Authority, in charge of a 31-km coastline, is drawing up the Integrated Coastal Management Plan.

Abruzzo Region

Abruzzo Region. Abruzzo was among the first Italian regions to acknowledge the importance of an integrated and sustainable management of the coastal strip, highlighting the possibility of promoting and supporting the development and management of an integrated process. In 1997, Abruzzo obtained from the EU the joint funding of RICAMA project (*Rational for Integrated Coastal Area Management*), within the framework of the LIFE programme. The RICAMA project is intended to respond to the needs of defining and employing new methodological and organizational tools to face the widespread coastal erosion, worsened by inadequate facilities and by a chaotic urban development. SICORA (Informative Support for Abruzzo Region Coastal area management) project was subsequently prepared and aimed at setting up a Decision Support System (DSS), operating constantly, which will enable the launching and development of the governance process of the coastal area, so that Public Authorities may supply effective and convincing answers in a short time.
Initially, the monitoring of vulnerable areas was carried out, followed by a feasibility study of protection interventions and management of the coastline strip on a regional scale. An organized plan was then prepared to evaluate the risk of vulnerable areas. Geomorphological and socio-economic risk levels have priority on interventions, even through coordination with neighbouring regions.

Marche Region

Marche Region. The Integrated Management Plan for Coastal areas, approved on 2/02/05, defines the following goals, actions and interventions:

a) renourishment and protection of the coastline from marine erosion;
b) optimization of marine works for the protection of the railway line, even through the reutilization of relict breakwaters;
c) harmonization of public use with tourism activities and recreational development of the coastal area;

d) protection and enhancement of coastal strips (both above and below sea-level) having a landscape, naturalistic and environmental value;
e) monitoring of coastline dynamics, waters and botanical ecosystem;
f) coordination with neighbouring regions.

The following elements were also identified: priorities of interventions on the basis of economical and environmental macro-indicators, reorganization of marine works and impact of ports and piers.

Emilia Romagna Region

Emilia Romagna Region. This region has been facing the problem of coastal protection for many years, analysing the causes that have determined a retreating of the coastline and marine transgression, issuing new laws to contrast these phenomena and applying innovative systems on environmental protection. The main research and analysis tools are:

1) Regional Plan for coastal protection, drawn up in 1981 and approved by the region in 1983;
2) Project Plan for sea protection and coastal environmental upgrading, drawn up in 1996;
3) Document entitled "*Stato del Litorale romagnolo all'anno 2000*" (Emilia Romagna coastline conditions in 2000) edited by ARPA Emilia Romagna.

In addition, Guidelines for an Integrated Coastal Zone Management (ICZM) have been drawn up. This project provides for the establishment of:

- coastal data bank;
- coastline evolution and morphodynamic c cartography;
- DTM of the coastline through LIDAR;
- infrastructures catalogue;
- sand grain size distribution;
- integrated digital terrain model;
- relation between subsidence and marine transgression;
- historical analysis of main sea storms;
- danger and risk documents.

Veneto Region

Veneto Region. Regional law 34/86 allocated to the coast consistent funds for intervention and research. In particular, the coastal

evolutionary processes were studied in three macro-areas (Piave - Tagliamento, Lagoon – the Po Delta and Brenta - Adige). In the lagoon area, research was also carried out by the Venice Water Authority. The Waters Protection Plan regulates extraction activities in areas subject to subsidence, where embankments have been constructed for coastal protection. As regards subsidence and eustasy, there are existing projects by CNR/ISMAR aimed at the Northern Adriatic sea. With reference to subsidence problems related to underground gas extraction, specific research has been conducted by AGIP.

Friuli Venezia Giulia Region

Friuli Venezia Giulia Region. As per Regional Law no. 16 of 3/07/2002, the region carries out coastal protection tasks through the regional services specialized in hydraulics and navigation. These are supported by ARPA Friuli Venezia Giulia. There are no plans or specific programmes.

Sardinia Region

Sardinia Region. The coastal erosion problem was included in the regional programme for the fight against desertification. Sardinia has actively taken part in carrying out the EUROSION project with the Coastal Erosion Information System of Cagliari University and a good level of research and risk evaluations.

Sicily Region

Sicily Region. In the 70's and 80's, following the substantial urbanization of the coastal strip, more widespread erosion took place along the entire coastline.
The only opposing action to this phenomenon was the construction of barriers above sea level and groins, which have protected the area lying immediately behind and shifted downstream the erosion phenomenon.
A new approach to coastal protection planning was started in 2000, both with the enforcement of the Environmental Impact Evaluation regulations and with the "Coastal area integrated protection" measure within the framework of the 2000-2006 Sicily POR, containing priorities in areas to be protected and the type of projects to adopt.
Sicily Region is preparing a Hydrogeological Settlement Plan (PAI) aimed at coastal protection and based on only twenty-one small territorial domains (physiographic units).

European Initiatives

Strategic projects for adapting coastal areas to climate change have been drawn up in Great Britain, France, Spain, Belgium and Holland.
In some of these countries, national projects and programmes on coastal conditions have been launched since 1980. The aim is to first of all provide basic knowledge and make it available to the whole country, secondly to develop instruments and methods to forecast scenarios and, lastly, to decide and apply adaptation options in a homogenous manner. Even if coastal planning tools are decentralized, like in Italy, there are common criteria, methods and guidelines that originate from national levels and are agreed among the players involved and the local authorities.
Significant experiences were analysed in order to observe how different countries follow different approaches to face climate change impact risks.

Belgium

Belgium. The Belgian part of the Northern Sea has been the subject of extended interdisciplinary research funded by the Ministry concerned and carried out by the Planning Federal Office, in charge of implementing a global national plan for the sustainable development of the coastal environment. The concept of sustainability has been introduced in Belgian legislation since 1999 (Sea protection law). Funded projects concern the climatic change impact and the most adequate responses in terms of adaptation. Primary impacts are the sea level rise, increase in number of storms, likely increase in rainfall, erosion, temperature changes, salinity, etc.

Spain

Spain. Spain has recently given the go-ahead to a national adaptation plan under the responsibility of the Oficina Española de Cambio Climático. This institute, operating under the Ministry of Environment, coordinates the participation of the different levels of local government and social parties. The Institute suggests operating programmes to the Climate Change Coordination Committee, which establishes action with the aim of implementing adaptation policies in Spain. The national plan faces many issues like industry, tourism, transport, ecosystems and fishing, deser-

tification, health, coastal areas, agriculture etc., and is aimed at the creation of national cartography to establish risks and impacts related to various scenarios. The projects provide for the involvement of experts, national institutions and private parties. Moreover, in 2003, Spain gave the go-ahead to the ECCE project (Climate change effect in Spain) with the purpose of integrating and updating current research on climate change in the country and deepening knowledge on the country's conditions.

Holland

Holland. The adaptation plan promoted by the Dutch government is part of a national programme for the scientific evaluation and analysis of the climate change policy. This programme has the purpose of collecting and analysing the current scientific knowledge of the sector, required to develop policies and implement action in this field. Adjustment priorities determined for the Dutch coastline, starting from 2005, indicate that the choice of implementing structural protection interventions is very costly, therefore specific action oriented towards the improvement of resilience of coastal contexts has been examined. The dunes and wet areas are considered fundamental elements to fight coastal floods and salt intrusion. Lastly, great attention is directed to the monitoring of climate change impacts and the natural environment response.

England

England. Since the mid 80's, the United Kingdom started national programmes on evaluation and mitigation of coastal vulnerability. During the same time, programmes at different government levels were set in motion to support the development of strategies and policies on climate change. Many institutions are involved in supporting or carrying out climate change adjustment policies. Among there are: *Office of Climate Change* (OCC) and DEFRA (*Department for the Environment, Food and Rural Affairs*). DEFRA, which holds the global political responsibility for flood and coastal erosion risks in England, ensures that the risk is efficiently managed by the competent authorities. It also issues guidelines aimed at this purpose.
The basic principle is that damages caused by floods and coastal erosion can be reduced and managing the risk is possible by

means of careful planning of land use, suitable building projects, increased information and greater involvement of individuals and specialized organizations.

France

France. In France there are specific laws on the coastline. In 2001 ONERC (National Observatory on global warming due to climate change) was established to provide new adjustment and mitigation measures with the aim of preparing territorial climate plans, which also provide for long term impact evaluations. Since 2004, numerous scientific programmes have been started to acquire the necessary knowledge for such plans. However, over the last few years, a new awareness is growing among local communities, which tend to leave the coastline free from urbanization and limit the excessive impact.